Health Psychology
2006, Vol. 25, No. 2, 181–189

0278-6133/06/$12.00 DOI: 10.1037/0278-6133.25.2.181

Expressive Disclosure and Benefit Finding Among Breast Cancer Patients: Mechanisms for Positive Health Effects

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A randomized trial ($n = 60$; A. L. Stanton, S. Danoff-Burg, L. A. Sworowski, et al., 2002) revealed that 4 sessions of written expressive disclosure or benefit finding produced lower physical symptom reports and medical appointments for cancer-related morbidities at 3-month follow-up among breast cancer patients relative to a fact-control condition. The goal of this article is to investigate mechanisms underlying these effects. Within-session heart rate habituation mediated effects of expressive disclosure on physical symptoms, and greater use of negative emotion words in essays predicted a decline in physical symptoms. Postwriting mood and use of positive emotion and cognitive mechanism words in essays were not significant mediators, although greater cognitive mechanism word use was related to greater heart rate habituation and negative emotion word use.

Keywords: emotional disclosure, benefit finding, expressive writing, breast cancer

The experience of breast cancer can elicit a variety of powerful emotions, including fear, grief, hope, and gratitude. Coping strategies aimed at expressing feelings surrounding cancer are associated with improved adjustment to the illness (Stanton et al., 2000), and psychosocial interventions designed to encourage emotional expression and processing can improve quality of life among cancer patients (Goodwin et al., 2001; Spiegel, Bloom, Kraemer, & Gottheil, 1989). In addition, experimental research on written expressive disclosure (Pennebaker & Beall, 1986), in which participants are randomly assigned to write during several sessions about either their deepest thoughts and feelings regarding a stressful experience or a neutral control topic, suggests that emotional disclosure about a stressful life event can yield significant physical health benefits. However, the mechanisms through which expressive writing carries its effects remain elusive. The goal of the present study is to examine mediators of the effects of two writing interventions for women with breast cancer.

Recently, we (Stanton, Danoff-Burg, Sworowski, et al., 2002) examined the effects of a written emotional disclosure intervention in 60 early stage breast cancer patients, representing the first randomized trial to examine the physical health effects of expressive disclosure in breast cancer patients and the first trial to compare the efficacy of writing about one's deepest thoughts and feelings about cancer to writing about the positive aspects of dealing with breast cancer (i.e., benefit-finding condition). Disclosure of positive emotions about stressful experiences has been less thoroughly studied, but existing evidence suggests that writing about benefits associated with a stressor, such as strengthened personal relationships or enhanced self-concept, can also produce health changes (King & Miner, 2000).

Relative to a control group (CTL), who wrote about the facts of their cancer and treatment, women who wrote about either their deepest thoughts and feelings (EMO) or their positive thoughts and feelings (POS) about cancer had significantly fewer medical visits for cancer-related morbidities (e.g., breast symptoms, possible recurrence) over the subsequent 3 months (Stanton, Danoff-Burg, Sworowski, et al., 2002). The EMO group also reported significantly decreased physical symptoms (e.g., headaches, shortness of breath) at 3-month follow-up relative to the CTL group. In addition, the interventions interacted with self-reported cancer-related avoidance to affect psychological adjustment. In the present analyses, we examined potential biological, emotional, and cognitive mechanisms by which the interventions produced the observed physical health effects.[1]

The findings of Stanton, Danoff-Burg, Sworowski, et al. (2002) are consistent with the expressive disclosure literature, in which it has been demonstrated repeatedly that writing about negative emotional experiences can improve physical health and functioning among healthy adults (see Smyth, 1998, for a meta-analysis). Although most written disclosure research has focused on healthy participants, the paradigm recently has been extended to medical populations, including patients with asthma or rheumatoid arthritis (Smyth, Stone, Hurewitz, & Kaell, 1999) and various cancers (deMoor et al., 2002; Rosenberg et al., 2002; Stanton, Danoff-

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This research was supported by the U. S. Army Medical Research and Material Command under DAMD-17-94-J-4244 awarded to Annette L. Stanton. We thank Samuel B. Green for his quantitative expertise.

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[1] In examining mechanisms for the interventions' effects in the current article, we focused on outcomes relevant to physical health. Analyses for mediation on psychological outcomes were not relevant because experimental condition did not have a significant main effect on psychological outcomes but rather had moderated effects as a function of cancer-related avoidance (Stanton, Danoff-Burg, Sworowski, et al., 2002), and sample size was too limited to examine mediators of the moderated effect.

Burg, Sworowski, et al., 2002; Walker, Nail, & Croyle, 1999; Zakowski, Ramati, Morton, Johnson, & Flanigan, 2004). A recent meta-analysis of nine studies that tested effects of written emotional disclosure relative to a control condition in individuals with physical or psychiatric disorders demonstrated that it significantly improved physical ($d = .21$) but not psychological ($d = .07$) health outcomes (Frisina, Borod, & Lepore, 2004).

Though much research has supported the conclusion that expressive disclosure produces health benefits, the pathways through which these simple interventions lead to positive outcomes are only recently receiving empirical attention (see Booth & Petrie, 2002; Sloan & Marx, 2004b, for reviews). Furthermore, no research to date has addressed the issue of how two fundamentally different writing interventions both can produce positive health outcomes. We hypothesized that written expressive disclosure and benefit finding improve health by enhancing regulation of stress-related physiological, affective, and cognitive experience (i.e., self-regulation, King, 2002; Lepore, Greenberg, Bruno, & Smyth, 2002). Further, we expected that the physical health effects would be explained by different pathways for the two distinct writing interventions.

First, we postulated that health effects observed in the EMO condition would result in part from autonomic habituation, or a decrease in physiological arousal, to negative thoughts and memories about cancer. We expected that approaching negative thoughts and feelings in that condition would lead to arousal but that prolonged or repeated exposure would allow decreases in arousal during writing sessions. Such habituation may reflect desensitization to cancer-related thoughts and memories (i.e., stimulus-specific habituation) as well as increased tolerance of one's negative emotional reactions to stress-provoking stimuli in general (i.e., response-specific habituation; Lepore et al., 2002). Thus, autonomic activation and subsequent habituation may be indicative of emotional processing and improved self-regulation and should be associated with improvements in health (Bootzin, 1997; Foa & Kozak, 1986; Jaycox, Foa, & Morral, 1998).

Preliminary work by Petrie and colleagues (Petrie, Booth, Pennebaker, Davison, & Thomas, 1995) demonstrated that skin conductance levels assessed during writing declined steadily for participants in a trauma-writing group over four sessions, but the relationship between habituation and physical health outcomes was not examined. Furthermore, Sloan and Marx (2004a) found that greater physiological activation in the first writing session, as assessed by cortisol reactivity (i.e., prewriting to 20 min postwriting), was associated with reduced psychological symptoms in the expressive disclosure group, but the relation between activation and physical health improvements was not significant. Thus, the mediating roles of physiological arousal and habituation during writing on physical health outcomes require study.

Affective processes were a second target of study. Because we did not expect arousal to be as pronounced in the POS condition, we did not anticipate that autonomic habituation would occur for that group to the same extent as in the EMO condition. Rather, we predicted that the health effects of the POS condition might be achieved through experience and expression of positive emotions. Expressing positive emotions in the context of writing about a stressful experience may physiologically "undo" the arousal associated with memories of the stressor (Fredrickson, Mancuso, Branigan, & Tugade, 2000). Further, writing about benefits of the cancer experience and associated positive emotions may lead to renewed engagement with meaningful life goals, an orientation associated with positive changes in immune status and health (Bower, Kemeny, Taylor, & Fahey, 1998). Although the mechanisms through which positive emotion predicts health require specification (Bower & Segerstrom, 2004; Cohen, Doyle, Turner, Alper, & Skoner, 2003), we expected the subjective experience of positive emotion and the expression of positive emotional content in the essays to be related to improved health in the POS group.

Pennebaker, Mayne, and Francis (1997) found that greater use of positive emotion words in essays were associated with health benefits. However, they did not examine effects of specific writing instructions (e.g., expressive disclosure vs. benefit finding) on the relation between the use of positive emotion words and health benefits. Subjective negative emotion and the use of negative emotion words also may be important, although the data are not consistent with regard to the link between negative emotional expression and health outcomes (e.g., Lepore & Greenberg, 2002; Pennebaker et al., 1997). Because the POS condition was designed specifically to induce positive experience, we expected that the relation between positive emotional expression and health improvement would be stronger in that condition than in the EMO condition.

Finally, we expected cognitive processing of the cancer experience to predict health outcomes in both experimental samples, as both writing interventions encouraged the restructuring of stressful events into a coherent and meaningful narrative. This cognitive resolution may be accompanied by a decrease in or desensitization to intrusive thoughts and aversive meanings attached to the situation (e.g., Lepore & Greenberg, 2002; Park & Blumberg, 2002), which may lessen the demonstrated association between rumination and negative health outcomes (e.g., Thomsen et al., 2004). In the expressive disclosure literature, increased use of cognitive processing words over writing sessions has been associated with improved health, and writing focused on both cognitions and emotions has been linked to greater benefits than has writing about emotions alone (Pennebaker et al., 1997; Ullrich & Lutgendorf, 2002). However, the role of cognitive processing in written benefit finding and expressive disclosure has not been adequately explored.

In summary, we evaluated the following hypotheses:

Hypothesis 1. Objective (i.e., heart rate [HR]) physiological activation and habituation within and across writing sessions will account for the health benefits in the EMO condition.[2]

Hypothesis 2. Subjective positive emotion and essay words indicating positive emotion will account for health benefits in the POS condition (we also explore the role of negative emotion as a mediator).

Hypothesis 3. Essay words indicative of cognitive processing will mediate the health effects of both interventions.

[2] Skin conductance also was assessed during writing sessions. Preliminary analyses revealed no significant group, session, or Group × Session effects on this variable, and no further analyses were conducted.

Method

Participants

Sixty women who had a first diagnosis of Stage I or Stage II breast cancer and who had completed primary medical treatment (i.e., surgery, radiotherapy, chemotherapy) in the last 5 months participated in the randomized trial. Participants were excluded from the experiment if they had been diagnosed with recurrent or metastatic disease or if they were unable to read and write in English. Participants were offered $100 compensation for their time.

Procedure

Patients were recruited from four participating oncology practices in the Midwestern United States. They were informed by research staff or medical personnel that the purpose of the study was "to learn more about how women adjust to having breast cancer" and were told that they would be asked to write about their experiences with breast cancer. Figure 1 depicts trial accrual and retention (complete description of sample and procedures provided in Stanton, Danoff-Burg, Sworowski, et al., 2002). After baseline assessment, women were randomized to one of three conditions. Each participant was instructed by trained research assistants blind to the research hypotheses to write about her (a) "deepest thoughts and feelings" regarding her experience with breast cancer (EMO; $n = 21$), (b) positive thoughts and feelings regarding her experience with breast cancer (POS; $n = 21$), or (c) facts regarding her cancer and its treatment (fact-control condition [CTL]; $n = 18$). Each woman was informed of her group assignment immediately prior to beginning writing at the first session, and she engaged in the 20-min writing task at each of four sessions within a 3-week period. Writing sessions were conducted in patients' homes, a research laboratory, or a participating medical institution. Participants were instructed to write continuously, without concern for spelling or grammatical structure. Writing instructions for the three conditions, as well as writing samples, are provided in Stanton and Danoff-Burg (2002). Participants received the baseline measures by mail and returned them at the first writing session. At 3 months, they received and returned questionnaires by mail.

Measures

Physical health variables. At the final writing session, participants were given a form on which to record prospectively any medical visits over the subsequent 3 months. At the 3-month follow-up, these reports were confirmed through medical records for 20% of patients ($n = 12$), with patients' consent, demonstrating 92% agreement (23 patient-reported appointments/25 medical records appointments). Divided into appointments for cancer-related morbidities (e.g., lymphedema, breast symptoms, possible recurrence) and other appointments (e.g., medical check-ups, appointments for other problems), the former was of interest in this analysis.

At baseline and 3 months after the final writing session, participants also completed a 9-item measure adapted from King and Emmons (1990) and Pennebaker (1982) to assess physical symptoms. Participants reported the number of days in the past 30 days that they had experienced each symptom (i.e., headache, stomach ache/pain/upset, chest pain, runny/congested nose, coughing/sore throat, faintness/dizziness, shortness of breath, racing/pounding heart, stiff/sore muscles), and a total score was computed (potential range: 0–270). Chosen on the basis of factor analytic work on a large list of physical symptoms (Pennebaker, 1982), items reflect symptoms that are precursors to serious illness (e.g., chest pain; Friedman

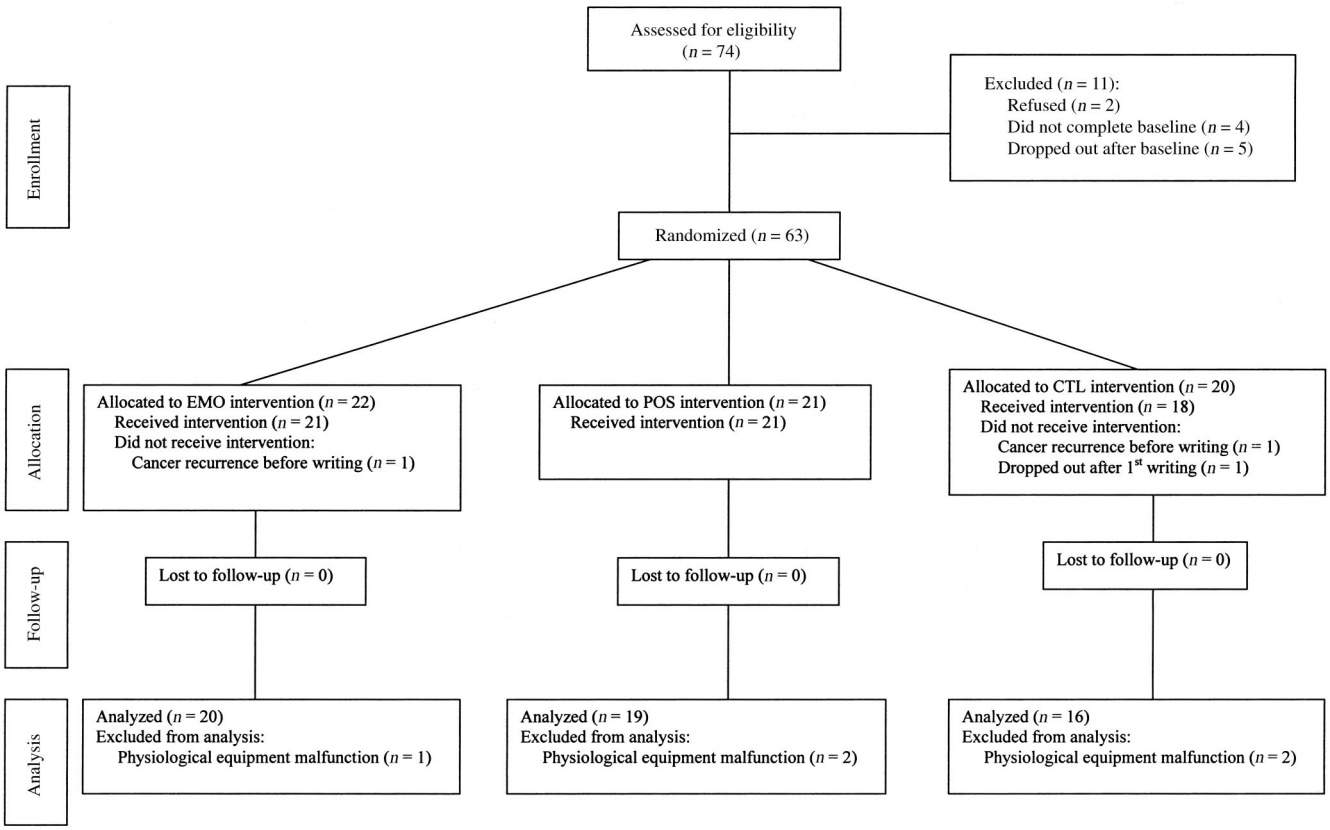

Figure 1. CONSORT trial participation flow diagram.

Table 1
Effect of Experimental Condition on Physical Health

Dependent variable	EMO		POS		CTL				
	M	*SE*	*M*	*SE*	*M*	*SE*	*F*	*p*	n^2
Physical symptoms—3 months	16.71_a	3.12	20.88_a	3.09	31.37_b	3.42	5.08[a]	.010	.169
Medical appointments for cancer-related morbidities	$.42_a$	.43	1.00_a	.43	2.56_b	.47	6.04[b]	.004	.191

Note. Means are adjusted for unequal cell sizes. For physical symptoms, means are also adjusted for the covariate (baseline physical symptoms). Means with different subscripts differ significantly at $p < .05$. EMO = emotional writing condition; POS = positive writing condition; CTL = control condition.
[a] $F(2, 50)$. [b] $F(2, 51)$.

& Booth-Kewley, 1987), are indicative of acute illness (e.g., coughing/sore throat), are late effects of medical treatments (e.g., chest pain, sore muscles), or may be interpreted by breast cancer patients as reflecting cancer metastasis (e.g., headache, shortness of breath). This measure was positively correlated with medical appointments for cancer-related morbidities at 3 months ($r = .26$, $p < .05$).

HR during writing sessions. During each session, participants' HR was monitored for an initial 4-min resting baseline period, a 20-min writing interval, and a 4-min resting postwriting period. HR was assessed by using the J & J Personal Computer Physiological Monitoring System (J & J Engineering, Poulsbo, WA) with an optical sensor on the middle finger's fleshy tip. Beat-to-beat recordings were recorded electronically at a rate of 5 readings/s and were computer-averaged every 10 s throughout each 1-min interval. These were then averaged for each 4-min baseline, the middle 8 min of the 20-min writing period (i.e., writing HR), and 4-min postwriting period. The middle 8 min was used to indicate writing HR based on evidence that arousal during imaginal exposure to a stress-related stimulus often follows a curvilinear pattern (see Foa & Kozak, 1988) and because greatest engagement in writing likely occurs once one settles into the task. In addition to the baseline, writing, and postwriting HR indices, a peak-end index (i.e., HR habituation during writing) was computed (e.g., Jaycox et al., 1998; Kozak, Foa, & Steketee, 1988) by subtracting HR observed during the last 1 min of writing (i.e., mean of six 10-s intervals) from the peak 1-min HR (i.e., mean of six 10-s intervals)[3] observed during the 20-min writing period. As a result of a computer failure, all physiological data were missing for 1 participant in the EMO condition, 2 in the POS condition, and 2 from the control group; data from these 5 women were excluded from the analyses.

Linguistic content analysis. All essays were analyzed with the computerized text analysis program, Linguistic Inquiry and Word Count program (LIWC; Pennebaker et al., 1997). The LIWC program searches text files and computes the percentage of words judged to reflect high-level content categories. The relevant LIWC content categories were positive emotion words (e.g., *happy*, *joy*), negative emotion words (e.g., *angry*, *cried*), and use of words reflecting cognitive processing, such as insight and causal reasoning (e.g., *because*, *think*, *realize*). Percentage scores for each text category were computed for each writing session.

Self-reported mood. Immediately prior to and after each writing period, participants completed the "right now" version (instructions were not specific to the cancer experience) of the Profile of Mood States (McNair, Lorr, & Droppelman, 1971). The scale has 65 affect adjectives rated on a 5-point scale (0 = *not at all*, 5 = *extremely*). As in other studies (Stanton, Danoff-Burg, & Huggins, 2002; Stanton et al., 2000), we constructed a distress index (POMS Distress) by summing items (e.g., *tense*, *sad*) on the Anger, Depression, Tension, Fatigue, and Confusion subscales, and we used the Vigor subscale (POMS Vigor, e.g., *energetic*, *cheerful*) to indicate positive mood. In this study, internal consistency estimates of reliability ranged from .89 to .94 for POMS Vigor and .81 to .88 for POMS Distress.

Results

Effect of Experimental Condition on Physical Health Outcomes

To establish that there is an effect to be mediated, it must first be demonstrated that the independent variable (i.e., experimental condition) is significantly associated with the dependent variables (Baron & Kenny, 1986). Although Stanton, Danoff-Burg, Sworowski, et al. (2002) reported a significant group effect on both reported physical symptoms (controlling for baseline) and medical appointments for cancer-related morbidities at 3 months, these analyses were repeated, excluding the 5 women for whom physiological data were missing. As in the full sample, the three experimental conditions did not differ in self-reported physical symptoms at baseline in this smaller sample, $F(2, 51) = 1.51$, $p > .05$. As shown in Table 1, the main effect of experimental condition was significant for both physical health outcomes at 3 months. Consistent with hypotheses, women in both the EMO and POS writing conditions differed significantly from the control writing group in that they reported fewer somatic symptoms and fewer cancer-related medical appointments at the 3-month follow-up assessment.[4]

Group Effects on Potential Mediator Variables

Data analysis. The second requirement in testing mediation is that the intervention significantly affects the putative mediator. Because the data were hierarchical with writing sessions nested within persons, multilevel modeling analyses were conducted (SAS PROC MIXED; SAS Institute, 1996). At the writing-session level, the following two predictors were included in the model in addition to the intercept: writing session, which was centered around the midpoint of the writing sessions, and the relevant time-varying covariate, which was centered around its mean for each person. At the person level, intercepts at the writing-session level were predicted from the means of the time-varying covariate and treatment group as well as the intercept. A residual term also was included in this prediction equation, allowing for random

[3] Over 70% of peak 1-min HR intervals occurred during the middle 8 min of the writing sessions.

[4] The significant effect of experimental condition on medical appointments for cancer-related morbidities was maintained when baseline self-reported physical symptoms was controlled, $F(2, 49) = 5.01$, $p < .01$.

intercepts. Also at the person level, equations were specified to predict the within-person slopes for sessions and within-person slopes for the covariate. Experimental group and an intercept were included in the prediction equation for the within-person sessions slopes, whereas only an intercept was included in the prediction equation for the within-person covariate slopes. Initially, residual terms were included in both of these prediction equations, allowing for estimates of slope variances. If these variances were estimated to be zero or close to zero (and the effect was not significant at the .10 level), the variances were fixed to zero (i.e., the residual sources were eliminated from the model). The primary focus of these analyses was the test of the fixed effects: session, experimental group, and Session × Group controlling for the covariate. As previously described, the covariate was included as a centered time-varying covariate at the session level and covariate means at the person level. Follow-up tests of between-groups comparisons of adjusted means used the Tukey–Kramer adjustment for multiple comparisons.

HR. With regard to activation, habituation, and recovery, we expected HR to be more responsive to the writing exercise in the EMO group than in the other groups, owing to EMO participants focusing on more arousing cancer-related negative emotions and thoughts than were participants in the other conditions. HR changes within and between sessions were of interest. Multilevel modeling analyses were conducted on four HR indices: (a) 4-min HR baseline, which provided an analysis of prewriting habituation across sessions as a function of experimental group; (b) 8-min writing HR, with mean baseline HR as a time-varying covariate (i.e., *HR activation*); (c) HR in last minute of writing subtracted from HR in peak minute of writing (i.e., *HR habituation during writing*), covarying mean baseline HR; and (d) 4-min postwriting HR, with mean baseline HR as a time-varying covariate (i.e., *HR recovery*). Table 2 displays adjusted means for the variables as a function of group. On baseline HR and HR activation, no significant effects emerged for group, session, or Group × Session. Multilevel modeling analyses on peak-end HR during writing, controlling for baseline HR, revealed a significant effect for group but no significant effect for session or Group × Session. As shown in Table 2, between-groups comparisons of adjusted means indicated that EMO participants had significantly greater HR habituation during writing than did POS and CTL participants, which did not differ significantly.

Analyses for HR recovery yielded a significant effect for group but no significant effect for session or Group × Session. As shown in Table 2, between-groups comparisons indicated that EMO participants had significantly greater HR recovery (i.e., greater difference between baseline and postwriting HR) than did CTL participants, and POS participants did not differ significantly from either group.

To offer a characterization of the pattern of HR response during the experimental sessions, we conducted a repeated-measures analysis of variance (ANOVA) on HR at baseline, peak and end (in light of the significant experimental group effect on HR habituation during writing), and postwriting. Because no significant session or Group × Session effects emerged for any of the HR indices, we averaged HR across sessions for each period. Analyses revealed significant time, $F(3, 50) = 70.98$, $p < .001$, and Time × Group, $F(6, 100) = 3.56$, $p = .003$, effects on HR. Group means are displayed in Figure 2. Simple effects analyses indicated that, for each group, mean HR at each period (i.e., baseline, peak, end, recovery) differed significantly from HR at the subsequent period at $p < .05$, and the groups did not differ significantly on HR at any single period. However, the significant Time × Group effect indicated that groups had distinct HR patterns, and Figure 2 suggests a steeper peak-end slope for EMO. Indeed, a univariate ANOVA with experimental group as the independent variable on the within-session HR habituation score (peak–end) was significant, $F(2, 52) = 10.17$, $p < .001$. Group means assumed the same pattern as in the multilevel modeling analyses, with the EMO group evidencing significantly greater habituation than the other two groups.

Essay content. We continued the multilevel modeling approach to analyze the LIWC word use variables of interest: positive emotion, negative emotion, and cognitive mechanisms. Word count for the essays was included as a time-varying covariate (note that the experimental groups did not differ significantly in essay word counts). Table 3 displays adjusted means for the variables as a function of group.

As predicted, positive emotion word use varied significantly as a function of group such that POS participants used significantly more positive emotion words than did women in the EMO group, who used more positive emotion words than did women in the CTL group. A significant session effect, $F(1, 161) = 17.15$, $p < .001$, revealed that women increased their use of positive emotion words over sessions (partial regression coefficient = 0.35 for EMO, 0.14 for POS, 0.18 for CTL). The Group × Session interaction was not significant.

Table 2
Effects of Experimental Condition on Heart Rate (HR) Indicators in Multilevel Models

Potential mediator	EMO ($n = 20$)		POS ($n = 19$)		CTL ($n = 16$)			
	M	*SE*	*M*	*SE*	*M*	*SE*	*F*	*p*
Baseline HR	81.68_a	2.46	81.46_a	2.52	82.58_a	2.74	0.05[a]	.95
HR activation (writing HR controlling for baseline HR)	87.43_a	1.03	84.76_a	1.02	85.89_a	1.11	1.70[b]	.19
HR habituation during writing (peak-end HR controlling for baseline HR)	16.78_a	1.52	10.27_b	1.54	6.52_b	1.67	10.74[c]	< .001
HR recovery (postwriting HR controlling for baseline HR)	77.35_a	1.06	$79.90_{a,b}$	1.08	81.95_b	1.17	4.29[d]	.019

Note. Means with different subscripts differ significantly at $p < .05$ (with Tukey–Kramer adjustment). Means are adjusted for slightly different cell sizes and the relevant covariate. EMO = emotional writing condition; POS = positive writing condition; CTL = control condition.
[a] $F(2, 52)$. [b] $F(2, 48)$. [c] $F(2, 50)$. [d] $F(2, 51)$.

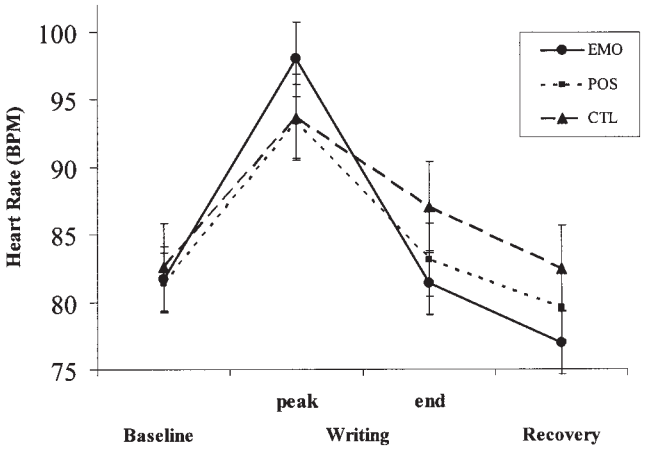

Figure 2. Heart rate activity before, during, and after writing, averaged across the four writing sessions.

Negative emotion word use also varied significantly as a function of group, with EMO participants using more negative emotion words than the POS or CTL participants, who did not differ from each other (see Table 3). Although the session effect was not significant, the Group × Session effect was significant, $F(2, 161) = 5.41$, $p = .005$. Specifically, use of negative emotion words by the EMO group declined significantly across sessions (partial regression coefficient = −0.20; $t[162] = -2.50$, $p = .013$), did not change significantly for POS (partial regression coefficient = −0.07; $t[162] = -0.84$, $p = .404$), and increased significantly for CTL (partial regression coefficient = 0.19; $t[162] = 2.15$, $p = .033$).

A significant group effect indicated that use of cognitive mechanism words was greater in the EMO group than in the POS or CTL group, which did not differ from each other (see Table 3). Effects for session and Group × Session were not significant.

Self-reported mood. In multilevel modeling analyses, through the use of the relevant pre-essay mood variable as a time-varying covariate (see Table 3), a significant effect for experimental group emerged on negative mood, but no group differed from another significantly after Tukey–Kramer adjustment. Session and Group × Session effects were not significant. No significant effects emerged on positive mood.

Analysis of Mediational Effects on Physical Health Outcomes

To examine the final step in mediation (Baron & Kenny, 1986), we tested the effect of both the relevant process variable (i.e., HR habituation during writing, HR recovery, positive and negative emotion essay words, cognitive mechanisms essay words, negative mood) and the independent variable (i.e., experimental group) on the outcome. If the effect of the process variable is significant and the effect of experimental group is reduced or eliminated, we have evidence for statistical mediation. At present, statistical packages are not yet available for analyzing mediated effects in multilevel modeling (Llabre, Spitzer, Siegel, Saab, & Schneiderman, 2004), and methods for testing mediation in multilevel analyses are still in development (Kenny, Korchmaros, & Bolger, 2003). Further, the foregoing analyses demonstrated that relevant HR process variables (i.e., HR habituation during writing, HR recovery), cognitive mechanism essay words, and self-reported negative mood did not vary significantly across writing sessions. Consequently, the indices for HR habituation during writing and cognitive mechanism word use each were averaged across the four sessions. To obtain an index of HR recovery, we subtracted baseline HR from postwriting HR and averaged this score across sessions.[5] We subtracted prewriting self-reported negative mood from postwriting negative mood and averaged across sessions to examine that index. For potential mediator variables that evidenced significant effects of session or Group × Session interactions (i.e., LIWC positive and negative emotion words), in addition to examining mean word use across sessions, we constructed a linear orthogonal polynomial change score for each variable, as used in Pennebaker et al. (1997), to capture the session effect (i.e., [Day 4 × 3] + [Day 3 × 1] − [Day 2 × 1] − [Day 1 × 3], such that higher change scores indicate increased use over time of a particular content category).

We conducted regression analyses, entering each process variable (i.e., HR habituation during writing, HR recovery, mean positive emotion and negative emotion word use as well as change scores, cognitive mechanism word use, and self-reported negative mood after writing) as a predictor and Group as a fixed factor, with self-reported physical symptoms and medical appointments for cancer-related morbidities as dependent variables. For the self-reported physical symptoms dependent variable, we included baseline physical symptoms as a covariate.

A significant effect of HR habituation during writing and a reduction of the group effect emerged on physical symptoms. When HR habituation and group were entered into the analyses, HR habituation was significantly associated with physical symptoms, $F(1, 49) = 9.37$, $p = .004$, $\eta^2 = .160$, whereas experimental group no longer had a significant effect on outcome, $F(2, 49) = 2.13$, $p = .13$, $\eta^2 = .080$. Controlling for the effect of HR habituation, the strength of the effect size for experimental group on physical symptoms dropped from .161 to .080. Greater within-session HR habituation was associated with fewer physical symptoms at follow-up across groups ($pr = -.39$, $p = .004$, with baseline physical symptoms partialed). The estimated marginal means became 19.38 for the EMO group, 20.22 for the POS group, and 28.97 for the CTL group and no longer differed significantly between groups. Inclusion of HR habituation produced the greatest change in mean physical symptoms for the EMO participants, supporting the hypothesis that physiological habituation was a mechanism underlying change in perceived physical symptoms after expressive disclosure.

Negative emotion word use also appeared to mediate the group effect on physical symptoms. When mean negative emotion word use and group were entered into the model, negative emotion word use was significantly associated with symptoms, $F(1, 49) = 4.09$, $p = .049$, $\eta^2 = .077$, and the effect of experimental group became nonsignificant, $F(2, 49) = 3.00$, $p = .059$, $\eta^2 = .109$. As with HR habituation, the effect size for experimental group dropped when

[5] We used change scores instead of residualized change scores on the basis of the recommendation of Llabre, Spitzer, Saab, Ironson, and Schneiderman (1991), with regard to analysis of change in cardiovascular reactivity research.

Table 3
Effects of Experimental Condition on Essay Word Variables and Self-Reported Mood During Writing Sessions in Multilevel Models

Potential mediator	EMO (n = 20)		POS (n = 19)		CTL (n = 16)			
	M	*SE*	*M*	*SE*	*M*	*SE*	*F*	*p*
Positive emotion essay words[a]	2.94_b	0.25	4.80_a	0.26	1.41_c	0.28	37.89[c]	.001
Negative emotion essay words[b]	2.24_a	0.13	1.18_b	0.13	0.98_b	0.15	25.78[c]	.001
Cognitive mechanism words	9.51_a	0.29	6.51_b	0.30	6.44_b	0.33	33.99[c]	.001
Self-reported negative mood	13.58_a	1.15	9.73_a	1.18	13.91_a	1.30	3.78[d]	.029
Self-reported positive mood	17.40	0.53	17.96	0.55	17.52	0.59	0.28[c]	.755

Note. Means with different subscripts differ significantly at $p < .05$ (with Tukey–Kramer adjustment). Means are adjusted for slightly different cell sizes and the relevant covariate. EMO = emotional writing condition; POS = positive writing condition; CTL = control condition.
[a] The analysis for positive emotion essay words revealed a significant effect for writing session. [b] The analysis for negative emotion essay words revealed a significant experimental Group × Session effect. [c] $F(2, 51)$. [d] $F(2, 54)$.

mean negative emotion word use was controlled from .161 to .109. Across groups, greater negative emotion word use was associated with lower physical symptoms across time ($pr = -.28$, $p = .03$). However, there was no significant change in the estimated marginal means when negative emotion word use was included, as EMO and POS continued to differ significantly from CTL on physical symptoms (17.52 for EMO, 20.54 for POS, and 30.80 for CTL). Thus, change in negative emotion word did not eliminate the previously obtained group differences.

Analyses yielded nonsignificant effects of the other process variables (i.e., HR recovery,[6] cognitive mechanism and positive essay words, self-reported negative mood) on health outcomes, including both the mean values and change scores that were tested.

Post Hoc Analyses of Relations of Potential Mediator Variables

Once we established that HR habituation and negative emotion word use in part mediated intervention effects on physical symptoms, we became interested in whether the other tested process variables might be associated with those mediators. Zero-order correlations revealed that greater within-session HR habituation was associated with greater use of cognitive mechanism words ($r = .44$, $p < .001$). Greater use of negative emotion words was also associated with more cognitive mechanism word use ($r = .52$, $p < .001$) and with greater HR recovery ($r = -.29$, $p = .031$), and greater mean cognitive mechanism word use was associated with decreased negative emotion word use and increased positive emotion word use over time ($r = -.30$ and $r = .27$, respectively, $p < .05$).

Discussion

The present study examines potential physiological, emotional, and cognitive mechanisms underlying the positive health effects produced by written emotional disclosure and benefit finding. Findings support the hypothesis that autonomic activity (as indicated by HR) mediates the effect of experimental condition, particularly expressive disclosure, on self-reported physical symptoms. Within-session HR habituation was greater for the EMO group than for the other conditions. When both HR habituation during writing sessions and experimental condition were used to predict self-reported physical symptoms, HR habituation predicted lower reports of somatic symptoms across time, and the effect of experimental condition on symptoms became nonsignificant. Use of negative emotion words in essays also was greater in the EMO group than in other conditions and was associated with lower physical symptoms, but group differences in symptom reports remained when this variable was controlled. Taken together, findings suggest that the positive health outcomes observed in the expressive disclosure group may be related to the decreasing autonomic arousal that occurs as participants engage in emotional processing of negative memories (Bootzin, 1997; Jaycox et al., 1998). This prolonged and repeated exposure and concomitant processing might contribute to improved regulation of physiological responses, presumably leading to less stress on bodily systems and ultimately, enhanced physical health. There is much still to investigate with regard to the role of habituation in expressive writing. Because all women were writing about their cancer experience and thus the same general stimulus, our data do not allow a conclusion regarding whether stimulus-specific habituation or response-specific habituation is more important. Both processes may be at work during emotionally expressive writing (see Lepore et al., 2002; Sloan & Marx, 2004a). Further, it is interesting that within-session but not across-session HR habituation mediated the intervention effects; indeed, no evidence for across-session HR habituation emerged. Given that within-session habituation is thought to promote across-session habituation over time (Foa & Kozak, 1986), a greater number of sessions may be required to produce a decrease in arousal upon confronting cancer-related stimuli for women who have recently undergone medical treatment. Finally, it remains unclear how these different indices of autonomic habituation in the laboratory might promote later reduction in physical symptom experience, an important question for future research.

With regard to linguistic process variables, the benefit-finding group did use language more reflective of positive emotions in their essays relative to the other two groups. However, positive emotion word use (and subjective positive mood) did not mediate

[6] Upon a reviewer's recommendation, we also conducted analyses examining HR recovery as the change in HR during writing to postwriting. Similar to findings with the HR recovery index reported in this article, experimental groups differed significantly on this index in multilevel modeling analyses, but it was not a significant mediator of outcomes.

the effects of writing on health outcomes. This result contradicts the findings of Pennebaker and colleagues (Pennebaker et al., 1997), who found that positive emotion word use was associated with improved physical health. However, the samples used in those analyses consisted of physically healthy participants asked to recall stressful life events in the past and to write about associated deepest thoughts and feelings. In that context, use of positive emotion words may represent successful resolution of a past stressful experience. However, the current sample wrote about their experiences with a life-threatening disease that had only recently been treated and that was likely still influencing their health, their relationships, and their thoughts about the future. For chronic, ongoing stressors, use of more positive emotion words may not reflect resolved acceptance and adaptation. More work is needed to clarify the effect of stressor characteristics on the expressive writing paradigm and its mechanisms.

Also unexpectedly, cognitive mechanism word use was not a significant mediator of effects. However, greater engagement of cognitive mechanisms (i.e., insight and causal words) was associated with more HR habituation, suggesting that grappling with the meaning of the cancer experience might facilitate habituation to the stressor. The limitations of the text analysis software used in this study should be noted. This program calculates the percentage of words associated with various content categories, but it does not take into consideration the context in which the words are used and cannot capture the tone or themes of an essay. Qualitative analysis may be more instructive in this regard.

Our analyses were unsuccessful in identifying a clear mediator of the health effects of writing about positive thoughts and feelings. Though the benefit-finding intervention clearly produced health effects similar to the emotional disclosure task (with a narrow advantage for the emotional disclosure condition; Stanton, Danoff-Burg, Sworowski, et al., 2002), the essays generated by women in this condition were markedly different, both qualitatively and quantitatively, than either the emotional disclosure or the control group essays. In the benefit-finding condition, there was more expression of positive emotion, less discussion of negative feelings, and less evidence of cognitive processing than in the emotional disclosure condition. However, neither these linguistic differences nor the physiological indicators accounted for the observed physical health effects. Thus, the processes through which benefit finding can lead to improved physical health require further study, and future research should examine alternative mechanisms. For example, writing about the positive aspects of a life-threatening experience may affect goal-relevant self-regulatory processes such as self-efficacy to pursue goals, hopefulness, or goal clarity (King, 2001). The role of goal-relevant processes in benefit-finding interventions warrants further scientific attention. Another possibility is that exposure to cancer-related stimuli and subsequent habituation may contribute to the effects of this writing condition as well, but to a lesser degree.

Several limitations to the present study must be noted. First, the relatively small sample size limited the power of our analyses to detect significant mediators of the effects. A second limitation regards generalizability of results. Because our sample was limited to women with early stage breast cancers, the findings may not extend to patients with more advanced disease or men, for example. Finally, the reliance on participant self-report for assessment of physical health outcomes may have compromised validity, and it should be noted that evidence of mediation occurred only for self-reported physical symptoms, for which the clinical significance remains unclear. The physical symptoms assessed may reflect acute illness or markers of serious disease relevant to the general population as well as late effects of medical treatments or symptoms prompting concern about cancer metastasis for cancer patients specifically. The positive correlation between physical symptoms and medical appointments supports the validity of the health measures, but the import of these measures for the long-term health of individuals with cancer requires study.

Important goals of future research should be replication of these findings in a larger sample as well as exploration of alternative mediators of the interventions. Further, investigation of additional, more refined biological mediators, such as cytokine, endocrine, or parasympathetic nervous system activity, would also help to clarify the processes underlying the physical health effects of writing about emotional experiences.

This work carries implications for clinical interventions. Because autonomic habituation to emotional processing was related to health improvements in the emotional disclosure group, clinicians may want to consider interventions that prompt this exposure and habituation. However, the nature of the intervention must be considered carefully. It could be argued that the control participants also experienced exposure to stressful experiences, as they were asked to recount the detailed facts of their cancer experiences. However, because their physical health appeared worse than that of the emotional-writing participants at follow-up, it seems that mere exposure to the facts of a traumatic experience may be insufficient to produce health effects. Rather, exposure to the associated emotions and thoughts seems to be necessary for adaptive habituation to occur, which in turn is associated with health benefits.

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