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An Emotional Processing Writing Intervention and Heart Rate Variability: The Role of Emotional Approach

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Abstract

Expressing and understanding one's own emotional responses to negative events, particularly those that challenge the attainment of important life goals, is thought to confer physiological benefit. Individual preferences and/or abilities in approaching emotions might condition the efficacy of interventions designed to encourage written emotional processing. This study examines the physiological impact (as indexed by heart rate variability) of an emotional processing writing task as well as the moderating influence of a dispositional preference for coping through emotional approach (emotional processing and emotional expression), in response to a laboratory stress task designed to challenge an important life goal. Participants ($N = 98$) were randomly assigned to either Emotional Processing (EPW) or Fact Control (FCW) writing following the stress task. Regression analyses revealed a significant dispositional emotional processing by condition interaction, such that high emotional processing participants in the EPW condition demonstrated higher HRV after writing compared to low emotional processing participants. No significant main effects of condition or emotional expression coping were observed. These findings suggest emotional processing writing interventions may be best suited for those with preference or ability to process emotions related to a stressor or might require adaptation for those who less often cope through emotional approach.

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Keywords

emotional approach; heart rate variability; emotional processing; emotional expression; expressive writing

Functionalist theories suggest that attending to emotions underlies effective self-regulation (Carver & Scheier, 1998; Fridja, 1986). Expressing and processing emotion enables "emotional disturbances [to be] absorbed and decline to the extent that other experiences and behavior can proceed without disruption" (Rachman, 1980, p. 51). Emotional approach coping involves expressing, identifying, acknowledging, and understanding emotional responses to stressful or challenging circumstances (Stanton, Kirk, Cameron, & Danoff-Burg, 2000). There is increasing interest in how emotional approach can influence physical health and behavior (DeSteno et al., 2013), as empirical work supports a salutary role for processing and expressing emotions in adjustment to stressors (e.g., Pennebaker, 2012; Stanton et al. 2000).

However, attempts at emotional processing (EP) are not always adaptive. Repetitive or prolonged focus on negative emotional material can maintain or even amplify negative emotional states (Ehring & Watkins, 2008; Morrow & Nolen-Hoeksema, 1990). Unconstructive EP (e.g., rumination) is a passive, inefficient process that heightens – rather than resolves – physiological arousal and allostatic load (Brosschot, Gerin & Thayer, 2006). In contrast, constructive EP is active, intentional, and goal-oriented, and facilitates dynamic problem-solving and values clarification (Hoyt, Austenfeld, & Stanton, in press). Effectively acknowledging and processing negative emotions can lead not only to greater mood repair (McFarland & Buehler, 1997), but also supports physiological habituation (Foa & Kozak, 1986; Low, Stanton, & Danoff-Burg, 2006), which might be an important mechanism by which emotional approach influences physical and mental health.

Heart rate variability (HRV) is the degree of fluctuation in the length of intervals between heartbeats that reflects the continuous interplay between sympathetic and parasympathetic influences on heart rate that yields information about autonomic flexibility and thereby represents the capacity for regulated emotional responding (Thayer, Ahs, Fredrikson, Sollers,& Wager, 2012). HRV is a widely used measure of stress reactivity that is associated with greater ability to respond dynamically to environmental challenges and even signals better emotion regulation (Appelhans & Luecken, 2006; Shaffer, McCraty, & Zerr, 2014). HRV is thought to reflect the functional integrity of a network linking the heart to brain regions involved in coordinating contextual cues, threat and safety appraisals, and behaviors (Thayer et al., 2012).

Reduced HRV has also been associated with misguided attempts at emotional regulation, such as being linked to patterned worry underpinning anxiety disorders (e.g., Aldao, Mennin, & McLaughlin, 2013). In fact, unconstructive forms of EP have been linked to chronically reduced HRV which in turn is linked to numerous adverse physical and mental health outcomes, including anxiety disorders, chronic inflammation, and cardiovascular disease (Shaffer et al., 2014). Thus, managing emotions in a way that promotes physiological habituation and lightens allostatic load likely has powerful implications for health and wellbeing.

Despite the potential benefits of EP, interventions designed to promote EP have mixed results (Fratarolli, 2006). It may be that the success of EP is sensitive to the fit between the characteristics of the stressor and the individual (Lazarus, 1996; Austenfeld & Stanton, 2004), in that interventions might confer optimal benefit when matched to an individual's preferred coping style (e.g., Engebretson, Matthews, & Scheier, 1989). For instance, Stanton and colleagues (2000) observed that individuals who engaged in expressive writing demonstrated greater reductions in negative affect and arousal if they also reported dispositional tendencies towards emotionally expressive coping. Furthermore, a more recent randomized control trial suggested that expressive writing may actually be contraindicated for individuals who do not habitually express emotions (Niles et al., 2014). Yet other studies show that greater alexithymia and/or ambivalence about emotional expression predicts greater subjective and physiological benefits (e.g., Lu & Stanton, 2009). Given the potential role of EP in behavioral adaptation and physiological habituation to stressors, we sought to examine how dispositional EP affects physiological response to an EP writing exercise.

In the present study, we recruited undergraduate students for whom attending graduate, law, or medical school was an important personal goal. Participants were interviewed by a supposed "expert in graduate admissions," who provided challenging feedback regarding their potential as an applicant. Participants then were randomly assigned to complete either an EP or neutral writing task. We predicted that participants assigned to EP writing would demonstrate greater physiological benefit from the intervention (as indexed by higher HRV) if they also endorsed a greater preference for coping via emotional approach (emotional expression, emotional processing).

Method

In addition to a full description of the utilized study methods, below we report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Participants

Participants (*N*=98) were university undergraduates recruited from a student subject pool who were fluent in English and reported a moderate to strong intent to apply to medical, law, or other doctoral-level studies. This was determined by a single item screening question: "How important to you is applying to medical school, law school, or a Ph.D. program upon completion of your undergraduate studies?" rated on a 5-point scale ranging from 0 (Not at all important) to 4 (Extremely important). Only those answering 4 or 5 were invited to participate.

Participants were mostly female (*n*=64), with a mean age of 20.02 years (*SD* = 2.58). Approximately 46% were upperclass students and the majority (75%) identified as non-White ethnic minorities (see Table 1). Sample size estimates were determined by G*Power

(Faul, Erdfelder, Lang, & Buchner, 2007), in which a sample size of 89 participants was estimated to achieve .80 power.

Measures

Emotional expression and emotional processing.—Emotional expression (EE) and emotional processing (EP) were measured by the Emotional Approach Coping scales (Stanton et al., 2000). Higher scores on each 4-item subscale indicate greater dispositional preference for that form of coping in relation to stressful occurrences. Items were rated in response to how they *usually* respond to stressors on a 4-point response scale (1=I don't do this at all; 4=I do this a lot). Cronbach's alpha was .77 for EP and .90 for EE. EE and EP were positively correlated (r=.61, p<.001).

Heart rate variability (HRV).—HRV was calculated as the standard deviation of interbeat intervals (SDNN). SDNN has been recommended as a good measure of overall variability in heart rate (e.g., Allen, Chambers, & Towers, 2007). Decreased HRV can reflect either parasympathetic withdrawal or "a saturatingly high level of sympathetic input" (Task of the European Society of Cardiology, 1996) and SDNN summarizes total variability as a function of both parasympathetic and sympathetic influences. Whether HRV analyses should account for concurrent respiration has been a subject of debate (Allen et al., 2007). However, during resting state recordings when respiration is not expected to vary significantly, controlling for respiration rate is likely unnecessary. SDNN is also less subject to respiratory influence than other measures of HRV (Allen et al., 2007).

The electrocardiogram (EKG) was recorded using two Ag/AgCl electrodes (EL503; Biopac Systems, Inc., Goleta, California, USA), connected to an ECG100C amplifier for the MP36R System (Biopac Systems, Inc.). Electrodes were placed in a modified lead-II configuration. The EKG was acquired continuously in Biopac Student Lab (Biopac Systems, Inc.) and digitized at a sampling rate of 1kHz, with high- and low-pass filters at 0.5 and 35Hz.

EKG data during the baseline and post-writing period were extracted from the continuous recording and exported to QRSTool and CMetX software programs (Allen et al., 2007; http://psychofizz.org). QRSTool interpolates the series of interbeat intervals (IBIs) in a graphical user interface for semi-automatic R-peak detection and cleaning. CMetX calculates time-domain metrics of HRV from the cleaned IBI series. Both QRSTool and CMexX have shown good field validity (Hibbert, Weinberg & Klonsky, 2012). In order to minimize the likelihood of artifact contamination recordings with excessive motion or poor electrode contact were excluded from analysis. Data were manually inspected and removed if HRV values exceeded three standard deviations from the mean and CMetX identified artifacts in the cleaned IBI series (when the difference between successive IBIs falls under a threshold of 300ms). Six samples were excluded due to artifacts. One individual's data was removed due to the presence of ectopic beats, and the remainder excluded due to artifacts from movement or poor electrode contact (these tend to co-occur).

Sociodemographic and biobehavioral factors.—Participants self-reported social and demographic variables (e.g., age, class year, ethnicity) and relevant biobehavioral factors (e.g., medication use, recent caffeine intake, cigarette use).

Procedures

Following informed consent, participants completed self-report measures and a ten-minute resting physiological baseline. They were introduced to an "authority on graduate admissions" who conducted a uniform, ten-minute interview regarding participants' plans and preparedness for graduate study, while providing standardized feedback intentionally highlighting their weaknesses and a general high bar for admission. A guided imagery exercise followed, in which participants vividly imagined receiving an ultimate admissions rejection.

Participants were then randomized into one of two writing conditions using writing instructions adapted from studies of expressive writing (Pennebaker & Beall, 1986): 1) Emotional Processing Writing (EPW) condition directed participants to identify and attempt to understand any emotions elicited during the tasks, and to consider the meaning of their current affective state; 2) Fact Control Writing (FCW) participants were instructed to describe a factual account of activities performed in the prior 24 hour period with little to no emotional content. Instructions in both conditions were to write continuously for ten minutes without concern for grammar, spelling, or punctuation. After writing, participants underwent a second ten-minute physiological recording (the "post-writing" period). During physiological recording (baseline and post-writing), participants were seated upright, asked to make as few movements as possible, and were left alone in the testing room. There was an approximate 1-minute lead in time at each recording. Participants were fully debriefed at the close of the study.

Participants were compensated with course credit. All study procedures were approved by the university Institutional Review Board.

Results

Sample Characteristics at Baseline

Participants in the two conditions did not differ significantly on age, race/ethnicity, or year in school (see Table 1). Neither EE in the FCW (M=2.36, SD=0.79) and EPW (M=2.52, SD=0.85) [t(96)=−.80, p=.42] nor EP in the FCW (M = 2.76, SD = 0.67) and EPW (M = 2.96, SD = 0.67) [t(96)=−1.37, p=.17] conditions differed significantly between groups.

Manipulation Check

At the conclusion of the experimental session, participants were asked to rate the extent to which they experienced "real" emotions about their graduate school goals during the study on a scale from 1 (no real emotions) to 7 (very real emotions). Generally, participants reported experiencing moderately real emotions, M=4.17, SD=1.43. Ratings did not differ significantly between the FCW (M=4.11, SD=1.62) and EPW (M=4.22, SD=1.25) conditions [$t(96)=-.34$, $p=.72$]. All writing samples were independently coded by two raters unaware of study assignment to identify condition, and accuracy was 100%.

To consider the possibility that emotional processing inadvertently occurred in the FCW group, all essays were coded by a team of 4 independent coders with adequate interrater reliability using a coding rubric for evidence of both constructive and unconstructive forms of emotional processing (Hoyt, Austenfeld, & Stanton, in press). All writing in the control condition had negligible evidence for emotional processing.

Heart Rate Variability

Neither baseline nor post-writing HRV were significantly associated with age, cigarette use, caffeine intake, gender, or medication status. Baseline HRV was significantly correlated with EE ($r=.27$, $p<.01$), but not EP ($r=.09$, *ns*). However, post-writing HRV was significantly correlated with both EE ($r=.21$, $p<.05$) and EP ($r=.20$, $p<.05$). HRV did not differ by condition at baseline [FCW: $M=64.48$, $SD=20.64$; EPW: $M=71.70$, $SD=23.63$; $t(96)=-1.53$, $p=.13$; Cohen's $d=-.33$] or during the post-writing period [FCW: $M=71.70$, $SD=23.63$; EPW: $M=79.00$, $SD=22.62$; $t(96)=-1.46$, $p=.15$; Cohen's $d=-.30$].

We regressed post-writing HRV on condition, EP, and their interaction by multiplying the dummy-coded condition variable (FCW=0, EPW=1) with mean-centered EP scores using methods outlined by Aiken & West (1991) for categorical by continuous variable interactions. The model [$F(3,97)=3.42$, $p=.02$, $R^2=.098$] was on the border of significance for an effect of condition ($B=.62$, $p=.06$) and no significant main effect of EP was observed ($B=-.19$, $p=.27$). However, the EP x condition interaction was significant ($B=.90$, $p=.02$). For individuals in the EPW condition, EP was positively related to HRV ($B=.21$, $p=.04$), however, the simple effect was not significant for FCW ($B=.17$, *ns*). See Figure 1.

Identical analyses were conducted to examine the effect of EE [$F(3,97)=1.90$, $p=.14$, $R^2=.057$]. Additionally, no significant main or interaction effects were observed.

In post-hoc analyses, models were reexamined when controlling for baseline HRV. However, largely due to strong correlations between baseline and post-writing HRV, no significant effects were detected.

Discussion

Identifying and understanding one's emotional responses to negative events, particularly those that challenge attainment of important life goals, is thought to confer psychological and physiological benefit for some people. While examining the physiological impact of an EP writing task in response to a laboratory stressor designed to challenge an important life goal, the present study identifies dispositional preference for coping through EP as an important individual difference that influences the intervention impact. Importantly, condition alone did not predict post-writing HRV, but participants with higher dispositional EP exhibited higher HRV following EP writing.

EP interventions, particularly those that rely on written expression and exploration of emotion, may be most beneficial when matched with individual differences in coping and emotional style and abilities (Engebretson et al., 1989; Stanton et al., 2000). Identification of "for whom" such interventions are beneficial helps to clarify inconsistent results across studies. However, the question of whether differences in preference for EP versus ability of EP accounts for results remains. Notably, we did not find an effect for coping by emotional expression. Also, the EP by condition interaction explained only about four percent of the variance in HRV; larger effects might be observed on self-reported outcomes (e.g., Tamagawa et al., 2013).

Our findings add to the growing literature that suggests dispositional factors are important moderators to effects of written emotion-focused interventions. However, no previous study has specifically focused on the processing of emotion. The finding that EP, but not emotional expression, interacted with condition highlights the importance of individual and intervention match. Previous findings that have found a moderating role for emotional expression have utilized a writing intervention designed to enhance expression (and not processing) of emotion (Austenfeld, Paolo, & Stanton, 2006) and participants demonstrated both constructive and unconstructive EP when instructed to merely express (Hoyt, Austenfeld, & Stanton, in press). Unconstructive processing attempts might thwart resolution of stress and maintain or amplify negative responses, including goal failure (Brosschot et al., 2006; Jones, Papadakis, Orr, & Strauman, 2013). Future work should distinguish EP forms and other potential individual difference factors (e.g., depressive history, neuroticism, avoidance) should be explored.

The bivariate correlations suggested a positive, though modest, relationship between EE and HRV at baseline. The law of initial values (Wilder, 1967) suggests that participants who exhibit the lowest (or highest) baseline values would exhibit the most (or least) amount of change to a stimulus. Thus, it may be that those higher in EE exhibit a more consistent pattern of higher HRV and therefore have less opportunity for physiologic gains from expressive writing. Jin (1992) offered an extension of the LIV and suggested that reversed responses might occur when initial values reach an upper extremity. However, no known "upper extremity" for SDNN has been determined. Past reviews of normative HRV values suggest a mean SDNN of 50 (Nunan, Sandercock, & Brodie, 2010); which is significantly lower than observed baseline values in our study. As Jin notes, systematic group differences in initial values are generally not expected with random assignment. Thus, controlling for baseline values in a randomized experiment alters the research focus to potential differences if subjects were at the same basal level. Nevertheless, to the extent that EE involves recognizing and labeling emotions, this pattern of association is consistent with prior work demonstrating a relationship between emotion recognition and HRV in both psychiatric and non-psychiatric populations (Bal et al., 2010; Quintana et al., 2012). However, the psychological benefit from expressive interventions may be more pronounced and immediate with less necessary physiological concurrent change for those higher on EE.

As reported, no effects were detected when baseline HRV was controlled. Additional research is needed to better characterize the potential of expressive writing to alter HRV patterns. Although no baseline differences in HRV or other variables of interest were observed between groups, it remains possible that observed results are accounted for by an unknown third variable. Further, in the absence of longitudinal data, the long-term impact of

EP writing cannot be determined. Distinguishing immediate and distal consequences on health and physiology is warranted. In the present study, we used a control condition designed to distract (or turn attention way) from emotions, assuming that distraction would obstruct emotional processing. It should be considered that distraction can be effective at reducing negative emotions in the short term (Uusberg, Thiruchselvam, & Gross, 2014). This study also utilized a novel stress task in a controlled setting. These relationships should be tested in clinical populations and samples more diverse in age, education, and stress-related characteristics.

We observed that participants who endorsed greater tendency to engage in EP demonstrated greater physiological habituation following an EP intervention for a personally-relevant stressor, whereas those with lower dispositional EP had lower HRV overall but showed little difference by condition. It is important to interpret these findings in the context of the short duration of elapsed time. It is also possible that the EPW was more stressful for people lower in EP but could yield long-term benefits. Regardless, these findings underscore the influence of important individual differences, which can moderate the benefits of emotion-focused interventions. Future EP writing interventions might attempt to match individual preferences or skills to maximize utility and efficacy or might require adaptation for those who less often cope through emotional approach.

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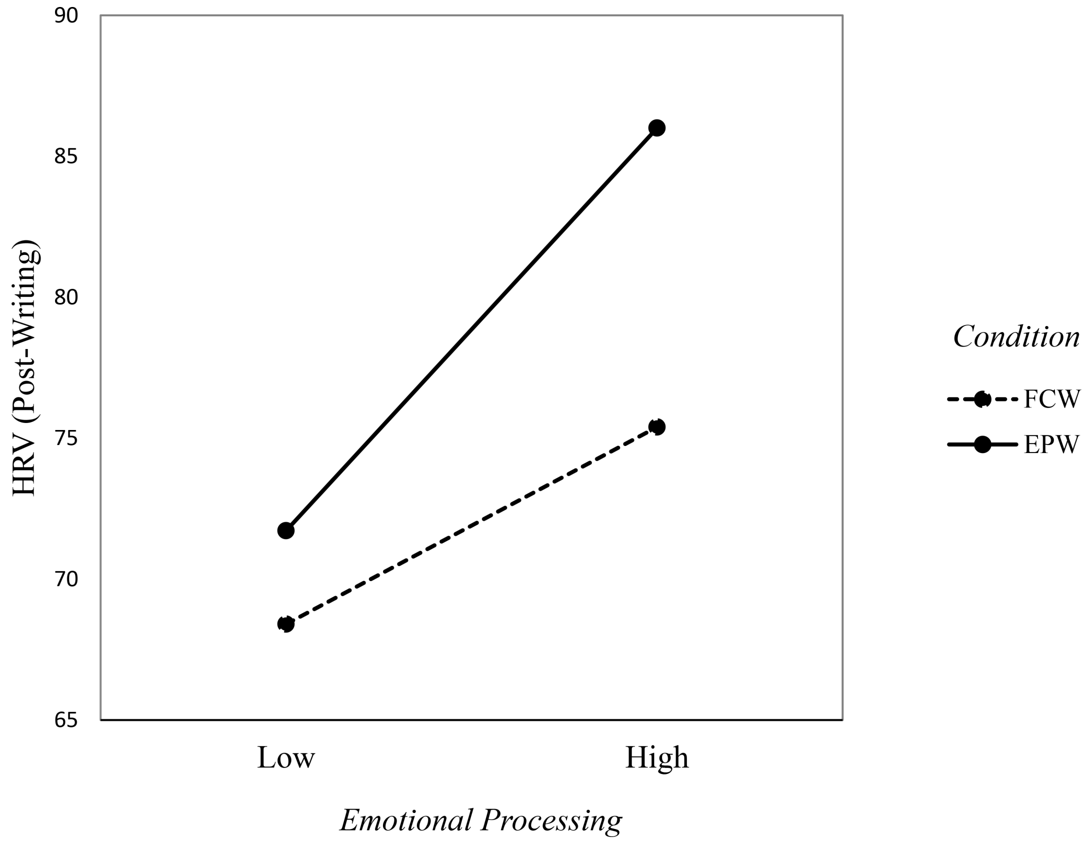

Figure 1.
Association between Heart Rate Variability and Emotional Processing in Emotional Processing and Fact-Control Writing Conditions
Note. FCW = Fact-Control Writing condition; EPW = Emotional Processing Writing condition; HRV = heart rate variability (in standard deviation of interbeat intervals). ‘Low’ and ‘High’ labels on the graph depict directionality of the continuous scale.

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Table 1

Sample Characteristics by Condition.

Demographics *n* (%)	**Condition**	
	FCW (*n* = 49)	**EPW (*n* = 49)**
Female	32 (65.3)	32 (65.3)
Male	17 (34.7)	17 (34.7)
Age *M (SD)*	20.31 (3.04)	19.73 (2.01)
African-American	3 (6.1)	5 (10.2)
Asian	14 (28.6)	14 (28.6)
White (non-Hispanic)	12 (24.5)	13 (26.5)
Hispanic	12 (24.5)	10 (20.4)
Native American	0 (0.0)	1 (2.0)
Other	8 (16.3)	6 (12.2)
Freshman	15 (30.6)	16 (32.7)
Sophomore	9 (18.4)	10 (20.4)
Junior	11 (22.4)	10 (20.4)
Senior	12 (24.5)	12 (24.5)
Other	2 (4.1)	1 (2.0)
% Medication Use	12.7%	14.7%
M cups of coffee/week	1.15 (SD = 1.7)	.97 (SD = 1.25)
M # of cigarettes/week	.96 (SD = 4.84)	.34 (SD = 1.42)

Note. FCW= Fact Control Writing condition; EPW = Emotional Processing Writing condition