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Emotional disclosure for whom? A study of vagal tone in bereavement

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Abstract

Recent investigations have shown little evidence that written disclosure benefits bereaved individuals over a control condition. The present study hypothesized that the effectiveness of written disclosure for bereavement may be moderated by vagal tone, as indexed by respiratory sinus arrhythmia (RSA). Vagal tone has been identified as an important individual difference in depression. The present study investigated 35 bereaved participants in a longitudinal design, with participants writing each week for 3 weeks, and then participating in follow-up sessions 1 week and 1 month later. As with previous studies, bereaved participants showed improvement, although no differential improvement was seen in the emotional Disclosure group compared to a Control writing group. As hypothesized, however, those participants with the highest RSA benefited most from the written disclosure, while RSA level did not predict outcome in the control condition. Future research should investigate whether vagal tone moderates the impact of written disclosure for non-bereaved individuals.

Keywords: RSA; Vagal tone; Bereavement; Depression; Emotional disclosure; Parasympathetic

1. Introduction

Motivated by reports of the beneficial effects of written personal disclosure on mental and physical health (Pennebaker, 1993, 1997), several recent investigations have examined written disclosure for bereaved individuals (Kovac and Range, 2000; Range et al., 2000;

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Segal et al., 1999; Stroebe et al., 2002). Despite the generally positive effects of written disclosure among the general population, these studies found little evidence to support the use of written disclosure for bereaved persons. Three of these investigations addressed both psychological and health outcomes (Kovac and Range, 2000; Range et al., 2000; Segal et al., 1999), with little differential improvement observed in the group that wrote about their feelings in response to the death as compared to a group that wrote about trivial topics. These studies utilized multiple outcomes, increasing the likelihood that a positive result would be obtained. In one study, a small improvement in self-reported hopelessness was observed (Segal et al., 1999), and in another (Kovac and Range, 2000), improvement was seen using a measure specific to grief following a suicide.

In a review of several studies using this basic writing paradigm for bereaved individuals, Pennebaker et al. (2001) have proposed that written disclosure may work best under certain conditions and for particular persons. Their hypotheses are based upon work done with bereaved and non-bereaved persons. These conditions and individual characteristics include a sudden death (with the presumed greater need to come to some understanding of the unexpected death), bereaved individuals who avoid emotion, and when physical health rather than negative mood is the outcome variable (Pennebaker et al., 2001).

The most recent published report (Stroebe et al., 2002) focused on expectedness of the death and need for disclosure as moderating variables, as Pennebaker et al. (2001) proposed. The writing task did not result in a reduction of distress nor of doctor visits, immediately after the bereavement or at a 6-month follow-up. Importantly, neither unexpectedness of the loss nor a high need for disclosure resulted in any greater improvement.

It remains possible that these studies did not find an overall differential benefit of disclosure because unassessed individual differences moderated the response to the intervention. The written disclosure may have been effective for some, but not necessarily for the majority of bereaved individuals. The present study hypothesized that written disclosure could be effective for those with good physiological self-regulation. Individual differences in physiological self-regulation, as a moderator of the written disclosure paradigm, have not previously been investigated. The following brief review of physiological self-regulation highlights why it may be an important moderating variable in the bereavement process.

1.1. Physiological self-regulation

Vagal tone has been hypothesized as an autonomic correlate of emotional expression, emotional reactivity, and emotional self-regulation (Porges, 1991, 1997). Although frequently used as an indication of individual differences in self-regulation within the infant development literature, such as studies concerned with sociability in children (Calkins and Fox, 1992), it has only recently begun to be used in research with adults. Moreover, vagal tone has been shown to have an important role in depression (Chambers and Allen, 2002; Hughes and Stoney, 2000; Musselman et al., 1998; Rottenberg et al., 2003; Yeragani et al., 2002).

The vagus nerve provides an inhibitory regulatory influence on the heart, allowing heart rate to increase rapidly through vagal withdrawal, as in response to a stressor in one's environment. Vagal withdrawal usually co-occurs with an increase in sympathetic activation of the heart, or what has come to be known as the fight-or-flight response. Vagal tone reflects the degree to which there is tonic vagal influence on the heart, and can be measured by

assessing the extent of variability in heart rate that is synchronized with respiration. This variability reflects decreased vagal activity coincident with the respiratory inspiration and increased vagal activity with the expiration. Those with greater vagal tone thus show greater heart rate variability. Because of this coupling of heart rate to respiration, a commonly used index of vagal activity is called respiratory sinus arrhythmia (RSA). Those individuals with high vagal tone, or high RSA, have greater vagal control of the heart. This individual difference hypothetically allows greater ability to react to the environment and physiologically regulate following the stressor (Porges, 1991).

In bereavement, there may be several stressors that co-occur because of the death of a loved one, in addition to the stress of the loss of the relationship itself. The inability to self-soothe and return to homeostasis may occur after the many "pangs of grief" associated with bereavement. Emotional disclosure, in the form of talking or writing about the loss, may evoke pangs of grief. A lack of physiological self-regulation, or low RSA, in turn may influence how beneficial emotional disclosure is to those with bereavement.

1.2. Study hypotheses

The present study hypothesized, therefore, that those bereaved individuals with high self-regulation, as indexed by RSA, would show improvement using a written disclosure paradigm, while those with low RSA would not show improvement. Those bereaved individuals in a control writing condition designed to elicit comparatively little emotion would, in contrast, be hypothesized to show comparable outcome regardless of the level of self-regulation, since little or no emotion would be elicited by the writing task.

2. Method

2.1. Participants

Thirty-five bereaved participants were recruited from the greater Tucson, Arizona population, and randomized to one of two writing interventions (Disclosure, 20 and Control, 15). Six participants failed to complete the writing sessions (four from the Disclosure group, two from the Control group), resulting in a final sample of 29 participants (Disclosure, 16 and Control, 13). There were no significant demographic, psychological or psychophysiological group differences between the completers and non-completers (all $P > 0.16$, except for intrusive thoughts as measured by the Impact of Events Scale, $P < 0.06$). Psychological data from the final follow-up session were not recorded from two participants (both in the Control group), but psychophysiological data were available for all subjects. Thus, the present report focuses on these 29 subjects, with analyses involving the final follow-up session including 27 subjects.

Participants' descriptive information, categorized by intervention group, can be seen in Table 1. There were no significant differences in any of the demographic measures between groups at baseline. Participants were recruited through general advertisements and group presentations through hospices, hospitals, mental health clinics, and university classes.

Table 1
Participant descriptive data

	Disclosure group ($N = 16$)	Control group ($N = 13$)
Female	13	12
Ethnicity		
White	13	8
Latino	1	1
African-American	1	1
Native American	0	2
Other reported ethnicity	1	1
Mean age (range)	37 (19–60)	45 (20–63)
Mean time since death in months (range)	5 (<1–13)	6 (<1–16)
Expected death (more than 1 week notice)	11	5
Relation to the deceased		
Parent	9	6
Spouse	3	4
Grandparent	2	1
Child	0	1
Sibling	1	0
Other	1	1

Note: The Disclosure and Control groups did not differ significantly on any of these demographic variables.

2.2. Instruments

Participants reported demographic information, relationship to the deceased, length of time since the death, and whether the death was expected. Participants were given the Beck Depression Inventory-II (BDI-II; Beck and Steer, 1996) and the Beck Anxiety Inventory (BAI; Beck and Steer, 1990) to assess depression and anxiety. The Impact of Event Scale (IES) was used to assess the grief reaction to the death, and includes Avoidance and Intrusive Thoughts Subscales (Horowitz et al., 1979). The Positive and Negative Affect Scale (PANAS) was administered before the writing tasks (with instructions to report on affect in the prior week) and after the writing tasks (with instructions to report on current affect) (Watson et al., 1988). Table 2 summarizes the time points of administration for each of the measures.

Table 2
Study timeline

First writing session (week 1)	Second writing session (week 2)	Third writing session (week 3)	Outcome session (week 4)	Follow-up session (week 8)
BDI-II	BDI-II	BDI-II	BDI-II	BDI-II
BAI			BAI	BAI
IES			IES	IES
PANAS	PANAS	PANAS	PANAS	PANAS
ECG	ECG	ECG	ECG	ECG
Writing task	Writing task	Writing task		

BDI-II, Beck Depression Inventory-II; BAI, Beck Anxiety Inventory; IES, Impact of Events Scale; PANAS, Positive and Negative Affect Scale; ECG, electrocardiographic assessment.

Table 3
Instructions to participants in the written Disclosure group

Day 1	What I would like you to write about today is what happened when your loved one died and your deepest emotions and thoughts about it. You can write about what your loved one died of, how you found out they were dying, when you heard the news that they had died, and what you did afterward. Whatever you choose to write, however, it is critical that you really delve into your deepest emotions and thoughts. Write about what you felt, what you were thinking, how you reacted, and what physical sensations you experienced. Use as many emotion words as you want to describe your reaction. In addition, you can write about how you are feeling now since time has passed since your loved one died. Sometimes people feel positive emotions as well as negative ones, like relief, pride, compassion, love, and gratitude. Remember, the most important part is to write about your deepest emotions and thoughts.
Day 2	Today is the second of three days of writing. What I would like you to write today is a letter to your loved one who died. You can write anything to them that you would like them to know. I would like you to express your deepest emotions and thoughts. Many people wish that they had said or done things while the person was alive, and these are things that you can do in this letter. Other people want to tell their loved one how they are doing now. Some people want to express their gratitude for something the person who died did, or apologize for something that they did while the person was alive. Write the letter just as you would if the person were reading it. Finally, at the end of the letter, write a good-bye to the person. Sometimes this means good-bye for now, or good-bye for the way you knew them while they were alive. Again, the important thing is to examine your deepest emotions and thoughts. You can start by writing "Dear _____,".
Day 3	You have done very well to complete the first two sessions, and today is the last session. Today I would like you to write about how the death of your loved one has affected your life, your relationships and your priorities. As with the first 2 days, I want you to examine your deepest emotions and thoughts. Sometimes people who lose a loved one find some positive aspect in the experience. For example, some people feel they learn something about themselves or others. Explore how living through the death of your loved one has impacted other parts of your life such as improvement in other relationships, new appreciation for life or spirituality, or enjoyment of the present moment. Write about those times, however, brief, that you have felt positive emotions during this experience, and how those feelings helped you. Remember to focus on your deepest emotions and thoughts.

2.3. Writing tasks

Participants were asked to write for 20 min on each of 3 days, which varied from 7 to 14 days apart. They participated in follow-up sessions 1 week and 1 month after the final writing session. Participants in the Disclosure group were given instructions (see Table 3) adapted for bereavement from Pennebaker's written disclosure paradigm (Pennebaker et al., 2001). Participants in the Control group were asked to write about their day (see Table 4). These instructions controlled for the impact of writing and expectations as previously done in the Pennebaker paradigm. Each participant sat alone in a room during the writing. Writings were placed in a sealed envelope with an identification number and collected.

2.4. Psychophysiology

Resting electrocardiographic (ECG) data was recorded for 5 min prior to the writing task at each session. The ECG was recorded with a J & J Amplifier System (Poulsbo, WA),

Table 4
Instructions to participants in the Control group

Day 1	What I would like you to write about over the next three sessions is how you use your time. Each day, I will give you different writing topics on the way you spend your time. In your writing, I want you to be as objective as possible. Your writings won't include emotions or opinions. Rather I want you to be completely objective. Feel free to be as detailed as possible. In today's writing, I want you to describe what you did yesterday from the time you got up until the time you went to bed. For example, you might start when your alarm went off and you got out of bed. You could include the things you ate, where you went, which buildings or objects you passed by as you went from place to place. The most important thing in your writing, however, is for you to describe your days as accurately and objectively as possible.
Day 2	This is the second day of writing. Today, I would like you to describe what you have done today since you woke up. Again, I want you to be as objective as possible to describe exactly what you have done up until coming to this session. Feel free to be as detailed as possible. You could write about getting ready to go out, the things you gathered to take, the chores you finished before you left. The most important thing in your writing, however, is for you to describe your day as accurately and objectively as possible.
Day 3	This is the third day of writing. Today, I want you to describe in detail what you will do as soon as this session is over and until you go to bed tonight. Again, I want you to be as objective as possible to describe exactly what you have done up until coming to this session. Feel free to be as detailed as possible. For example, you might start by noting that you will walk out of the door, go down the steps, get into your car and so forth. The most important thing in your writing, however, is for you to describe your day as accurately and objectively as possible.

attaching Ag–AgCl electrodes to the left and right upper forearm with Signa Crème electrode conductive cream. The ground was attached to the lower right forearm. No instructions were given about how to breathe. ECG was sampled at 1024 Hz. Ectopic beats and abnormalities were monitored on the screen and noted for later correction or exclusion.

Interbeat interval (IBI) series were first derived from the raw ECG, using an *r*-spike detection algorithm, followed by hand screening with correction for artifacts (missed or erroneous beats). Heart period variability in the high frequency band (0.12–0.4 Hz) was extracted using CMet Software (Allen, 2002), which produces an estimate of respiratory sinus arrhythmia that correlates 0.99 with that produced by MX Edit Software (Delta-Biometrics, Inc., 1988–1993). Whereas MX Edit uses a polynomial filter, CMet uses an optimal finite impulse response digital filter using FWTGEN V3.8 from Cook and Miller (1992). CMet converts the IBI series to a time-series sampled at 10 Hz, filters the series using a 241-point optimal finite impulse response filter with half-amplitude frequencies of 0.12 and 0.40 Hz, and then takes the natural log of the variance of the filtered waveform as the estimate of RSA.[1]

3. Results

The Disclosure and Control groups did not differ at baseline on any symptom measures or psychophysiological variables (see Table 5), all F's$(1, 28) < 2.9$, P's > 0.10.

[1] CMet is available for research use from http://www.apsychoserver.psych.arizona.edu.

Table 5
Mean ± standard deviation of baseline measures for each group

Index	Disclosure group	Control group	Significance
BDI	17.2 (11.8)	21.8 (9.6)	0.27
BAI	12.7 (9.1)	19.2 (11.0)	0.09
IES-Avoidance	16.6(5.8)	17.8(4.6)	0.57
IES-Intrusion	22.3(5.5)	23.2 (4.0)	0.63
PANAS-positive	27.2 (11.1)	26.2 (9.1)	0.79
PANAS-negative	24.3 (7.7)	27.5 (9.1)	0.31
Heart rate	74.0 (11.0)	77.7 (10.3)	0.37
RSA	6.1 (1.2)	5.2(1.7)	0.10

BDI-II, Beck Depression Inventory-II; BAI, Beck Anxiety Inventory; IES, Impact of Events Scale; PANAS, Positive and Negative Affect Scale; RSA, respiratory sinus arrhythmia.

3.1. Written disclosure effects

A 2 (group: Disclosure and Control) × 5 (time: first, second, third, outcome, and follow-up sessions) repeated measures ANOVA was used to determine whether participants' psychological and physiological indices showed improvement over time, and whether the groups differed in the pattern of change over time. These analyses included the 27 subjects with complete self-report data at all times of assessment, and all 29 subjects for the psychophysiological data. In no case was there a significant interaction of group × time (all P values were <1.0), but several main effects of time were significant. Significant tests were corrected using Greenhouse-Geisser epsilon correction, with corrected P values reported along with original degrees of freedom. Across both groups, participants showed a reduction over time in several self-report measures, including those assessing depression ($F(4, 100) = 5.92$, $P < 0.01$), anxiety ($F(2, 50) = 9.49$, $P < 0.01$), and grief symptoms (IES-Avoidance: $F(2, 50) = 6.27$, $P < 0.01$; IES-Intrusion: $F(2, 50) = 4.85$, $P < 0.05$). They also showed an increase in positive affect ($F(4, 100) = 4.65$, $P < 0.01$) and a decrease in negative affect ($F(4, 100) = 8.15$, $P < 0.001$). Although HR did not change over time ($F(4, 108) = 0.383$, *ns*), RSA did show a main effect of time ($F(4, 108) = 2.91$, $P < 0.05$). Table 6 details which time points differ from the baseline assessment for each measure.

3.2. Respiratory sinus arrhythmia as a moderator

Although the written Disclosure group did not show any differential change as assessed by the outcome measures in Table 6, it is possible that physiological self-regulation may have moderated the effects of the intervention. RSA was tested as a possible moderator, guided by the hypothesis that those highest in RSA would benefit most from the written disclosure, while RSA level would not predict outcome for those in the control condition, as outlined above. A linear regression was performed to test the moderator effect of RSA. An adjusted post-study depression score was created by taking the standardized residual from the BDI score at the follow-up session regressed on the BDI score at the first session. This BDI residual was then used as the dependent variable, with group, RSA (first session), and the interaction of group and RSA (first session) entered into the regression

Table 6
Mean ± standard deviation over time for the full sample

Index	Session 1	Session 2	Session 3	Outcome session	Follow-up session
BDI-II	19.2 (10.9)	16.5 (9.5)*	15.2 (10.1)*	17.2 (10.7)	11.8 (8.4)*
BAI	15.6 (10.4)			15.0 (9.9)	10.2 (8.2)*
IES-Avoidance	17.1 (5.3)			15.3 (5.4)	14.4 (4.5)*
IES-Intrusion	22.7 (4.8)			21.8 (3.7)	20.5 (3.9)*
PANAS-positive	26.7 (10.1)	25.8 (8.7)	27.2 (8.6)	27.5 (8.7)	31.4 (8.4)*
PANAS-negative	25.7 (8.3)	21.2 (7.9)*	20.5 (7.1)*	20.7 (8.0)*	18.3 (6.5)*
HR	75.7 (10.7)	77.0 (14.7)	75.9 (11.2)	77.4 (12.2)	76.8 (10.4)
RSA	5.7 (1.5)	5.5 (1.8)	5.8 (1.6)	5.7 (1.9)	5.1 (1.5)*

All measures showed a significant effect of time ($P < 0.05$) except for HR. BDI-II, Beck Depression Inventory-II; BAI, Beck Anxiety Inventory; IES, Impact of Events Scale; PANAS, Positive and Negative Affect Scale; HR, heart rate; RSA, respiratory sinus arrhythmia. *Note*: $n = 29$ for all occasions of assessment except for the follow-up session, where $n = 27$ for self-report measures and $n = 29$ for all occasions of assessment for HR and RSA.

* $P < 0.05$ is significantly different than the first session value assessed by simple repeated measures contrast coding.

Table 7
Predictors of residualized BDI change

Predictor	sr^2	Significance of R^2 change
Group	0.064	0.20
RSA	0.116	$0.08^{\dagger}$
Group × RSA	0.114	$0.07^{\dagger}$

sr^2, Semi-partial correlation squared which represents the increase in variance accounted for at each step. Total model $R^2 = 0.294$. *Note*: $n = 27$.

model. The interaction term was marginally significant ($P < 0.07$; see Table 7). With a sample of only twenty-nine participants who completed the follow-up phase, this result is provocative. Because of a priori directional hypothesis, follow-up tests were conducted to determine whether those individuals with the highest RSA in the emotional disclosure condition derived the greatest benefit from the writing intervention.

To decompose this interaction trend and to describe the way in which RSA may moderate outcome as a function of group, simple regressions were computed separately for each group to predict residualized follow-up BDI change (residualized on first session BDI). For the Disclosure group, first session RSA was a significant predictor of outcome ($R^2 = 0.326$, $P < 0.02$), whereas it was not for the Control group ($R^2 = 0.000$, *ns*). Fig. 1 depicts these relationships.

4. Discussion

4.1. Respiratory sinus arrhythmia as a moderator

The results suggest that although all participants' psychological health improved over time, this effect was unrelated to the specific intervention involving written disclosure. This

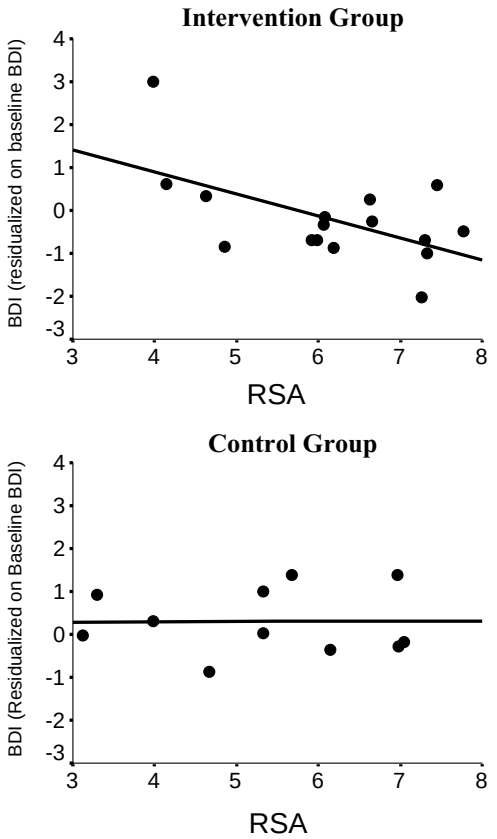

Fig. 1. First session respiratory sinus arrhythmia (RSA) as a moderator of change in Beck Depression Inventory (BDI) scores by group (Control or Disclosure). *Note*: Negative residualized BDI represents improvement from baseline to post-study. Regression equations for control intervention = 2.67 + 0.005*RSA, whereas for disclosure intervention = 2.97 − 0.52*RSA.

main effect of improvement across time in bereavement studies has been documented in a number of studies (for review, see Stroebe et al., 2002). Such findings highlight that measures used in the present study are sensitive to changes in the psychological state of bereaved individuals.

The HR finding parallels the lack of group differences in the psychological measures of the present and previous studies. Moreover, HR per se did not change over the 2-month period. This finding that HR does not decrease is notable, given that bereaved individuals have higher heart rates than their non-bereaved counterparts (O'Connor et al., 2002). RSA, however, did show an unexpected decrease in the last session, perhaps related to worrisome thinking surrounding the end of their participation (Lyonfields et al., 1995).

The studies reviewed by Stroebe et al. (2002) showed no differential change in psychological symptoms over time as a function of intervention, suggesting that those completing the written disclosure did not improve more than those performing the control writing task.

Stroebe et al. (2002) have suggested that the writing task may not have enough of an impact, and that this may be a reason that Pennebaker's writing paradigm has not been an effective grief intervention. Specifically, they note that in order for the writing paradigm to be effective, it would have to have an impact on bereavement above and beyond the normal and expected process of change and adjustment that occurs after the death of a loved one.

The present study, however, identified that physiological self-regulation, as assessed by RSA, shows promise as a possible moderator of the impact of the intervention. There is a range of RSA for which the written disclosure intervention proved more effective than the control writing condition. Those participants with higher RSA, and by inference better emotional regulation, may make effective use of the emotions elicited in the context of the written disclosure, whereas those with lower RSA and poorer regulation do not benefit. For the control writing intervention, however, which should not elicit as many emotions, the ability to regulate emotion appears not to be key to the outcome.

4.2. Summary and future directions

Bereavement serves as a unique opportunity to investigate an emotional diathesis-stress model. The death of a loved one often occurs in the lives of individuals without prior psychiatric or physical illness. The death event is clearly demarcated, and thus it is a stressor for which the emotional repercussions may be evaluated. Many bereaved individuals report that grief is the strongest emotion that they have ever experienced. Bereavement can be conceptualized as turning up the volume dial on emotion in an otherwise normal individual. This combination allow for the study of strong emotion in an individual, uncomplicated by extensive or complex histories, by comorbid psychopathology, or confounding treatments. Data from the present study suggest that how the bereavement process unfolds is a reciprocal relationship between the emotion that is experienced and the physiological regulation of that emotion.

Future research in this area could profitably focus on the influence of autonomic physiology on the bereavement process. Recent fMRI investigation of bereavement has shown that the anterior cingulate cortex and the cerebellum are highly involved in the grief response (Gündel et al., 2003). These regions have been shown to be critical in autonomic regulation (Critchley et al., 2003; Schmahmann, 1996). The reciprocal relationship between the autonomic nervous system and the central nervous system is an important area of research, which may give us greater leverage over how emotional disclosure benefits bereaved individuals.

The present findings, in bereaved individuals, suggest the possibility that vagal tone may serve as a moderator of the beneficial effects of emotional disclosure more generally. Thus, in addition to replication of the effects observed in the present study with a larger sample of bereaved individuals, the role of vagal tone as a moderator of emotional disclosure should also be investigated in non-bereaved individuals.

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