

ORIGINAL ARTICLE

Affectionate Writing Reduces Total Cholesterol: Two Randomized, Controlled Trials

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In two 5-week trials, healthy college students were randomly assigned either to experimental or control groups. Participants in the experimental groups wrote about their affection for significant friends, relatives, and/or romantic partners for 20 minutes on three separate occasions; on the same schedule, those in the control groups wrote about innocuous topics. Total cholesterol was assessed via capillary blood at the beginning of the trials and again at the end. Participants in the experimental groups experienced statistically significant reductions in total cholesterol. Control participants in the first study experienced a significant increase during the same period, whereas those in the second study did not. Cholesterol changes were largely unmoderated by linguistic features of the writing produced in the intervention. Potential therapeutic implications are discussed.

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One finds mention of affection in nearly every typology of fundamental human needs (Baumeister & Leary, 1995; Brown & Levinson, 1987; Maslow, 1970). Perhaps unsurprisingly, a robust literature attests to the mental and physical health benefits of receiving expressions of love and appreciation in the form of affectionate communication (for review, see Floyd, 2006a). Affectionate communication includes those verbal and nonverbal behaviors through which humans encode feelings of love, fondness, and positive regard for others, and it serves critical functions in the initiation and maintenance of personal relationships. Several studies have also shown that receiving expressions of affection reduces physical and psychological distress (Schwartz & Russek, 1998) and susceptibility to psychosomatic illness (Komisaruk & Whipple, 1998), and is inversely related to loneliness (Downs & Javidi, 1990), depression (Mackinnon, Henderson, & Andrews, 1993; Oliver, Raftery, Reeb, & Delaney, 1993), and alcohol abuse and physical aggression in families (Shuntich, Loh, & Katz, 1998).

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Whereas the benefits of *receiving* affection have been well established, the health effects of *expressing* affection have only recently been interrogated. Guided by affection exchange theory (AET) and relevant psychophysiological research, the present experiments investigate the ability of an affectionate-writing exercise to reduce total serum cholesterol over a 5-week period. This review begins with a brief description of AET and a summary of research demonstrating inverse associations between affectionate communication and stress. The relationship between stress and cholesterol is delineated next, and then the affectionate-writing intervention to be tested is described.

Affectionate communication and stress

Among the principal proposals of AET (Floyd, 2002, 2006a) is that expressing affection has stress-ameliorating physiological effects. Specifically, AET offers that communicating affection to loved ones initiates neuroendocrine processes that maximize reward and buffer the individual against the physiological effects of stress, and that these benefits are independent of those associated with receiving affectionate expressions.

Several studies have illustrated this effect. For instance, Floyd (2006b) examined the effects of expressed and received affection on diurnal variation in the steroid hormone cortisol. In the absence of acute stress, cortisol follows a strong diurnal (i.e., 24-hour) rhythm, wherein it peaks immediately after awakening and drops continually during the day, reaching its lowest point around midnight (Kirschbaum & Hellhammer, 1989). A high degree of morning-to-evening change in cortisol levels indicates healthy regulation of the hypothalamic–pituitary–adrenal axis, one of the body’s principal mechanisms for responding to acute stress; therefore, “flattened” diurnal curves, showing little change in cortisol values from morning to evening, are indicative of chronic stress (Chrousos & Gold, 1992; Giese, Sephton, Abercrombie, Duran, & Spiegel, 2004; Heim, Ehlert, & Hellhammer, 2000). As expected, Floyd (2006b) found that, with the influence of received affection controlled for, expressed affection was linearly related to the magnitude of morning-to-evening change in cortisol ($\beta = .56$).

A subsequent experiment by Floyd, Mikkelsen et al. (in press) demonstrated that, during episodes of acute stress (in which cortisol levels are typically elevated), expressing affection in writing to a loved one accelerates the recovery of cortisol levels to baseline values, relative to alternative activities. Grewen, Girdler, Amico, and Light (2005) similarly reported that engaging in nonverbal affectionate behaviors reduced cortisol levels for both men and women, and also elevated levels of the neurohypophyseal hormone oxytocin in women (see also Turner, Altemus, Enos, Cooper, & McGuinness, 1999), and Floyd, Hesse, and Haynes (in press) demonstrated a strong inverse relationship ($\beta = -.85$) between expressed affection and glycohemoglobin (an index of average blood glucose level, which is also elevated by stress), controlling for the effects of received affection.

These data are provocative in their demonstration that engaging in affectionate behavior is not only correlated with physiological health parameters but can also

effect improvements in health outcomes by ameliorating the effects of physiological stress. Indeed, these data have the potential to contribute to the development of behavioral interventions that may aid in the management of stress and its multiple related disorders (see, e.g., Blascovich, Shiffert, & Katkin, 1989; Kiecolt-Glaser et al., 1987; Roy, Kirschbaum, & Steptoe, 2001). The present experiments extend this research by testing the efficacy of a written affection intervention for reducing total cholesterol. The relationship between cholesterol and stress is addressed subsequently, followed by a description of the affectionate-writing exercise to be tested herein.

Stress and cholesterol

Cholesterol is a soft, waxy substance (lipid) found in the bloodstream and the cell membranes of all body tissues. It performs a number of essential functions, including maintaining membrane fluidity, producing bile, and contributing to the metabolism of fat-soluble vitamins (Shier, Butler, & Lewis, 2004). It is also the major precursor for steroid hormones, including cortisol, aldosterone, progesterone, estrogen, and testosterone. Most of the body's cholesterol is produced by the liver, although the consumption of foods that are high in cholesterol, trans fat, and/or saturated fat (such as egg yolks, red meat, full-fat dairy foods, and fried foods) elevates cholesterol levels in the bloodstream (Mader, 2005).

Total cholesterol is composed of triglycerides (fat molecules) and high-density and low-density lipoproteins (HDL and LDL, respectively, which transport fats through the bloodstream). American Heart Association guidelines provide that total cholesterol should be less than 200 mg/dL; cholesterol concentrations are considered borderline high if 200–239 mg/dL and high if 240 mg/dL or greater (American Heart Association, 2006). Chronic high cholesterol, a condition known as *hypercholesterolemia*, can lead to the formation and accumulation of plaque deposits in the arteries, which is problematic because it can contribute to atherosclerosis or coronary heart disease.

Besides being affected by diet, cholesterol levels are also influenced by stress. Stress includes the body's physiological regulatory responses to environmental threats, whether genuine or merely perceived (see Selye, 1956). Multiple investigations have demonstrated that acute and chronic stress are associated with elevations in serum cholesterol (see, e.g., Bacon, Ring, Lip, & Carroll, 2004; McCann et al., 1995; Muldoon et al., 1995; Stoney, Niaura, Bausserman, & Metacin, 1999). The specific mechanisms through which stress elevates cholesterol level are as yet unknown, although some have speculated that they may reflect evolved processes through which stress induced increases in energy (in the form of metabolic fuels such as glucose and fatty acids) initiate ancillary processes that elevate levels of LDL in the bloodstream (see Steptoe & Brydon, 2005).

If engaging in affectionate communication has stress-ameliorating physiological effects, as AET predicts, then one potential outcome of increasing affectionate behavior is a corresponding reduction in total cholesterol. The present experiments

test the ability of a written affection exercise to effect such a reduction. The intervention is described subsequently.

Affectionate writing as a stress-alleviating intervention

The present intervention is a variant on that used in Pennebaker's written disclosure paradigm (e.g., Pennebaker, 1993, 1995; Pennebaker, Hughes, & O'Heeron, 1987; Pennebaker, Kiecolt-Glaser, & Glaser, 1988; Petrie, Booth, Pennebaker, Davison, & Thomas, 1995; Smyth, 1998; Smyth, Stone, Hurewitz, & Kaell, 1999). Work in this paradigm involves having participants write for short periods of time on the most traumatic events they have experienced in their lives. Participants are encouraged to disclose thoughts and feelings about the trauma, and the writing exercise is theorized to produce a cathartic effect whose influence is compared to a control condition in which participants write about innocuous topics, such as what they did the day before. Writing sessions in Pennebaker's paradigm are typically 20 minutes long, and most studies employ between two and four sessions that occur either on consecutive days or on recurring days in consecutive weeks (e.g., every Monday). Research using this protocol has demonstrated that, compared to control group subjects, those who engage in traumatic disclosure writing experience improvements in cardiovascular function (Pennebaker et al., 1987), hepatitis B and Epstein-Barr virus antibody titers (Esterling, Antoni, Fletcher, Margulies, & Schneiderman, 1994; Petrie et al., 1995), natural killer cell activity (Christensen et al., 1996), and mental distress (Greenberg & Stone, 1992), as well as a reduction in physician visits lasting as long as 14 years after the traumatic disclosure writing intervention (Pennebaker, Barger, & Tiebout, 1989).

The variant on Pennebaker's procedure tested here is one developed in our lab that encourages expression of positive, relationally focused emotions rather than emotions associated with trauma. In the present protocol, experimental participants write about their positive feelings for three significant relational partners. King (2001) has demonstrated that health improvements can be elicited via positive- as well as negative-affect disclosure, and our protocol focuses the positive-affect writing on participants' most significant relationships. Initial research in our lab has indicated that relationally focused affectionate writing accelerates recovery of elevated cortisol during acute stress, an effect that does not manifest simply as a function of thinking about the target relationship (see Floyd, Mikkelson et al., in press). In the present procedure, experimental participants are asked to write about their positive, affectionate feelings for a close friend, a close relative, and the closest person in their lives. Three writing sessions are conducted over 3 weeks, and their effects on total cholesterol are compared to those of control participants who are writing on the same schedule about innocuous topics.

Hypothesis and research questions

The prediction to be tested is that engaging in affectionate expression (in the form of a written exercise) effects a significant reduction in total cholesterol that is not

manifested in the control group. This derives from AET's principle that expressing affection has stress-ameliorating physiological effects and from the associated observation that stress is directly related to total cholesterol. Stated as an hypothesis:

H1: Affectionate writing reduces total cholesterol to a greater extent than writing about innocuous topics.

Pennebaker's studies have found that the effects of traumatic disclosure writing on physical or psychosocial health outcomes are moderated by linguistic features of the writing. For instance, across several experiments (e.g., Pennebaker, Mayne, & Francis, 1997; Slatcher & Pennebaker, 2006), two noteworthy patterns have emerged (albeit somewhat inconsistently): (a) the more positive-emotion words used, the greater the health benefit and (b) the more participants increased their use of cognitive words related to causality and insight, the greater the health benefit. It is also possible that linguistic features of participants' writing would moderate the effect of the intervention on their blood chemistry. To explore these possibilities, we looked at the effects of linguistic features of participants' writing, and we also looked at the effects of how the linguistic features changed over the course of their three writing activities. Pennebaker et al. have found that both the averages of various linguistic features, and also increases or decreases in the use of particular linguistic features, can be influential. Our analyses were guided by the following questions:

RQ1: What linguistic features of writing, if any, affect change in cholesterol levels and/or moderate the influence of writing on change in cholesterol levels?

RQ2: Changes in what linguistic features, if any, affect change in cholesterol levels and/or moderate the influence of writing on change in cholesterol levels?

Study 1

Participants

Participants ($N = 34$) were 22 female and 12 male adults enrolled in upper-division undergraduate communication courses at a large university in the southwestern United States. Ages ranged from 20 to 31 years, with an average of 23.08 years ($SD = 2.80$). Most of the participants (77.8%) were Caucasian, whereas 8.3% were African American, 8.3% were Hispanic, 5.6% were Asian/Pacific Islander, 2.8% were Native American, and 5.6% were of other ethnic origins (these percentages sum to >100 because participants were allowed to indicate more than one ethnicity). Two participants were married and the rest were single. Two additional participants completed the procedures, but after they had completed the cholesterol assessments and left the laboratory, we discovered that the cholesterol monitor gave error readings for their cholesterol scores. We therefore deemed these scores to be unusable, and these participants were dropped from the analyses.

Procedures

Prescreening procedures

Prospective participants completed prescreening measures to determine their eligibility for the study. To be considered eligible, prospective participants had to report no history of diagnosis or treatment for hypercholesterolemia and no current use of blood-thinning agents such as Coumadin. Because the audience sampled consisted primarily of healthy young adults, all but one of those who completed the prescreening questionnaire met all of the qualification criteria. Women and men were equally likely to be qualified for the study ($p > .05$). The prescreening measure also assessed how often, in a typical week, participants used tobacco products, drank alcohol, and exercised for at least 30 minutes; these were not exclusion criteria but were measured for use as potential moderating factors.

Laboratory procedures

Qualified participants who consented to take part in the study made an appointment to visit the Communication Sciences Laboratory and were given a questionnaire to fill out beforehand. At their laboratory visit, participants turned in their completed questionnaires and filled out informed consent forms. Next, a researcher (one of the authors) drew 10 μ l of capillary blood from the third digit fingertip of each participant's nondominant hand for Time 1 (T_1) assessment of total cholesterol. The researcher used a 1.75-mm Tenderlett surgical blade lancet to extract the blood, which was applied directly from the fingertip to the test instrument for analysis. The researchers had received university training in the avoidance of bloodborne pathogens and employed universal precautions while drawing and handling blood samples, including the use of synthetic (nonlatex) gloves (see McCall & Tankersley, 2003). After each capillary blood draw, lancets, test materials, and gloves were discarded into biohazard containers.

At the end of the study, participants returned to the laboratory for their Time 2 (T_2) cholesterol assessment, which followed the same procedure as the initial assessment. They also completed a follow-up questionnaire at that time. After the second laboratory visit, participants were debriefed about the purposes of the study. Participants received extra course credit in exchange for their participation.

Experimental procedures

To ensure an equal sex distribution across conditions, we used stratified random assignment (via a randomizer software program) to assign participants to the experimental and control groups. A 2 (condition) \times 2 (sex) analysis of variance (ANOVA) indicated that T_1 cholesterol values did not differ significantly between the experimental and control groups (all main and interaction effects were $p > .05$). Participants in both conditions were each administered the writing intervention on three separate occasions during consecutive weeks following their initial visit to the laboratory (i.e., every Wednesday for 3 weeks). During each writing activity, participants were given a topic to write about and were instructed to write

for 20 minutes. They were told not to worry about spelling, punctuation, or grammar but instead to write about whatever came to mind on their topic. Participants were asked to continue writing for the full 20 minutes, after which time they were instructed to stop writing and to seal their writing in an envelope before returning it to the researchers. The writing activity forms were coded only with each participant's ID number; participants were instructed not to put their names anywhere on the writing activity form or on the envelope. We used a Latin-squares design within each condition to determine the order in which each participant would receive the three writing topics relevant for his or her group. The topics are described subsequently.

Experimental condition writing topics

In random order, each participant in the experimental group responded to each of the following topics:

1. Think about the one person in your life right now whom you love more than anyone else. In the space provided, describe why you love and care for this person so much. If you were to describe your feelings about this person to him or her, what would you say?
2. Think about a friend you've known for a long time, and imagine that you had only one opportunity to tell this friend how much he or she means to you. In the space provided, write this friend a letter in which you express how much you care about him or her.
3. Think about someone in your family whom you feel close to and really appreciate. This could be anyone you're related to somehow. What is it about this person that you appreciate so much? In the space provided, describe this person's most positive qualities.

Control condition writing topics

In random order, each participant in the control group responded to each of the following topics:

1. Think about the things that have happened to you in the last week. Other than coming to class, what sorts of things have you been doing over the last 7 days? In the space provided, give a description of the events of the past week.
2. Think about the house/apartment/dorm room in which you currently live. What does your residence look like, what is the layout, what furnishings do you have, etc.? In the space provided, give a detailed description of your current residence.
3. Think about your current job or the last job you held. What was your position? How did you spend your time at your job? What did your place of employment look like? In the space provided, give a detailed description of how you spent your time at work and the environment in which you worked.

Biochemical analysis

Total cholesterol was assessed in mg/dL using reflex photometry with a Clinical Laboratory Improvement Amendments (CLIA)-waived in vitro diagnostic monitor manufactured by Lifestream Technologies (Post Falls, ID). Each participant's capillary blood of 10 μ l was applied to a sterile test strip that was read by the monitor. Clinical validation data show the monitor's readings to average within \pm 4% of the National Reference Cholesterol Method.

Linguistic analyses

Following each administration of the writing intervention, the researchers typed each participant's writing verbatim into a Microsoft Word document. Using the Linguistic Inquiry and Word Count (LIWC) software (Pennebaker, Francis, & Booth, 2001), we analyzed each participant's writing for multiple linguistic features, including total number of words, average number of words per sentence, positive- and negative-emotion words, pronouns, and terms related to cognition, sensory experience, and social relationships. These data were used both to check for manipulation consistent linguistic differences between the experimental and control groups and also to examine potential moderators of the effect of writing on cholesterol change. Reliability and validity data for LIWC appear in Pennebaker and Francis (1996), and Pennebaker et al. (2001).

Preliminary analyses

Cholesterol scores at T_1 ranged from 151 to 240, with an average of 171.91. As noted, a factorial ANOVA with participant sex and experimental condition as the independent variables confirmed that T_1 cholesterol scores did not differ significantly by condition, sex, or their interaction. Thus, although average T_1 cholesterol scores were higher in the experimental condition (178.80) than in the control group (166.17), this between-groups difference was not statistically significant, $t(33) = -1.83$, $p = .076$. T_1 and T_2 cholesterol scores were significantly correlated, $r = .84$, $p < .001$.

Based on height and weight, we calculated body mass index (BMI) for each participant (using the National Institutes of Health formula) for use as a potential covariate. For the sample, BMI scores ranged from 17.18 to 30.34, with an average of 23.45 ($SD = 3.06$). This average score represents a "normal" (i.e., not underweight or overweight) BMI for adults, according to Centers for Disease Control and Prevention (CDC) standards (CDC, 2006). BMI was significantly higher for men ($M = 25.76$, $SD = 2.71$) than for women ($M = 22.14$, $SD = 2.43$), $t(32) = 4.12$, $p < .001$, $r = .59$.

As a type of manipulation check on the writing intervention, we compared the writing samples produced by the experimental and control conditions on multiple linguistic characteristics. Due to the relational nature of the experimental writing instructions, and the relatively impersonal nature of the control group writing instructions, we expected significant differences in the use of positive-emotion words, negative-emotion words, personal pronouns, social words (e.g., references to friends, relatives, other people), cognition words (e.g., references to thought,

propriety, causality), and sensory words (e.g., references to seeing, touching, hearing). In each of these cases, we anticipated higher average scores for writing produced by the experimental group than the control group. We had no reason to expect significant differences in features such as word count or average number of words per sentence, but we analyzed these for use as potential covariates. The check succeeded on all counts, as Table 1 reports.

To control for the possibility that observed changes in total cholesterol were caused by changes in health behaviors (as opposed to the writing intervention), we asked participants to report at the end of the study if they had experienced any changes in their diet, exercise habits, or general health during the period of the study. If so, they were asked to describe the changes in writing. Some changes constituted improvements that would be expected to reduce total cholesterol (e.g., “I have exercised more often”); others constituted changes that would be expected to increase total cholesterol (e.g., “I have been eating much more fast food”). For analytic purposes, we coded each participant’s responses for diet, exercise, and general health as showing either positive change (+1), negative change (−1), or no change (0), creating a score ranging (theoretically) from −3 to +3 for each participant. Observed scores ranged from −2 to 1, with a mean of 0.06 ($SD = 0.79$). These health change index scores did not differ by experimental condition or participant sex ($p > .05$) but were tested as a potential covariate in the test of the writing intervention.

Hypothesis and research question

The hypothesis was that the affectionate-writing intervention would reduce total cholesterol to a greater extent than the control intervention. To test the prediction, we analyzed T_1 and T_2 cholesterol scores in a mixed-model analysis of covariance

Table 1 Linguistic Analyses of Experimental Group and Control Group Writing for Study 1

Linguistic Feature	Experimental <i>M/SD</i>	Control <i>M/SD</i>
Total word count	420.65/110.83	419.16/90.33
Average words per sentence	19.54/3.21	18.13/3.43
First-person singular pronouns	9.20/1.57	6.84/1.72 ^a
First-person plural pronouns	1.83/1.02	1.09/0.75 ^a
Second-person pronouns	3.16/1.84	0.50/0.48 ^a
Third-person pronouns	3.67/1.14	1.51/0.84 ^a
Positive-emotion words	5.02/1.36	1.87/0.66 ^a
Negative-emotion words	1.08/0.53	0.63/0.42 ^a
Cognition words	7.16/1.11	3.92/1.23 ^a
Sensory words	2.32/0.78	1.46/0.36 ^a
Social words	14.54/1.15	6.26/1.57 ^a

Note: Scores are averaged across the three writing periods.

^aMeans differ significantly, per independent samples *t* test.

(ANCOVA), with participant sex and experimental condition as between-subjects factors and time as the within-subjects factor. Covariates included participant age, BMI, number of days between T₁ and T₂ cholesterol assessments (range 20–28 days, $M = 24.75$, $SD = 2.16$), number of alcoholic beverages consumed in a typical week (range 0–20 drinks, $M = 5.75$, $SD = 6.52$), number of times in a typical week that participants exercise for at least 30 minutes (range 0–10, $M = 3.32$, $SD = 2.82$), whether participant was a smoker (coded as 1 = *yes*, 0 = *no*), and the health change index score described previously. All of the covariates produced nonsignificant effects and were therefore removed from the analysis. Zero-order correlations between these covariates and cholesterol values appear in Table 2.

As hypothesized, cholesterol was affected by a significant interaction between experimental condition and time, $\Lambda = .66$, $F(1, 32) = 16.85$, $p < .001$, partial $\eta^2 = .35$. No other main or interaction effects were significant (all $ps > .05$). Consistent with the prediction, the experimental condition experienced a significant reduction in total cholesterol from T₁ ($M = 178.80$, $SD = 29.25$) to T₂ ($M = 171.56$, $SD = 25.79$), $t(14) = 3.95$, $p = .001$. By contrast, the control group experienced a significant increase in cholesterol from T₁ ($M = 166.17$, $SD = 24.02$) to T₂ ($M = 174.33$, $SD = 20.03$), $t(14) = -.16$, $p = .88$. The interaction is depicted in Figure 1. The hypothesis is confirmed.

The first research question asked whether linguistic features of participants' writing affected changes in cholesterol and/or moderated the influence of the writing intervention. To address the question, we first computed cholesterol change (Δ) scores by subtracting T₁ cholesterol values from T₂ values; positive scores therefore indicated increase in cholesterol and negative scores indicated decrease. We then conducted a series of linear regression analyses, using zero-centered variables, to test for potential moderator effects, as per the method recommended by Baron and Kenny (1986). The linguistic features showing significant differences between experimental and control groups (see Table 1) were tested as potential moderators. In each regression analysis, experimental condition and the linguistic feature were entered in the first step, and their interaction was entered in the second step.

Table 2 Zero-Order Correlations between Cholesterol Values and Potential Covariates for Study 1

Variable	Cholesterol Time 1	Cholesterol Time 2
Participant age	.18	.24
Number of alcoholic drinks in average week	-.17	-.16
Frequency of exercise in average week	-.10	-.16
Body mass index	.05	.26
Whether participant smokes	.02	-.08
Health change index during study	-.13	-.12
Days between cholesterol assessments	.03	.18

Note: None of the correlation coefficients is statistically significant.

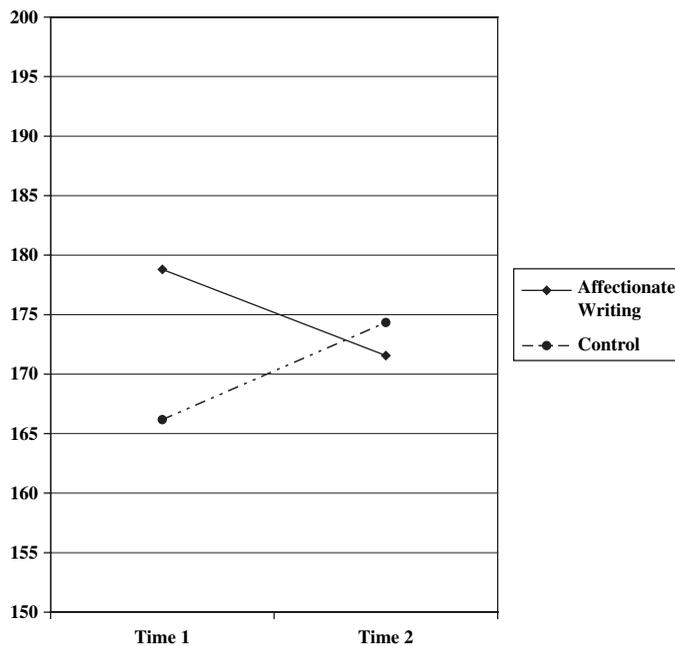


Figure 1 Time by experimental condition interaction on total cholesterol for Study 1 ($N = 34$)

Note: Cholesterol measurement is in mg/dL. Both within-subjects comparisons (changes over time) are statistically significant.

The cholesterol change score was entered as the criterion variable. Evidence of moderation is provided if the interaction effect is significant.

Of the linguistic features analyzed, only the use of third-person pronouns significantly moderated the influence of the intervention on cholesterol change ($\beta = 1.57, p = .012$). We probed the interaction by examining the regression slopes separately for the experimental and control groups. For those in the experimental condition, cholesterol decreases were more pronounced when the participant used fewer third-person pronouns (words such as *she, they, it, his*), as opposed to more ($\beta = .72, p = .002$). The opposite was true in the control group, although the beta was nonsignificant ($\beta = -.33, p = .169$). No other linguistic characteristics moderated the effect of the writing intervention on cholesterol change, and none had a direct influence on cholesterol change (all $ps > .05$).

The second research question asked whether changes in the use of linguistic features affected cholesterol change and/or moderated the influence of the writing intervention. Following the procedures of Pennebaker et al. (1997), we computed change scores for the linguistic features (first-person singular and plural pronouns, second- and third-person pronouns, positive- and negative-emotion words, and cognitive, sensory, and social words) by subtracting values for the first writing session from those for the third. We entered these values, along with experimental

condition, in the first step of hierarchical regression analyses, with change in cholesterol as the criterion values. In the second step, we entered the interaction term of experimental condition and change in the linguistic feature. None of the linguistic feature changes affected cholesterol change, and none moderated the influence of the writing intervention (all $ps > .05$).

Discussion

AET provides that expressing affection to a loved one ameliorates the physiological effects of stress, even in the absence of receiving an affectionate expression in return. In support of this proposition, correlational studies (as we reviewed above) have found that one's trait level of affectionate expression is inversely associated with blood glucose and directly associated with morning-to-evening cortisol change (both after controlling for the effects of received affection). As we also indicated, experimental studies have also found that engaging in affectionate behavior reduces cortisol and increases oxytocin (the latter for women only). The present experiment adds to these findings by demonstrating that engaging in three 20-minute affectionate-writing exercises reduces total cholesterol within a 5-week period.

As hypothesized, the affectionate-writing intervention produced a decrease in total cholesterol. At least four things are noteworthy about this outcome. First, the reduction was observed after only an average of 25 days between the first and second cholesterol assessments, demonstrating that the effects of the intervention are relatively rapid. Second, the reduction was independent of the effects of multiple alternative sources of variance, including smoking, drinking, age, body mass, and changes in diet, exercise, or general health, each of which had the potential to account for changes in blood lipid levels. Third, the intervention is brief, utilizing only three 20-minute writing sessions during consecutive weeks. Writing interventions in Pennebaker's studies average two to four writing sessions either on consecutive days or consecutive weeks, although effects in his studies have tended to be larger when the intervention occurs over a longer period of time (i.e., consecutive weeks as opposed to consecutive days; see Smyth, 1998). Finally, and perhaps most important, the intervention that produced the reduction in total cholesterol is entirely communicative in nature. The only instruction was to write about one's affection and positive feelings for significant relational partners. That this intervention significantly affected total cholesterol values (independently from physical characteristics that would be expected to affect them) illustrates the stress-ameliorating effect of affectionate communication theorized by AET and previously demonstrated in the neuroendocrine system (Floyd, Mikkelsen et al., in press).

The time-by-condition interaction produced a moderate effect size (partial $\eta^2 = .35$), but this is partly attributable to the cholesterol increase experienced by the control group. We made no specific prediction about cholesterol value changes in the control group, only that the experimental group would experience a greater reduction in cholesterol than the control group would. Thus, it was not contrary to our hypothesis that cholesterol values in the control group increased, although

this does partly account for the magnitude of the interaction effect and it does beg explanation. Our speculation is that the study sample, as a whole, experienced an increase in stress from the beginning to the end of the study, whose effects on cholesterol were buffered by the affectionate-writing exercises in the experimental group but were not buffered by the innocuous writing exercises in the control group. The study took place during a 5-week summer session in which a regular 16-week semester's worth of course material is presented. T_1 cholesterol assessment took place during the first week; the three writing activities occurred during the second, third, and fourth weeks; and then T_2 cholesterol was measured in the fifth week. Hence, we speculate that the sample experienced a general increase in stress as the fifth week (and final exams) approached. As an ad hoc test of this explanation, we analyzed participants' self-reports of their psychological stress (measured with the 14-item Perceived Stress Scale developed by Cohen, Kamarck, & Mermelstein, 1983; $\alpha = .91$ at T_1 and $.77$ at T_2) in a mixed-model ANOVA, with sex and experimental condition as between-subjects factors. The ANOVA produced a significant main effect for time, $F(1, 30) = 12.18, p = .002, \text{partial } \eta^2 = .29$. No other main or interaction effects were significant. Consistent with our explanation, stress scores increased from T_1 ($M = 2.69, SD = 1.14$) to T_2 ($M = 3.19, SD = 0.64$), and this change was unmoderated by experimental condition or participant sex.

Because of the theorized stress-ameliorating effects of affectionate expression, we speculate that those in the experimental condition were buffered against the physiological effects of the increased stress and were able to experience reductions in their blood lipids. However, without the benefit of the affectionate expression intervention, those in the control group were susceptible to the effects of increased stress, including increases in total cholesterol. This is our speculation as to why the control group saw an average increase in lipid values; replication of the study during a less stress-inducing period (as we did in Study 2) will illuminate the merits of this explanation. It will also test the possibility that the cholesterol-reducing effects of affectionate writing would be even greater in a less stressful environment.

We also examined the possibility that linguistic features of the writing (or changes in linguistic features) would affect total cholesterol change, either directly or by moderating the influence of the writing intervention. We analyzed first-person singular and plural pronouns, second- and third-person pronouns, positive- and negative-emotion words, cognition words, sensory words, and social words as potential moderators and found that only third-person pronoun use had a significant moderating effect. Specifically, those in the experimental group experience a larger reduction in total cholesterol the fewer third-person pronouns they used in their writing. We speculate that this moderating effect related to the perspective experimental participants elected to take in their writing. In response to the experimental condition writing instructions, some participants wrote *to* their loved ones (i.e., in second-person voice) and others wrote *about* them (i.e., in third-person voice). The observed moderating effect suggests that writing *to* loved ones instead of *about* them is more efficacious in reducing total cholesterol, although there was not a

corresponding moderating effect for the use of second-person pronouns. No other linguistic features or changes in linguistic features moderated the influence of the writing intervention, and none affected total cholesterol change directly.

Summary and limitations

Results from the first trial provide preliminary evidence of the efficacy of an affectionate-writing intervention for reducing total cholesterol, but three methodological issues temper confidence in the results. First, T_1 cholesterol scores were unequal for the experimental and control groups. Despite random assignment to conditions, the initial cholesterol values for the two groups—although they were not significantly different—were different enough to raise questions about the true nature of the experimental effect. Indeed, the pattern of results, wherein cholesterol values in the experimental group decreased whereas those in the control group increased, simulates the *regression to the mean* effect that is sometimes observed in repeated-measures designs with groups chosen for their extreme values (see, e.g., Bland & Altman, 1994).

Second, due to ambiguity in the experimental condition's writing instructions, there was variance in how experimental participants addressed their letters. As we noted above, approximately half of the experimental participants addressed their letters *to* a loved one, whereas the others wrote *about* a loved one, and the difference in the use of third-person pronouns moderated the effect of the intervention on cholesterol change. Third, because the trial occurred during a 5-week summer school session, participants had their T_2 cholesterol assessed during the week they took final exams, which likely provided for a general increase in psychological stress relative to the first assessment. As we noted above, we believe this may account for the control group's linear increase in total cholesterol.

To address these limitations, we replicated the first study in a new trial that featured four methodological improvements. First, to ensure T_1 equivalency on cholesterol scores, we conducted random assignment to conditions after collecting T_1 cholesterol scores (rather than beforehand, as we had done in the first study). Second, we slightly modified the writing instructions in the experimental condition, directing participants to write *to* their loved ones rather than *about* them. Third, we conducted the new trial in the middle of a regular 16-week semester, ensuring that neither T_1 nor T_2 cholesterol assessments would overlap with major examinations. Finally, although we have no reason to question the validity of our biochemical analyses from the first study, we introduced a newer cholesterol monitor with greater sensitivity in the second trial. Specifics of the second study appear subsequently.

Study 2

The second study was designed as a replication of Study 1, with the methodological improvements described above. The hypothesis and research questions were identical for the two trials.

Participants

Participants ($N = 30$) were 22 female and 8 male adults enrolled in upper-division undergraduate communication courses at a large university in the southwestern United States. Ages ranged from 19 to 31 years, with an average of 21.93 years ($SD = 2.80$). Most of the participants (90%) were Caucasian, whereas 10% were Hispanic, 3.3% were African American, 3.3% were Native American, and 3.3% were of other ethnic origins. Two participants were married and the rest were single.

Procedures

Prescreening procedures

Participants in the second study were recruited and prescreened using the same procedures as in Study 1. All participants screened were qualified for the study.

Experimental procedures and writing topics

All procedures and writing topics (in both conditions) were identical to those used in the first study, with two exceptions. First, to ensure greater equivalency in T_1 cholesterol scores between the experimental and control groups, we performed assignment to conditions after completing T_1 cholesterol tests and then tested the groups for mean differences. The stratified random assignment procedure was identical to that used previously. In this study, the experimental group had a mean T_1 cholesterol value of 170.20 ($SD = 31.50$), whereas the mean for the experimental group was 173.73 ($SD = 38.51$). A factorial ANOVA, with participant sex and experimental condition as the independent factors, produced no significant main or interaction effects (all $ps > .05$). Via this procedure, we were able to ensure that the two conditions were nearly identical in their T_1 cholesterol values.

The second difference was that we added one sentence at the end of each set of writing instructions for the experimental group: "Please write TO this person, instead of ABOUT him or her." This added instruction (which was not relevant to any of the writing guidelines for the control group) was intended to encourage more direct expression of affectionate emotion to the targets of participants' writing activities. Writing instructions for the control group were identical to those used in the first study.

All other laboratory and experimental procedures were identical to those employed in Study 1.

Biochemical analysis

Total cholesterol was assessed in mg/dL with the Cholestech LDX, a CLIA-waived in vitro diagnostic monitor manufactured by Cholestech (Hayward, CA). For this test, 40 μ l of capillary blood was aspirated into a glass tube coated with lithium heparin, an anticoagulant. The blood was then applied to a sterile test strip that was read by the monitor. The monitor is quantitatively calibrated on a daily basis, is tested with manufactured controls monthly, and has been extensively validated for total cholesterol assessment in published clinical examinations (Gregory, Duh, & Christenson, 1994; Rogers, Misner, Ockene, & Nicolosi, 1993).

Linguistic analyses

LIWC was again employed to analyze narratives for total number of words, average number of words per sentence, number of questions, positive- and negative-emotion words, pronouns, and terms related to cognition, sensory experience, and social relationships.

Preliminary analyses

Cholesterol scores at T_1 ranged from 131 to 261, with an average of 171.97 (nearly identical to the T_1 cholesterol mean from the previous study). As noted, a factorial ANOVA with participant sex and experimental condition as the independent variables confirmed that T_1 cholesterol scores did not differ significantly by condition, sex, or their interaction. T_1 and T_2 cholesterol scores were strongly correlated, $r = .91$, $p < .001$. We again computed BMI for use as a potential covariate. BMI scores for this study ranged from 18.72 to 35.42, with a mean of 22.98 ($SD = 3.53$). Unlike in the first study, BMI was not significantly higher for men ($M = 23.30$, $SD = 1.94$) than for women ($M = 22.84$, $SD = 4.07$), $t < 1$.

As before, we compared the written narratives by experimental condition to ascertain whether those produced by the experimental group exceeded those from the control group in emotion words, pronouns, and social, cognitive, and sensory words. The results, which replicate those from the first study, appear in Table 3. We also calculated health change index scores for Study 2 participants, replicating the procedures from the previous study. For this sample, observed scores ranged from -2 to 2 , with a mean of 0.13 ($SD = 0.97$). The health change index scores did not differ by experimental condition or participant sex.

Table 3 Linguistic Analyses of Experimental Group and Control Group Writing for Study 2

Linguistic Feature	Experimental <i>M/SD</i>	Control <i>M/SD</i>
Total word count	447.29/99.12	408.31/103.78
Average words per sentence	19.21/2.62	19.06/3.70
First-person singular pronouns	8.44/1.83	7.42/2.40
First-person plural pronouns	1.53/0.73	1.56/1.18
Second-person pronouns	2.49/1.88	1.16/1.37 ^a
Third-person pronouns	3.27/1.47	1.93/1.36 ^a
Positive-emotion words	4.21/1.89	2.71/1.40 ^a
Negative-emotion words	1.01/0.55	0.62/0.47 ^a
Cognition words	6.64/1.62	4.80/2.08 ^a
Sensory words	2.05/0.58	1.63/0.47 ^a
Social words	12.49/3.71	8.70/4.38 ^a

Notes: Scores are averaged across the three writing periods.

^aMeans differ significantly, per independent samples t test.

Hypothesis and research questions

The hypothesis was that the affectionate-writing intervention would reduce total cholesterol to a greater extent than the control intervention. We again analyzed T_1 and T_2 cholesterol scores in a mixed-model ANCOVA, with participant sex and experimental condition as between-subjects factors and time as the within-subjects factor. We used the same covariates as before: participant age, BMI, number of days between assessments (range 25–30 days, $M = 26.67$, $SD = 1.27$), number of alcoholic beverages consumed in a typical week (range 0–30 drinks, $M = 6.20$, $SD = 6.60$), number of times in a typical week that participants exercise for at least 30 minutes (range 0–7, $M = 3.50$, $SD = 1.80$), whether participant is a smoker (1 = *yes*, 0 = *no*), and the health change index score. As before, all of the covariates produced non-significant effects and were therefore removed from the ANOVA. Zero-order correlations between these covariates and cholesterol values appear in Table 4.

As hypothesized, cholesterol was affected by a significant interaction between experimental condition and time, $\Lambda = .84$, $F(1, 26) = 4.74$, $p = .039$, partial $\eta^2 = .15$. No other main or interaction effects were significant (all $ps > .05$). Consistent with the prediction, the experimental condition experienced a significant reduction in total cholesterol from T_1 ($M = 170.20$, $SD = 31.50$) to T_2 ($M = 159.07$, $SD = 26.94$), $t(14) = 4.60$, $p < .001$. Those in the control group experienced a slight but non-significant increase in cholesterol from T_1 ($M = 173.73$, $SD = 38.51$) to T_2 ($M = 174.40$, $SD = 35.35$), $t(14) = -.16$, $p = .88$. The interaction is depicted in Figure 2. The hypothesis is confirmed.

Five participants (two from the experimental group and three from the control group) manifested fairly large changes in cholesterol (>15 points) from T_1 to T_2 . This magnitude of change is certainly not unreasonable, but it is somewhat surprising for a 5-week period, especially because none of the participants was on cholesterol medication at any point in the study. On the possibility that these cases might represent measurement error rather than true change, we reran the analysis for the hypothesis with these five cases removed. Minus these cases, the experimental group had a T_1 cholesterol score of 163.15 ($SD = 23.31$), whereas the score for the control

Table 4 Zero-Order Correlations Between Cholesterol Values and Potential Covariates for Study 2

Variable	Cholesterol Time 1	Cholesterol Time 2
Participant age	.08	.02
Number of alcoholic drinks in average week	-.12	-.13
Frequency of exercise in average week	.05	-.07
Body mass index	.04	-.05
Whether participant smokes	-.24	-.12
Health change index during study	.02	.07
Days between cholesterol assessments	.12	.04

Note: None of the correlation coefficients is statistically significant.

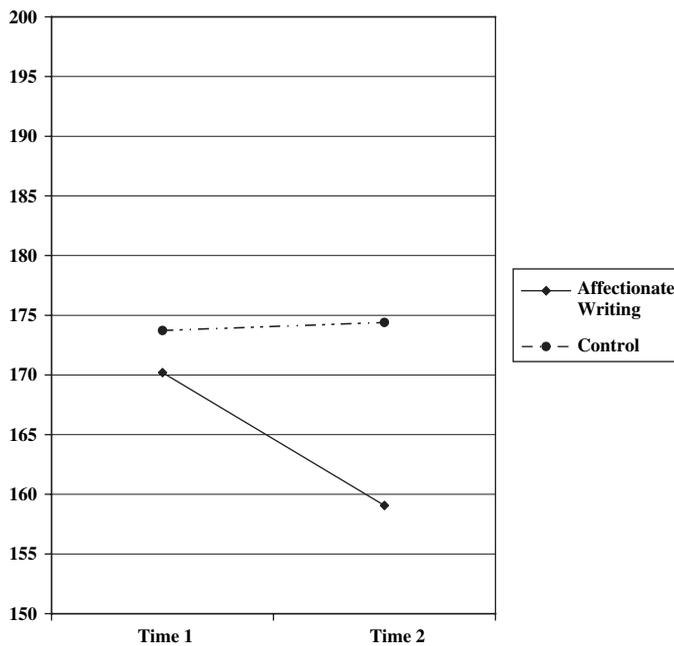


Figure 2 Time by experimental condition interaction on total cholesterol for Study 2 ($N = 30$)

Note: Cholesterol measurement is in mg/dL. The within-subjects comparison is statistically significant for the affectionate writing condition only.

group was 172.67 ($SD = 41.50$). These scores do not differ significantly, $t(23) = .71$, $p = .48$, although they are farther apart than the T_1 scores with all cases included. As before, the ANOVA produced a significant time-by-condition interaction, $\Lambda = .62$, $F(1, 21) = 13.02$, $p = .002$, partial $\eta^2 = .38$; no other main or interaction effects were significant. As with the full sample, the experimental condition experienced a significant reduction in total cholesterol from T_1 to T_2 ($M = 156.23$, $SD = 24.24$), $t(12) = 4.44$, $p < .001$. Those in the control group again experienced a slight but nonsignificant increase in cholesterol from T_1 to T_2 ($M = 175.17$, $SD = 39.65$), $t(11) = -.92$, $p = .38$. With these five potential outliers removed, therefore, the pattern of results was the same, although the experimental group's reduction in cholesterol was smaller (~ 7 points, similar to the reduction observed in the first study) with the outliers removed than with the outliers included.

We tested the research questions in the same manner as before. The first research question asked whether linguistic features of participants' writing affected changes in cholesterol and/or moderated the influence of the writing intervention. Unlike in the first study, no linguistic characteristics moderated the effect of the writing intervention on cholesterol change, and none had a direct influence on cholesterol change (all $ps > .05$). The second research question asked whether changes in linguistic features affected cholesterol change and/or moderated the

influence of the writing intervention. As before, none of the linguistic feature changes affected cholesterol change, and none moderated the influence of the writing intervention (all $ps > .05$).

Discussion

The second study served as a methodologically improved replication of Study 1. Via small changes in our procedures, we ensured greater T_1 equivalency in experimental and control group cholesterol values, we directed experimental participants to write *to* their loved ones instead of simply *about* them, and we prevented T_2 cholesterol assessments from overlapping with final exams. The net result was that experimental participants again significantly reduced their cholesterol levels, whereas levels for control participants did not change. Thus, our primary experimental outcome replicated, and in a less confounded manner. The effect size estimate of .15, although smaller than the one identified in the first study, still suggests a moderate effect. Also, whereas in the first study, one linguistic characteristic moderated the effect of experimental condition on cholesterol change, none did so in the second study.

General discussion

Perhaps, the most salient contribution of the current research is its demonstration that a brief, communicative, interpersonally focused writing intervention can reduce total cholesterol, and that this outcome is independent of a host of alternative sources of variance. Along with the studies by Floyd (2006b), Floyd, Hesse et al. (in press), and Floyd, Mikkelsen et al. (in press), this experiment contributes to a growing understanding of how interpersonal communication patterns related to the expression of affection can improve not only self-reported mental and emotional well-being but also objectively measured markers of physical health, such as cholesterol.

As Floyd et al. (2005) pointed out, it is important to disentangle the benefits of *expressing* affection from the benefits of *receiving* it because affectionate communication is such a strongly reciprocal behavior. In other words, what might appear to be a benefit of conveying affection may simply be the benefit of the affection one receives in return, and the design of some studies (like Grewen et al., 2005) does not allow these sources of variance to be separated. One strength of the current research design is that received affection can be ruled out as a potential effect on cholesterol change because participants' affectionate writings were not sent to their targets. It is important to acknowledge, however, that writing about their feelings of affection for their loved ones may have caused participants to become more verbally or non-verbally affectionate with those targets outside of the study, and that some of the benefit of the writing may have been indirect, as a function of this increased affection.

Because the current samples consisted of young, healthy college students who were prescreened for hypercholesterolemia, their T_1 and T_2 average cholesterol values (in both conditions) were all in the "desirable" (i.e., <200 mg/dL) range, according to American Heart Association (2006) guidelines. Consequently, the cholesterol

changes observed in the control and experimental groups may have marginal clinical significance for nonclinical populations such as these. Demonstration of a cholesterol-reducing effect of affectionate writing has potentially, clinically significant implications for a patient population, however. To the extent that engaging in an affectionate-writing exercise precedes reductions in total cholesterol, this activity may be useful as an ancillary behavioral (nonpharmacological) intervention for the treatment of hypercholesterolemia. The activity is brief, nearly free, and requires almost no training or supervision to conduct, all of which enhance its pragmatic value. The extent to which the observed cholesterol reductions would replicate in a nonlaboratory setting is unknown, but this would be a worthy topic for future field research.

The sample sizes were small relative to those typically seen in mainstream interpersonal communication research. However, they were within the norm both for writing intervention research (e.g., Pennebaker et al., 1988; Petrie et al., 1995) and for psychophysiological studies (e.g., Kurup & Kurup, 2003; Marazziti & Canale, 2004; van Niekerk, Huppert, & Herbert, 2001), including psychophysiological studies conducted within the field of interpersonal communication (e.g., Floyd, 2006b; Tardy, Thompson, & Allen, 1989). The controlled, longitudinal nature of the current trials and the relative inability of participants to introduce error variance in their cholesterol data by social desirability biases all argue for the adequacy of the sample sizes.

There are at least five promising ways to extend the current study in future research. One way to improve the current method would be to use a lipid profile panel assessment instead of a measurement of total cholesterol. Total cholesterol has diagnostic value, but a lipid panel (which separates total cholesterol into its constituent parts) provides greater specificity because changes in any element (triglycerides, HDL, LDL) change the total cholesterol value. (Lipid panels also require a fasting blood sample, which is not required of a total cholesterol assessment.)

Second, future research should investigate the physiological mechanisms responsible for the observed cholesterol reductions. As we noted in the literature review, the specific mechanisms via which stress elevates cholesterol are as yet unidentified, but increases in serum glucose and free cortisol are two suspects, given that they directly result from arousal of the hypothalamic–pituitary–adrenal axis, one of the body's principal physiological responses to stressors. Future studies should examine these as potential mediators of the stress-cholesterol association and as mechanisms through which reductions in stress can lead to reduced cholesterol.

Third, the benefits of affectionate writing might be compared not only to writing about innocuous topics but also to writing about traumatic emotions (which a majority of Pennebaker's writing studies has done). Some research (e.g., King, 2001) has found that both traumatic writing and positive-emotion writing (although not affectionate writing, as in the current study) have had health-relevant outcomes, such as reductions in the number of physician visits. Whether traumatic and affectionate forms of emotional writing would manifest comparable physiological outcomes is unknown, but this would be a fruitful topic for future work.

Fourth, given the treatment's efficacy with a nonclinical population, future research should test its effects in a population with hypercholesterolemia. To the extent that it proves effective at lowering total cholesterol (or its constituent components), it may be a useful ancillary to pharmacological treatments for chronic high cholesterol.

Finally, recent research by Lyubomirsky, Sousa, and Dickerhoof (2006) has suggested that the benefits of expressive writing (about positive past events, not affectionate feelings for a relational partner) vary according to whether the writer is induced to analyze the past event or to reexperience it. Specifically, Lyubomirsky et al. found that reexperiencing a positive past event through writing led to benefits in self-reported health indices, whereas analyzing the event did not (the opposite pattern emerged for negative past events). These findings suggest the need for further investigation of the mechanisms within the experience of writing itself that may mediate its benefits.

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