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Respiratory sinus arrhythmia predicts written disclosure outcome

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Abstract

Research has indicated that writing about traumatic experiences is associated with beneficial health effects compared with writing about emotionally neutral topics. What remains unclear are those factors that moderate the beneficial effects associated with written disclosure. This study examined respiratory sinus arrhythmia (RSA) as a moderator of written disclosure outcome. Findings indicated that individuals with the highest RSA during the first written disclosure session benefited most from written disclosure in terms of physical health complaints and depression symptoms. As expected, RSA did not impact outcome for participants assigned to a control condition. These findings indicate that individuals who display good emotion regulation skills are best served by written disclosure.

Descriptors

Written disclosure; Respiratory sinus arrhythmia; Emotion; Depression; Physical health

The written emotional disclosure procedure has received much attention in recent years (for a review, see Sloan & Marx, 2004b). Briefly, this procedure involves writing about the most traumatic experience of one's life for approximately 20 minutes in each of several consecutive sessions. The findings have generally indicated that compared with individuals who write about an emotionally neutral topic, people who write about traumatic experiences report fewer physical health complaints and fewer psychological symptoms at follow-up assessment.

Although there are a number of studies that have found beneficial effects (Kelley, Lumley, & Leisen, 1997; Pennebaker & Beall, 1986; Sloan, Marx, & Epstein, 2005; Smyth, Stone, Hurewitz, & Kaell, 1999; Stanton et al., 2002), other studies have either found no beneficial effects (Batten, Follette, Hall, & Palm, 2002; Kloss & Lisman, 2002; Stroebe, Stroebe, Schut, Zech, & van den Bout, 2002) or detrimental effects (Gidron, Peri, Connolly, & Shalev, 1996) associated with written disclosure. Thus, although written disclosure appears to be beneficial for some individuals, it does not appear to be beneficial for all. Understanding what factors contribute to or affect beneficial outcomes associated with written disclosure is an important next step for this promising intervention.

One factor that has been suggested as a possible moderator of written emotional disclosure outcome is respiratory sinus arrhythmia (RSA). RSA is an oscillation in heart period due to the respiratory cycle (Porges, 1986). Changes in RSA reflect the activity of the vagus nerve, and an increase in RSA is strongly positively correlated with increases in parasympathetic influence on the heart. RSA is measured by assessing how much heart period changes from beat to beat. RSA has been proposed to be a physiological correlate of emotion regulation (Porges, 1995), such that vagal responses to stress function as a "brake" to rapidly regulate responses to environmental demands. Empirical data supports this position with increased RSA associated with good emotional regulation ability. For instance, Chambers and Allen (2002)

found that depressed individuals with an increased level of RSA from before to after treatment showed the largest decrease in depressive symptoms. Alternatively, decreased levels of RSA have been found to be associated with emotion regulation difficulties in both children (e.g., Henderson, Marshall, Fox, & Rubin, 2004) and adults (e.g., Rottenberg, Wilhelm, Gross, & Gotlib, 2003). Given the evidence of RSA as a physiological index of emotion regulation ability, one would also expect RSA to moderate outcome associated with written disclosure, as this task elicits considerable emotional arousal (Sloan & Marx, 2004a). This possibility was recently investigated by O'Connor, Allen, and Kaszniak (2005).

O'Connor et al. (2005) examined RSA as a moderator of written disclosure among a group of bereaved adults. The investigators found that bereaved participants with the highest RSA (during the first written disclosure session) benefited most from written disclosure (in terms of self-reported depression), whereas RSA level did not predict outcome for the control participants. These findings indicate that individuals with presumably better emotion regulation ability benefit most from written emotional disclosure. Importantly, the finding of O'Connor and colleagues was merely a trend toward statistical significance, a likely result of the small sample size (i.e., 27 participants in total). It is also important to note that the investigators only examined one outcome measure (depression) and the sample consisted of bereaved individuals who were predominately female. Thus, the generalizability of the O'Connor et al. findings is limited. Furthermore, it is feasible that RSA might affect some outcome variables (e.g., psychological health, depression symptoms) associated with written disclosure but not affect other outcome variables (e.g., physical health).

The current study further examined whether RSA influences the effects of written disclosure on psychological and physical health. In this study a large number of both male and female college students, the most frequently studied group in the written disclosure literature (see Sloan & Marx, 2004b), were examined. Between-group differences for this study have been reported elsewhere (Epstein, Sloan, & Marx, 2005). Briefly, participants assigned to the written disclosure group reported fewer psychological and physical health complaints compared with participants assigned to the control group at follow-up assessment. Moreover, gender was not found to influence outcome for either group. Given the evidence that higher levels of RSA are an index of better emotion regulation ability, it was anticipated that disclosure group participants with the highest RSA would benefit most from written disclosure in terms of both psychological and physical health. However, RSA level was not expected to influence outcome for participants assigned to the control group.

Method

Participants

Participants were recruited from an undergraduate Introductory Psychology course at Temple University, which is a large urban university. A randomly generated list of the students (first name only) who were interested in participating in research was made available to the authors at the beginning of the semester. Students whose names appeared on this list were contacted by one of the authors and asked if they would be willing to volunteer for a study in which they would write stories related to their lives over several sessions in exchange for credit toward fulfilling a course research requirement. Approximately 15% of the students contacted declined participation because they either did not have time to participate or they had already completed their course research requirement. No one stated they were declining because of the nature of the experiment. The study was approved by the Institutional Review Board.

A total of 99 individuals (49 women) participated in the study; however, 5 participants dropped out before study completion. The remaining 94 participants (46 women) were included in the analyses. Participants were randomly assigned (within gender) to either the written disclosure

group ($n = 51$) or a neutral topic (control) writing group ($n = 43$). The majority of the participants were White ($n = 57$), with the remaining participants representing a diversity of racial and ethnic groups (African-American $n = 15$, Hispanic $n = 8$, Asian-American $n = 2$, and “Other” $n = 12$).

Materials and Procedures

Upon arrival at the laboratory and after providing informed consent, participants completed a demographic questionnaire measure, the Depression and Anxiety Stress Scale–21-Item (DASS₂₁; Lovibond & Lovibond, 1995), and the Pennebaker Inventory of Limbic Languidness (PILL; Pennebaker, 1982) prior to the first writing session. The DASS₂₁ and the PILL were completed again 1 month following the writing sessions.

The DASS₂₁ is a 21-item measure that asks about depression, anxiety, and stress symptoms over the past week using a 4-point Likert-type scale. This measure has excellent test–retest reliability and the depression and anxiety subscales have been shown to provide better separation between these symptom features than other measures of depression and anxiety (Antony, Bieling, Cox, Enns, & Swinson, 1998). The DASS₂₁ was included because of its strong psychometric properties and its ability to index several areas of psychological functioning.

The PILL is a 54-item measure of the frequency of physical health complaints occurring over the previous month. A total score is obtained by summing the total number of symptoms that the individual endorsed experiencing at least once a month. Items include symptoms such as runny or congested nose, chills, headaches, fever, and nausea. The PILL was included because it is commonly used in studies of written disclosure (see Sloan & Marx, 2004b) and has been found to be a sensitive measure of change in physical symptoms (Pennebaker, 1982).

Electrocardiography (ECG) data were recorded continuously for all participants during a 5-min baseline period (before each writing session) and during each writing session using the Polar S810 HR monitor (Lake Success, NY). The Polar Monitor is an ambulatory ECG system that consists of a wristwatch receiver and the T61 transmitter chest strap. A water-soluble transmitting gel was applied to the transmitter chest strap to facilitate conduction. These signals were transmitted to the wristwatch receiver that acquired the interbeat interval (IBI) between R waves, which was subsequently downloaded to a computer text file and hand screened with correction for artifacts. ECG obtained using the Polar Monitor system has been found to be highly correlated with ECG recordings during exercise, mental challenges, and resting periods, indicating that the system is a reliable device for recording ECG data in the laboratory (Goodie, Larkin, & Schauss, 2000). Heart period variability in the high frequency band (0.12–0.40 Hz) was extracted using CMet Software, which produces an estimate of RSA that correlates .99 (Allen, 2002) with that produced by MX Edit Software (Delta-Biometrics, Inc., 1988–1993). CMet converts the IBI series to a time series sampled at 10 Hz, filters the series using a 241-point 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. For the present study, only RSA during the first writing session was used in the analyses. This data analysis approach is consistent with O’Connor and colleagues (2005).

After completing self-report questionnaire measures participants put on the chest strap for recording heart rate and the resting period was recorded. Next, participants were given writing instructions for their assigned condition and subsequently completed the first of three writing sessions. All participants wrote for 20 min each session on 3 consecutive days. Writing sessions took place alone in a private location within the laboratory. Instructions for both the disclosure and the control writing conditions followed the protocol by Pennebaker (1997). Briefly, participants assigned to the written disclosure condition were asked to describe the most traumatic experience of their life with as much emotion and feeling as possible. Participants

assigned to the control condition were asked to describe how they spent their time, without describing any emotions or feelings. All participants were fully debriefed regarding the purpose of the study following the 1-month follow-up assessment.

Results

To examine whether RSA moderated written disclosure outcome, standard multiple regressions were performed for each outcome measure. Adjusted outcome means were calculated by creating standardized residuals by regressing the outcome score on the baseline score for each measure (depression, anxiety, stress, and physical health complaints). These residual scores were then used as the dependent variable with group (coded as control = 0 and disclosure = 1), RSA during first writing session (which was centered prior to creating the interaction terms; see West, Aiken, & Krull, 1996), gender (coded as women = 0 and men = 1), Group $\times$ RSA (at first session) interaction term, and Group $\times$ Gender $\times$ RSA interaction term entered into the regression model. This analysis approach was also used by O'Connor and colleagues (2005).

The full model predicting depression outcome was significant, $F(5,89) = 2.99, p < .05, R^2 = .15$. The main effect for group was significant ($\beta = 0.279, p < .01$), but this effect was qualified by a significant Group $\times$ RSA interaction ($\beta = 0.415, p < .05$). The full model predicting physical health complaints outcome (PILL) was also significant, $F(5,89) = 3.06, p < .05, R^2 = .15$, with a significant Group $\times$ RSA interaction term ($\beta = 0.461, p < .05$) also found.

The scatterplots of the relationship for RSA by depression outcome and RSA by physical health complaints outcome are shown in Figures 1 and 2, respectively. As illustrated in the figures, first session RSA was a significant predictor of depression outcome ($-0.17 + -0.29 \times \text{RSA}$) and physical health complaint outcome ($-0.05 + -0.37 \times \text{RSA}$) for the disclosure group (top panel of Figures 1 and 2, respectively), whereas it was not a significant predictor for the control group (depression = $0.40 + 0.20 \times \text{RSA}$; physical health complaint = $0.01 + 0.08 \times \text{RSA}$). Taken together, the findings indicate that, for the disclosure participants only, higher RSA level at the first written disclosure session was associated with an improvement in depression and physical health complaints at follow-up assessment.

Findings for the anxiety outcome measure indicated that the full model was not significant, $F(5,89) = 1.95, p > .10, R^2 = .11$, whereas the full model predicting stress outcome was significant, $F(5,89) = 4.47, p < .01, R^2 = .22$. For stress outcome, a significant group effect was found ($\beta = 0.434, p < .001$) but neither of the interactions terms were significant (largest $\beta = -0.306, p > .08$).

An examination of the stability of RSA across the writing sessions was also conducted. Results indicated a strong positive relationship among RSA levels across writing sessions for both the written disclosure participants (lowest $r = .61, p < .001$) and the control participants (lowest $r = .67, p < .001$), suggesting high consistency of RSA (or emotion regulation) across the writing sessions.

Discussion

Although we have previously found written disclosure to be beneficial to psychological and physical health (Epstein et al., 2005), the findings of this study indicate that the benefits of written disclosure for this sample of male and female college students are particularly pronounced for the participants with higher RSA level, and presumably better emotion regulation ability. This observation is also consistent with that of O'Connor and colleagues (2005), who studied a very different group of participants. Taken together, these findings indicate that a person's ability to regulate his or her emotions is displayed in the written disclosure task and is influential in affecting outcome associated with written disclosure.

The emotion regulation ability that participants demonstrated during the written disclosure task is likely reflective of a stable pattern of emotion regulation ability, as RSA level has been found to be stable across time. For instance, Salomon (2005) has shown that increases in RSA during a stress task predicted higher resting RSA approximately 3 years later in children and adolescents. In addition, the study reported here found that RSA level across the three writing sessions was highly correlated for both the disclosure participants and the control participants.

In recent years researchers have displayed much enthusiasm regarding the written disclosure procedure. However, some investigators have argued that written disclosure is not as promising as some have purported (e.g., Gidron et al., 1996). It is certainly the case that not every study examining written disclosure finds beneficial outcome associated with the procedure. However, the reason for the mixed findings is unclear. In addition to examining different samples (e.g., college students, cancer patients, trauma survivors, asthma patients), investigators have frequently altered various aspects of the written disclosure procedure (e.g., number of writing samples, time of writing session, time between writing sessions, instructions for written disclosure, time to follow-up assessment), and some investigators have altered several aspects of the procedure within the same study. Such alterations to the procedure could impact the outcome, making it difficult to determine whether the mixed findings that have been reported are related to moderator influences or method variance. Nonetheless, there is mounting evidence that written disclosure is more efficacious for certain individuals. For example, in addition to the findings of this study and the study by O'Connor et al. (2005), there is also evidence that written disclosure is most efficacious for individuals high in negative affect and in ambivalence about emotional expression (Norman, Lumley, Dooley, & Diamond, 2004) and for individuals who have limited social supports (Sheese, Brown, & Graziano, 2004).

Approximately 40 studies have now been conducted examining written disclosure. At this point it would seem useful for investigators to move away from examining whether or not written disclosure is beneficial and, instead, focus on understanding who benefits from written disclosure as well as understanding underlying mechanisms that account for observed beneficial outcomes. By addressing such questions we will gain a greater understanding of when written disclosure should be used and under what conditions.

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Figure 1.

Scatterplot, prediction line, and prediction equation for the relationship between respiratory sinus arrhythmia (log of the variance of the band-limited [.12–.40 Hz] IBI series) and depression score (residualized on baseline depression score), for the disclosure group (top panel) and the control group (bottom panel). Negative depression score represents improvement from baseline to follow-up.

Figure 2.

Scatterplot, prediction line, and prediction equation for the relationship between respiratory sinus arrhythmia (log of the variance of the band-limited [.12-.40 Hz] IBI series) and physical health complaint score (residualized on baseline physical health complaints score) for the disclosure group (top panel) and the control group (bottom panel). Negative physical health complaint score represents improvement from baseline to follow-up.