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The Impact of Narrative Expressive Writing on Heart Rate, Heart Rate Variability, and Blood Pressure Following Marital Separation

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Abstract

Objective—Divorce is a common stressor that is associated with increased risk for poor long-term physical and mental health. Using an experimental design, the current study examined the impact of expressive writing (EW) on average heart rate (HR), heart rate variability (HRV), and blood pressure (BP) 7.5 months later.

Methods—Participants from a community sample of recently separated adults (N=109) were assigned to one of three conditions, traditional EW, narrative EW, or a control writing condition, and assessed three times over an average of 7.5 months. Each study visit included 27 minutes of physiological assessment; the primary outcomes at each assessment were mean-level HR, HRV, BP scores averaged across six different tasks.

Results—Participants in the traditional EW condition did not significantly differ from control participants in their later HR, HRV, or BP. However, relative to control participants,those in the narrative EW condition had significantly lower HR, B = -3.38, 95% CI [-5.48, -1.23], p = .002, and higher HRV 7.5 months later, B = 0.34, 95% CI [0.15, 0.53], p < .001. These effects were moderately sized, Cohen's ds = -0.61 and 0.60, respectively, and durable across all task conditions when analyzed in independent models.The writing condition groups did not differ in their later BP.

Conclusions—Narrative EW decreased HR and increased HRV following marital separation, but did not affect BP. We discuss the possible disconnect between psychology and physiology in response to EW, as well as possible future clinical applications following marital separation.

Keywords

Heart rate variability; respiratory sinus arrhythmia; heart rate; blood pressure; divorce; expressive writing

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Conflict of interest The authors have no conflicts of interest to declare.

INTRODUCTION

Divorce is a common stressor that is linked to a range of psychological problems including loneliness (1), and decreases in happiness and life satisfaction (2). Divorce also is associated with a variety of physiological and health-related outcomes, including susceptibility to illness (3) and broad-based morbidity and mortality (4-5). Despite these established associations, relatively few published studies have explored interventions designed to improve divorcing adults' psychological and physical health. Rye and colleagues (6) created and tested an intervention focused on forgiveness, which increased participants' wellbeing, lowered their depressive symptoms, and resulted in less trait and state anger (7). More recently, Sbarra and colleagues (8) examined whether expressive writing (EW) would improve participants' psychological functioning after marital separation, but found no main effect for EW and an iatrogenic effect of EW among participants who reported a high degree of trait-like psychological rumination. However, no prior experimental studies have assessed cardiovascular outcomes among recently-separated adults. In the context of risk for poorer physical health following divorce, it is essential to identify whether psychological interventions can alter health-relevant physiology. The current study reanalyzes data from Sbarra and colleagues' EW intervention study (8), focusing specifically on changes in heart rate (HR), heart rate variability (HRV), and blood pressure (BP).

Divorce and Cardiovascular Activity

Although mechanistic accounts of precisely how marital dissolution might affect distal health are lacking (9), cardiovascular functioning is one biological system through which separation and divorce may exert their impact. Divorced adults have lower resting HRV compared to married adults (10), and lower resting HRV is associated in a dose-response fashion with increased risk of a cardiovascular event among people without cardiovascular disease (11). Beyond HRV, no studies have examined heart rate (HR), which is also an independent predictor of morbidity and mortality, especially among people with pre-clinical disease (12-13), following marital separation; including this construct as an outcome measure will be an informative addition to the literature in this area. Divorcing adults who report more separation-related emotional distress also have higher resting blood pressure (14), and recently-separated adults who report greater sleep disturbances evidenced increases in resting blood pressure over time (15). Prior studies have also investigated cardiovascular reactivity following marital separation—e.g., the prospective recent evidence suggests that the association between divorce-specific BP reactivity and divorce-related subjective distress depends on variability in HRV at a given occasion (16; also see 14, 33). The general finding from this work is that divorce-related psychological distress is associated with greater within-occasion cardiovascular reactivity.

In the current report, we take a different approach to investigating cardiovascular activity over time. Rather than studying reactivity to a specific laboratory challenge task or the psychosocial predictors of resting levels, we explore changes in mean levels of cardiovascular activity over time, averaging across all study epochs within each assessment. Given the prior research in this area, we explore the hypothesis that EW promotes mean-level changes in cardiovascular activity by mitigating the acute and potentially chronic stress associated with marital dissolution, and these changes can be observed across all laboratory tasks. Given the manifold associations between our indices of cardiovascular activity (i.e., mean-level BP, HR, and HRV) and both morbidity and mortality (e.g., 11,17), support for our hypothesis concerning mean-level change in cardiovasclar activity would be an important contribution for helping adults cope with the end of marriage.

Expressive Writing (EW)

Expressive writing (EW) is a cognitive behavioral intervention in which people record their “deepest thoughts and feelings” about a stressful or traumatic life event over the course of several days. Developed by Pennebaker and colleagues (18-19), the EW paradigm promotes disclosure of emotional content to improve people’s ability to adapt cognitively and make meaning out of stressful life events. Overall, EW interventions show positive effects on psychological wellbeing (20-21) and can improve physiological functioning (22). In addition, there are generally stronger effects of EW on physical health rather than on psychological wellbeing in clinical populations (23). More specifically, people who complete EW have improved immune function (24), as a well as lower BP and HR, as well as higher HRV during baseline assessments over time (21,25).

Although EW improves wellbeing for people dealing with stressors (20), such as non-marital breakups (26), Sbarra and colleagues (8) found that EW yielded no main effects and, relative to a control condition, *increased* separation-related emotional distress among recently-separated people who reported a tendency toward high psychological rumination. In addition to the traditional expressive writing condition, this study developed and implemented a novel, narrative EW condition that was designed to capitalize on prior EW research that found that meaning-making and the creation of a narrative to a stressful event were important elements of improvement due to EW (27-29). Participants in this condition received the traditional EW instructions, which focused on asking people to express their strongest emotions around their separation experience, along with additional prompting to create a story arc of their separation experience and develop a coherent story of their painful experience. Whereas traditional EW focuses on expressing emotions, the narrative EW prompted participants to regulate their emotions during the task with the specific goal of creating a coherent narrative. Although this meaning-making process can result in long-term psychological benefits when recovering from social stressors like divorce (30), there were no differences in psychological distress between either of the EW conditions and the control condition in the original study (8).

Sbarra and colleagues’ (8) findings are interesting and clinically-meaningful (suggesting *some people* get worse when they engage in emotional writing), but they are ultimately incomplete. It is well known that physiology does not always match people’s reported experience (31-32), thus raising the possibility that EW might be inert or even iatrogenic for some people when examining their self-report, while also being potentially beneficial when it comes to mean-level cardiovascular activity over time.

The Present Study

To explore whether EW impacts changes in mean-level cardiovascular activity following marital separation, this paper used data from a sample of recently separated adults (*N*=109) assessed at three laboratory visits across 7.5 months. As reported in detail by Sbarra and colleagues (8), participants were randomized to either a traditional EW (*n* = 33), narrative EW (*n* = 38), or an active control writing condition (*n* = 38). EW is associated with subsequent declines in HR and BP (21), as well as increases in baseline HRV compared to control writing (25). Given these prior findings, it is reasonable to believe that participants' in the current study who were randomized to the expressive writing conditions would evidence lower mean-level HR, higher HRV, and lower BP over time. Alternatively, in this sample of recently separated adults, HR, HRV, and BP might follow the same iatrogenic pattern found by Sbarra and colleagues (8) in which high ruminators reported the worst outcomes when assigned to *either* EW condition. In the current report, we tested these two competing hypotheses in a series of multiple regressions examining participants' mean-level cardiovascular activity in the months following the EW intervention, both aggregated across study visit, as well as independently by task condition.

Method

Participants

In the current study, 109 recently separated adults (*n* = 39 men) who reported recently experiencing a marital separation (mean time since separation = 3.8 months), with an average length of marriage of 13.7 years participated in an EW intervention study. As reported in Sbarra et al. (8), participants were recruited from 2006-2009 for a longitudinal sample with three assessments, the second of which occurred 3-months after their initial assessment. For the third assessment they were randomly assigned to complete their follow-up at either 6 or 9-months from T1; this sampling procedure was part of a planned missingness design (15). We refer to these assessment occasions as Time 1 (T1), T2, and T3, respectively, in the remainder of the paper. T3, the final assessment, represents outcomes reported, on average, 7.5 months after the initial assessment and EW intervention period. Of the 109 participants who completed the initial visit: 96 (88.1%) participated in the home visit, during which the intervention occurred for those in the EW group, 90 (82.6%) completed the first two assessments, and 79 (72.5%) completed all three assessments. Compared to people who completed all three assessments, people who did not complete the study were not significantly different in terms of how long they had been separated for (Cohen's *d* = -0.14), their age (*d* = -0.29), sex (*d* = 0.01), length of prior relationship (*d* = -0.09), self-reported separation distress (*d* = -0.43), as well as their mean T1 HR (*d* = 0.24), T1 HRV (*d* = -0.17), and T1 diastolic (*d* = -0.11) or systolic BP (*d* = -0.05). In addition, participants' characteristics (age, sex, lengths of prior relationship, time since separation, and minority status) did not differ significantly by EW condition.

Procedure

As reported in Sbarra et al. (8) and Sbarra and Borelli (33), adults who experienced a recent marital separation were recruited from the local community. Eligible participants physically separated from their partner within the past five months and cohabitated with their former partner for at least 2 years. The original CONSORT diagram for this study is reported in Sbarra et al. (8). The University of Arizona Institutional Review Board approved the study protocol. All participants signed an informed consent form prior to study participation.

Participants were informed the study's purpose was to understand "how adults adjust to marital separation and the ways in which your body responds when you reflect on your separation experience." 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 laboratory visits. In the laboratory participants completed a series of tasks outlined in Figure 1 during each of the three lab visits in a room that included physiological measurement devices.

Participants were first asked to sit without speaking and relax while watching a nature video in order to acclimate to the testing room, which provided baseline measurement. Following the video, participants engaged in a 5-minute serial subtraction math stressor task (31). During the task, participants were asked to pick a number then continuously subtract another number from that number. 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. Participants were then given a 3-minute recovery period, following which they engaged in a 4-minute mundane events recall, which is described in more detail in Sbarra and Borelli (33) and asked participants to reflect on a series of everyday life tasks (e.g., doing the laundry). Finally, participants completed a 7-minute divorce-related mental activation task (DMAT). 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 were provided during the DMAT related to the separation 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 DMAT, there was then a final 4-minute recovery period, after which the physiological equipment was removed.

As described in more detail by Sbarra and colleagues (8), participants were randomly assigned to one of three conditions, either traditional EW, narrative EW, or control writing, at the end of the first study visit. Participants completed their first assigned writing in the lab, then completed the second and third days of writing at home, and these three days of writing comprised the entirety of the EW intervention. Participants wrote by hand in diaries provided by the experimenters. The traditional EW condition instructed participants to write freely and continuously for 20 minutes about their strongest and deepest emotions surrounding their marital separation experience. Participants in the narrative EW condition were given similar instructions, but were also instructed to create a coherent and organized narrative of their separation experience in three parts. Day 1 involved telling the story of the end of their relationship, Day 2 involved narrating the separation experience, and Day 3 involved describing an end of the "divorce story." Participants in the control writing condition were asked to write for the same days and duration, but were asked to write continuously and without emotion about how they spend their time. The participants then completed the initial laboratory visit described above 3 months after their T1 assessment (T2) and 6 or 9 months later (T3).

Measures

Self-Report measures

Rumination: Rumination was measured by the Rumination Responses Scale (34). Composed of 22 items measuring how people respond to their depressed mood, this scale assesses the tendency to engage in perseveration about one's mood. Items include "I think 'What am I doing to deserve this?' and "I analyze my personality to try to understand why I am depressed', and are evaluated by a 4-point Likert Scale ranging from 1 (*almost never*) to 4 (*almost always*). (α = .94.)

Cardiovascular activity—As discussed in Sbarra and Borelli (33), 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 precordial 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 (IBI) signals was conducted using the MindWare Technologies HRV 2.60 application (www.Mindwaretech.com, Westerville, OH).

Heart Rate (HR), Heart Rate Variability (HRV), and Respiratory Rate (RR)—HR was calculated as beats per minute, and the arithmetic average for each study task was then calculated using these 1-minute epochs. These study task means were then used to average across tasks within each of the three visits to create a mean HR for each study assessment, with each task average contributing equally to the final study visit mean-level, regardless of each tasks total minutes of assessment. HRV was indexed using respiratory sinus-arrhythmia (RSA). RSA was calculated using frequency domain analyses as the natural log of the variance in the filtered interbeat interval time series associated with respiration (0.12-0.40 Hz) following the procedures outlined by Bernston and colleagues (36). This is a widely used and validated method for assessing RSA as an index of HRV and parasympathetic vagal influences on cardiac chronotropy more broadly (37). We also assessed respiration rate using the Biopac respiratory effort transducer and Mindware software HRV application to calculate respiratory rate (RR). One concern when analyzing RSA scores is that respiration rates outside the sampling range (approximately 7.2 breaths per minute) may no longer represent vagal influence on the heart. To account for this possibility, we ran all our analyses with missing data replacing any RSA scores at T1 or T3 for people with mean breathing rates below 7.2 breaths per minute (4 at T1; 2 and T3). Both RSA and RR were assessed over 1-minute epochs across 6 tasks, resulting in 27 minutes of total assessment at each study occasion. As with HR, these study task means were then averaged within each of the three visits to create a mean HR for each study assessment.

Blood Pressure (BP)—BP was assessed using a noninvasive tonometry device on the wrist covering the radial artery. The device was placed the device on participants' nondominant arm, and the device produces real time BP readings (Vasotrac AMP 205, Medwave Inc., Arden Hills, MN). Systolic BP measures the peak pressure present in the arteries during the start of the cardiac cycle, whereas diastolic BP measures the lowest pressure during the cycle. 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 averaged first across the tasks, then across the visits to create mean levels of SBP and DBP during each visit. We removed extreme BP scores (40 < DBP < 130; 80 < SBP < 200) as physiologically improbable.

Data Analysis

In the current study, participants' HR, HRV, and BP were assessed over 27 1-minute epochs across 6 tasks during each of three study visits. Mean scores for each task were computed individually using scores from their 1-minute epochs, and the task mean scores were then averaged across each study visit, resulting in mean scores for each visit across the 6 tasks for HR, HRV,RR, and BP. In addition, we were interested in testing whether experimental condition differences in HR, HRV, and BP depended on participants' self-reported rumination. As a result, our multiple regression models included experimental condition, T1 rumination, and a T1 Rumination × EW condition interaction as predictors of average T3 HR, HRV, and BP in independent models. All models also included average T3 RR and T1 HR, HRV, or BP respectively to account for respiration and baseline levels at T1[1]. We then conducted additional analyses using independent models for each study task to examine whether the effects were limited to the aggregate measures or could be observed across each type of study task.

Due to possible issues with multicollinearity, we mean-centered rumination scores at T1. In addition, to account for missing data in our models, we used full likelihood maximum likelihood (FIML) estimation the regression analyses. This method incorporates all available information from all participants with available data, and under conditions when data are missing at random, FIML produces unbiased estimates that outperform other missing data treatments, such as listwise deletion and similar response pattern imputation (37-38). In using FIML, we follow an intent-to-treat style methodology in which all available data are used to generate model parameter estimates (39). In cases where we were examining differences between specific conditions, we used a contrast coding system. Relevant conditions were coded as -1 and 1, whereas conditions omitted from the analysis were coded as 0, whereas we used dummy coding for the experimental condition(s) when comparing to the control condition (coded 1 and 0, respectively). Finally, we used robust ML estimation when running all regression models in MPLUS version 7.11 (40).

Results

Table 1 displays descriptive statistics and a correlation matrix of the main variables included in the study. We first tested whether there was a main effect of the EW intervention by collapsing both EW conditions into a single group, and comparing EW to the control

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[1] There were no significant differences in participants' characteristics by experimental condition, so we did not include these variables as covariates in our models. We did, however, test our models when including age, length of prior relationship, time since separation, membership in the 6 or 9-month follow-up, and whether the participant identified as a minority. All substantive results were replicated in these models.

participants. There were no main effects of intervention on either average T3 HR, *B* = -2.91 95% CI [-6.91, 1.10], *p* = .16, or T3 RSA, *B* = 0.43, 95% CI [-0.01, 0.86], *p* = .056. Similarly, there was no effect on either systolic, *B* = -2.79 95% CI [-12.07, 6.49], *p* = .556, or diastolic BP, *B* = -3.41 95% CI [-10.01, 3.20], *p* = .312. To explore the possibility that the group effects were conditional on self-reported rumination, we added the Rumination × EW condition interaction into the model after accounting for both main effects. The interaction was non-significant in all models, indicating that – for the indicators of cardiovascular activity studied here – the EW intervention does not appear to exert the same iatrogenic effect as observed with the self-reported outcomes.

Having failed to reject the null hypotheses for the (a) intervention versus control comparison, and (b) the Rumination × EW condition interaction effect, we next examined the differences between the EW groups to explore whether effects on HR, RSA, and BP were comparable between the traditional and narrative EW conditions. Participants in the narrative EW condition had significantly lower T3 HR, *B* = -3.38, 95% CI [-5.48, -1.23], *p* = .002, and higher T3 RSA, *B* = 0.34, 95% CI [0.15, 0.53], *p* < .001, compared to participants in the traditional EW condition, as well as lower T3 HR, *B* = -3.41, 95% CI [-5.76, -1.06], *p* = .004, and higher T3 RSA, *B* = 0.41, 95% CI [0.16, 0.67], *p* = .001, compared to participants in the control writing condition. There were, however, no differences in participants' systolic or diastolic BP between conditions, and this lack of significant differences was consistent across the different study tasks.

Based on the prior analyses with HR and HRV, we combined participants in the traditional EW and control conditions into a single group, then compared this combined group to the narrative EW condition. In this model, participants in the narrative EW had significantly lower average T3 HR, *B* = -7.05, 95% CI [-11.99, -3.30], *p* < .001, and higher T3 RSA, *B* = 0.79, 95% CI [0.42, 1.16], *p* < .001, than the combined traditional EW and control group[2]. The effects for HR and RSA were of moderate size, Cohen's *d* = -0.61, β = -0.29 for HR, and *d* = 0.60, β = 0.29 for RSA. The full results of this regression model are reported in Table 2 and the full raw HR and RSA means for each task across all three study occasions are presented in Figures 2 and 3. In contrast, there were no significant differences between the narrative EW and combined traditional EW and control group for either systolic, *B* = -4.95, 95% CI [-15.72, 5.82], *p* = .368, or diastolic BP *B* = -5.32, 95% CI [-13.83, 3.18], *p* = .220.

Given the current results for HR and HRV, we conducted a series of three additional analyses. First, it would be useful to know if RR changed differently over time by condition, similar to HR and RSA, which might account for some of the participants' change in HR and RSA the narrative EW condition. Participation in the narrative EW condition, however, did not significantly predict RR at T3, *B* = -0.26, 95% CI [-0.85, -1.38], *p* = .64, suggesting that the changes in HR and RSA were independent of changes in RR. Second, although we control for RR in our models, one concern is that our results emerged only with the inclusion

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[2] We also tested the outcomes after 3 months, at the T2 visit. The effects were in the same direction for narrative EW; lower T3 HR, *B* = -3.09, 95% CI [-6.32, 0.13], *p* = 0.060, and higher T3 RSA, *B* = 0.46, 95% CI [0.09, 0.83], *p* = 0.012, though the difference for HR was not significant at a .05 level. These results suggest the observed effects emerged over the course of the study, rather than only at the third study occasion.

of RR as a covariate. As a result, we ran our models without RR. All substantive results for HR and RSA were replicated in these models.

Finally, we tested the differences in HR and RSA during each study task at T3 independently using the same basic model, including adjusting for HR and RSA by task at T1. Within these models, we used task means rather than aggregated visit means to ensure the mean-level effect of increased HRV and decreased HR replicated across each individual task independently. Narrative EW had lower T3 HR and higher T3 RSA compared to traditional EW and control writing for every task. The results of these regression models for each task are reported in Table 3. Narrative, but not traditional, EW reduced participants' HR and increased HRV over the 7.5 months of study assessments across each study task, and the size of this effect was comparable across each task.There were no differences in these effects based on participants' self-reported rumination.

Discussion

In this study, 109 recently separated adults were randomized to either a traditional expressive writing (EW; $n = 33$), narrative EW ($n = 38$), or an active control writing condition ($n = 38$). Based on prior work suggesting that EW may have positive effects on cardiovascular activity (21,25), we evaluated the main effect of the intervention on mean-level HR, HRV, and BP. Following the findings of reported by Sbarra and colleagues (8), we also examined the possibility that EW would exert an iatrogenic effect (on these indicators)among people reporting a high degree of psychological rumination. We found no evidence for the iatrogenic effect and strong evidence for a positive main effect of *narrative* EW on HR and HRV relative to both the traditional EW and the control writing conditions. Compared to traditional EW and control participants, people assigned to narrative EW condition had significantly lower mean-level HR and higher mean-level HRV after 7.5 months, and these effects were of moderate size, $d = -0.61$ and 0.60, respectively. Importantly, when run in independent models, these effects were observed across all laboratory tasks for a given assessment period. We found no evidence for a significant effect of EW condition on mean-level BP.

On one hand, the results fit well with prior reports of positive effects of EW on HR and HRV (21). For example, McGuire and colleagues (25) reported that those participants with high blood pressure who completed EW had relatively higher later HRV compared to controls. Our findings extend this work to HR and HRV following a marital separation and provide a longitudinal assessment of post-intervention outcomes. In the EW writing literature, few papers track participants' outcomes beyond six months, and our study provides evidence for a durable main effect of narrative EW on both HR and HRV. On the other hand, in contrast to the existing EW physiology literature, we find no main effect benefit for traditional EW on the mean-level cardiovascular outcomes. Only the narrative expressive writing condition, in which participants were prompted to create a story and make meaning out of their painful experience, lowered HR and increased HRV relative to control writing. These results are consistent with other accounts of EW in which the narrative elements of the intervention were important for recovery following trauma and social disruption when using EW (27-30). Undergraduate students who were asked to engage in traditional EW, narrative EW or a control writing task and had higher levels of narrative structure, for example, yielded positive gains in terms of their psychological wellbeing (41).

It is notable that the narrative EW effects on HR and HRV were not restricted to a single paradigm or task. As shown in Figures 2 and 3, and reported in Table 3, these effects held across the full range of tasks at the third study occasion when evaluated in independent regression models. The outcome variables assessed *average* HR and HRV within each task, including a resting baseline period, a mundane event recall task, a general math stressor task, a divorce-related mental activation task, and a recovery period for the math and divorce stressor tasks. We believe the broad, consistent nature of the effects across these varied tasks is a unique strength of our analytic approach and lends confidence to the argument that the longitudinal differences are not due to an outlier effect of a single task, but generalize to mean-level HR and HRV during baseline, challenge, and recovery from challenge.

It is also important to understand the results for HR and HRV in the context ofthe null findings for BP. Although acute decreases in HR might be expected to lead to acute decreases within subject in BP, these mean-level decreases in HR and increases in HRV were not associated with concomitantly lower BP. The current study does not include all the necessary measures to examine the degree to which the precise sympathetic and parasympathetic physiological processes are differentially affecting HR and HRV but not BP. The results indicate that the benefits from narrative EW to cardiac vagal control and heart rate and do not necessarily extend to vascular dimensions of the broader cardiovascular response.

The implications of these results are twofold. First, to the extent that the physiological differences observed here are associated with clinically-relevant end-points, narrative EW might be one way of reducing the long-term health risk associated marital separation and divorce. The process of creating meaning following a stressful event is associated with positive psychological outcomes (30), and these processes may protect divorcing adults from the development of chronic stress, and ultimately be reflected in cardiovascular function that benefits longer-term health. For example, tonic differences in resting HR are associated with poorer health in the long-term, including the progression of coronary atherosclerosis, myocardial ischemia, and ventricular arrhythmias (42). In addition, resting differences in HR and HRV can predict increased mortality and cardiovascular events (11,17).

Second, it is important to understand the findings in the context of differences between self-reported psychological wellbeing and the cardiovascular outcomes (in this case HR and HRV) following divorce. Although people reporting a tendency toward high degrees of rumination may experience increased distress as a result of their EW (8), this effect appears independent of the physiological main effect observed for narrative EW (relative to traditional EW and control writing). Importantly, further examiniation of the original results reported by Sbarra et al. (8) suggest that the iatrogenic effects of EW on wellbeing for high ruminators was limited to the traditional EW condition, with no iatrogenic effect on wellbeing for people in the narrative EW[3]. Int this way, the current findings are not inconsistent with those reported in the prior paper from this intervention study.

The results of the current study should be considered in light of its limitations. First, this study reports the results of a reanalysis of data collected during a prior intervention. Although our hypotheses were derived *a priori*, they were not the orignal aims of the intervention and this may increase the possibility our results are due to chance. Second, our study had a moderate level of dropout (27.5%) over the three study occasions. Although we used FIML to account for missing data in an intent-to-treat style, it is possible that differential attrition may have biased the study's results. Third, the results of the current study were drawn from a community sample in southern Arizona and had a larger proportion of women than men (64% women). It is possible that these results may not generalize to people facing marital separation in other populations.

Conclusions

In a reanalysis of data from a prior intervention with recently-separated adults (8), we found that narrative EW caused reductions in HR and increases HRV over 7.5 months compared to tradtional EW and an active writing control. There were no differences in BP results by condition. Although prior analyses with this sample observed iatrogenic effects for EW on self-reported outcomes for people high in psychological rumination, the current results do not suggest this effect carries over to cadiovascular outcomes. Instead, narrative EW appears to have a salubrious effect on long-term changes in HR and HRV. If replicated, the results suggest that instructing participants to create a coherent narrative of their separation experience is one efficacious intervention for improving adults' mean-level cardiovascular activity over time. Furthermore, these results may suggest one avenue through which the risk for long-term poorer health following divorce is attenuated, though more research is needed to establish whether these differences translate to meaningful clinical outcomes.

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[3] The simple slopes for the main effect of rumination predicting psychological recovery following divorce for each of the three condition was: control writing ($\beta = -0.01$, $p = .978$), traditional EW ($\beta = -0.66$, $p < .001$), and narrative EW ($\beta = 0.17$, $p = .267$). Narrative EW does not show the iatrogenic effect of rumination on psychological wellbeing by condition, suggesting that the results were driven by traditional EW

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Abbreviations

EW	Expressive writing
HR	heart rate
HRV	heart rate variability
RR	respiration rate
BP	blood pressure
RSA	respiratory-sinus arrhythmia
FIML	full likelihood maximum likelihood
T1	time 1
T2	time 2
T3	time 3

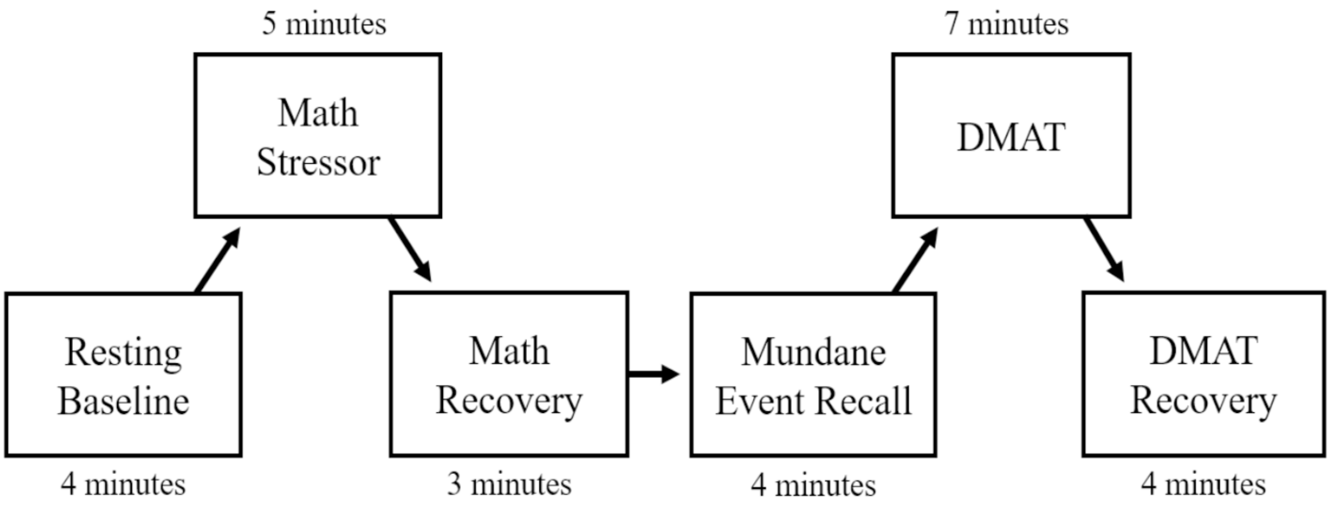

Figure 1.

The laboratory procedure tasks that participants completed at all three study visits. The Math stressor and DMAT tasks are placed higher to represent that they are conceptualized as stressful tasks. DMAT = Divorce-related mental activation task.

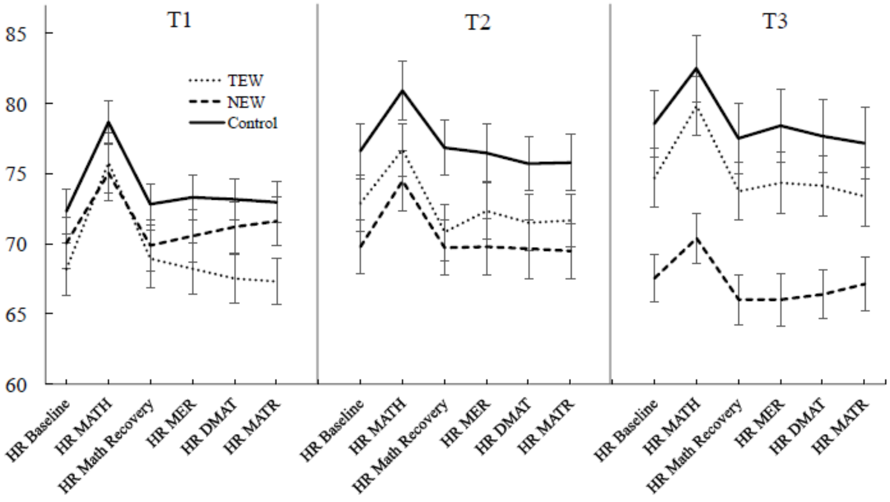

Figure 2.

Visualization of participants' mean raw scores for heart rate across all tasks at each visit occasion for traditional EW (TEW), narrative EW (NEW), and control writing. Error bars illustrate one standard error around each estimate. MER = Mundane event recall, MATR = DMAT recovery.

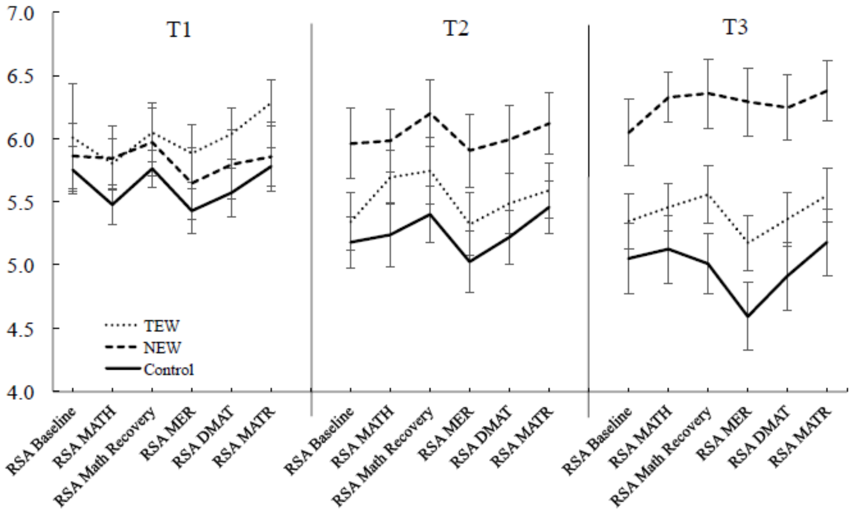

Figure 3.

Visualization of participants’ mean raw scores for heart rate variability across all tasks at each visit occasion for traditional EW (TEW), narrative EW (NEW), and control writing. Error bars illustrate one standard error around each estimate. MER = Mundane event recall, MATR = DMAT recovery.

Table 1

Demographics and Correlation Table for Study Variables

Variables	1	2	3	4	5	6
T1 HR (1)	1.0					
T1 RSA (2)	-0.58 *	1.0				
T1 Rumination (3)	-0.25 *	-0.11	1.0			
T3 HR (4)	0.63 *	-0.37 *	-0.08	1.0		
T3 RSA (5)	-0.43 *	0.74 *	0.03	-0.65 *	1.0	
T3 RR (6)	0.00	-0.10	0.05	-0.07	-0.12	1.0
Mean	71.68	5.91	2.05	74.00	5.56	13.02
SD	9.91	1.25	0.53	11.66	2.89	1.32

Note: All values used full-information maximum likelihood for missing data.

T1 = time 1, T3 = time 3, HR = heart rate, RSA = respiratory-sinus arrhythmia, RR = respiratory rate. $N = 109$.

* = $p < .05$

Table 2

Unstandardized Coefficients from Regression Models Predicting HR and HRV

	***N*=109**		***N*=71**		***N*=76**		***N*=71**		***N***	**=109**
	EW vs. Control		NEW vs. TEW		NEW vs. Control		TEW vs. Control		NEW vs. TEW + Control	
Outcome: T3 HR	*B*	95% CI	*B*	95% CI	*B*	95% CI	*B*	95% CI	*B*	95% CI
Intercept	23.98**	[5.76, 42.19]	16.67	[-1.60, 34.93]	22.71**	[4.50, 42.19]	19.27*	[0.79, 37.76]	22.25*	[4.33, 40.17]
T1 HR	0.78**	[0.59, 0.96]	0.81**	[0.62, 0.99]	0.74**	[0.57, 0.92]	0.82**	[0.63, 1.00]	0.76**	[0.59, 0.93]
T3 RR	-0.24	[-1.15, 0.66]	-0.03	[-0.85, 0.79]	-0.13	[-1.15, 0.80]	-0.25	[-1.09, 0.59]	-0.02	[-0.89, 0.85]
EW Condition	-2.91	[-6.91, 1.10]	-3.38**	[-5.48, -1.28]	-3.41**	[-5.76, -1.06]	0.17	[-1.99, 2.32]	-7.05**	[-10.81, -3.30]
Rumination	2.67	[-1.62, 6.95]	1.77	[-1.35, 4.90]	2.09	[-1.00, 5.18]	2.34	[-0.95, 5.63]	1.81	[-1.88, 5.50]
Rumination × EW	-0.38	[-6.94, 5.74]	0.75	[-3.07, 4.57]	-0.59	[-4.12, 2.92]	-0.11	[-3.70, 3.49]	-0.13	[-6.31, 6.05]
	EW vs. Control		NEW vs. TEW		NEW vs. Control		TEW vs. Control		NEW vs. TEW + Control	
Outcome: T3 HRV	*B*	95% CI	*B*	95% CI	*B*	95% CI	*B*	95% CI	*B*	95% CI
Intercept	0.76	[-0.55, 2.07]	1.30	[-0.03, 2.62]	1.49*	[0.06, 2.92]	0.76	[-0.57, 2.08]	1.35*	[0.02, 2.68]
T1 HRV	0.82**	[0.67, 0.96]	0.83**	[0.15, 0.97]	0.78**	[0.63, 0.93]	0.86**	[0.71, 1.00]	0.79**	[0.63, 0.94]
T3 RR	-0.02	[-0.09, 0.06]	-0.04	[-0.12, 0.03]	-0.03	[-0.11, 0.07]	-0.01	[-0.09, 0.06]	-0.05	[-0.12, 0.03]
EW Condition	0.43	[-0.01, 0.86]	0.34**	[0.15, 0.86]	0.41**	[0.16, 0.74]	0.05	[-0.18, 0.29]	0.79**	[0.42, 1.28]
Rumination	0.01	[-0.51, 0.52]	-0.09	[-0.40, 0.22]	-0.16	[-0.49, 0.17]	-0.17	[-0.52, 0.17]	-0.09	[-0.49, 0.32]
Rumination × EW	-0.30	[-0.99, 0.40]	0.00	[-0.39, 0.39]	-0.08	[-0.46, 0.30]	-0.21	[-0.62, 0.20]	-0.08	[-0.69, 0.53]

Note: 95% CI = 95% confidence interval. NEW = narrative expressive writing, TEW = traditional expressive writing, control = control condition. T1 = time 1, T3 = time 3, HR = heart rate, HRV = heart rate variability, EW = expressive writing condition. The EW vs. Control and NEW vs. TEW + Control comparisons were dummy coded with the first condition coded as 1, the second variable coded 0, whereas the remaining comparisons were contrast coded, with the first variable coded as 1, the comparison as -1, and the excluded condition as 0.

* $p < .05$.

** $p < .01$.

Table 3

Main effects of condition (narrative EW compared to traditional EW and control) predicting HR and HRV at the final assessment for each study task independently

***N*=109**	**T3 HR**		**T3 HRV**	
Task	***B***	***p***	***B***	***p***
Baseline	-6.56	.001	0.68	.003
Math stressor	-7.09	<.001	0.47	.003
Math stressor recovery	-6.29	.001	0.75	<.001
Mundane events recall	-8.21	<.001	1.09	<.001
DMAT	-7.91	<.001	0.92	<.001
DMAT recovery	-6.52	<.001	0.92	<.001

Note: Results reported here are for models identical to those reported in the main analyses, using task means, rather than visit means as predictors and outcomes as appropriate.

T3 = third study assessment, HR = heart rate, HRV = heart rate variability, DMAT = divorce mental activation task.