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Cognitive, Emotional, and Language Processes in Disclosure

James W. Pennebaker and Martha E. Francis
Southern Methodist University, Dallas, Texas, USA

Previous studies have found that writing about upsetting experiences can improve physical health. In an attempt to explain this phenomenon, 72 first-year college students were randomly assigned to write about either their thoughts and feelings about coming to college or about superficial topics for three consecutive days. Measures of language use within the writing samples and cognitive measures of accessibility and schematic organisation were collected in the weeks before and after writing. As in previous studies, writing about college was found to reduce health centre visits for illness and to improve subjects' grade point average. Text analyses indicated that the use of positive emotion words and changes in words suggestive of causal and insightful thinking were linked to health change. Improved grades, although not linked to these language dimensions, were found to correlate with measures of schematic organisation of college-relevant themes. Implications for using written language to understand cognitive and health processes are discussed.

INTRODUCTION

Numerous investigations have now demonstrated that having people write about upheavals in their lives brings about a variety of positive changes. Writing about traumatic experiences for 3–5 days, for as little as 10 minutes per day, has been shown to result in reductions in subsequent visits to physicians (Krantz & Pennebaker, submitted; Pennebaker & Beall, 1986; Pennebaker, Kiecolt-Glaser, & Glaser, 1988). Among those who report having had particularly significant traumas, writing about

Requests for reprints should be sent to James W. Pennebaker, Department of Psychology, Southern Methodist University, Dallas, TX 75275, USA; e-mail: pennebak@mail.smu.edu.

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traumas reduces physician visits after four days of writing (Greenberg & Stone, 1992) and even a single writing period following an imaging exercise (Greenberg, Stone, & Wortman, in press). Other studies indicate that writing about traumas is associated with improved immune function, as measured by enhancement in selected T-helper cell activity (Pennebaker et al. 1988), response to latent Epstein–Barr virus reactivation (Esterling, Antoni, Fletcher, Margulies, & Schneiderman, 1994), and response to hepatitis-B vaccination (Petrie, Booth, Pennebaker, Davison, & Thomas, 1995). Beyond health changes, other studies have now demonstrated that writing about adjusting to college is associated with improved grades (Pennebaker, Colder, & Sharp, 1990). Further, when adults who have been laid off from their jobs write about the experience, they are able to secure new jobs more quickly (Spera, Buhrfeind, & Pennebaker, 1994).

Beyond objective measures, writing also appears to have salutary psychological effects. Participants in each of the previous studies have consistently reported that writing about upheavals was a valuable and meaningful experience. Long-term follow-ups have provoked words of praise from participants who routinely report that the study caused them to think differently about the trauma (Pennebaker, 1989). Indeed, the first author often comes across students who were in writing studies several years earlier who are deeply grateful for the opportunity to have participated. Writing about traumas, then, is a profoundly powerful technique that influences objective and subjective well-being.

Despite the beneficial effects of writing, it is not entirely clear why it is effective in bringing about such striking health and behavioural changes. The theoretical rationale for the original writing studies was that not talking or, in some way, confronting emotional experiences was itself stressful. According to this inhibition model (cf. Pennebaker, 1989), the work of constraining thoughts, feelings, or behaviours is physiologically stressful. The stress of inhibition, then, places greater demands on the body thereby exacerbating a variety of psychosomatic processes. Indeed, several human and animal studies have confirmed that the inhibition of thoughts (e.g. Wegner, Shortt, Blake, & Page, 1990), behaviours (Fowles, 1980), emotions (Gross & Levenson, 1993), and even the discussion of traumatic experiences themselves (Pennebaker, Hughes, & O'Heeron, 1987) is associated with heightened autonomic nervous system activity, most notably electrodermal activity. Despite these demonstrations, no successful attempts have found strong links between inhibition-related autonomic changes and long-term health or behavioural improvements. Although one study found promising correlations between self-reports of prior inhibition and illness reductions (Pennebaker et al., 1988), subsequent studies failed to replicate this effect (Greenberg & Stone, 1992; Pennebaker et al., 1990).

Other findings have also called into question the viability of the inhibition model as the sole explanation of the benefits of disclosing or confronting emotional experiences. In one recent experiment, students were asked to dance expressively about a trauma (Krantz & Pennebaker, submitted). Half of the dance participants also wrote about the trauma each day after dancing. Although both dance conditions reported the study to be valuable compared to controls, only the group that danced and wrote exhibited reductions in physician visits and improved grades. Disinhibition through movement, then, was not sufficient in producing long-term health effects.

If the inhibition model is incomplete, what, then, accounts for the powerful effects of writing? In recent years, a number of investigators have begun to point to the critical role of cognitive changes that are brought about by writing. In two studies by Murray and his colleagues (Donnelly & Murray, 1991; Murray, Lamnin, & Carver, 1989), students either wrote or talked to a therapist about a trauma or about superficial topics. In addition to greater emotional expression in the two trauma conditions, subjects who wrote or talked about upheavals evidenced greater cognitive changes across the four days of the study. Cognitive change was measured by judges who evaluated transcripts on the degree to which they exhibited better understanding of the problem and the awareness of alternative explanations for the upheavals. Post-experimental self-reports of cognitive change were also apparent in the groups writing or talking about traumas. Our own studies bolster these findings in that subjects who write about traumas spontaneously report that writing forced them to think about the events differently (Pennebaker, 1989).

In understanding the broad issue of cognitive change, it is imperative to appreciate that a traumatic experience affects individuals on multiple levels, including attempts at understanding the meaning and significance of the event itself as well as the emotional responses to it (Silver, Boon, & Stones, 1983). Cognitive processing, then, must incorporate both emotions and perceived objective features of the event. A study by Pennebaker and Beall (1986) addresses this issue. Students were asked to write about a traumatic event from one of three perspectives: (1) focus only on the facts surrounding the trauma; (2) focus only on the emotions; and (3) focus on both. Subjects who only wrote about the facts were indistinguishable from controls who wrote about superficial topics. The emotion-focus group reported the study to be valuable but showed no long-term health improvements. Only those people who wrote about both the facts of the trauma and their emotional responses exhibited long-term health benefits.

For researchers, the definition and measurement of long-term cognitive change as the mediator of health improvement is a daunting task. One problem is defining what dimensions of mental activity best predict long-term improvement. For example, does writing about an event and its

associated emotions help to form a coherent schema of it? Once the schema is formed and reinforced, the individual may now be able to efficiently assimilate trauma-related reminders or experiences (cf. Markus, 1977). Less effortful processing, then, may be associated with lower chronic stress levels.

A related cognitive factor relevant to the writing procedure concerns the nature of chronic construct accessibility. Several researchers have reported that constructs that are chronically accessible to individuals may remain so for weeks or even years (Fazio, 1986; Higgins, 1989; Higgins, King, & Mavin, 1982). Further, chronically accessible constructs have been shown to guide the processing of information in a stable manner over time (Lau, 1989). On the surface, one would assume that writing about an event would make the event more broadly accessible. That is, after writing, individuals should be able to identify and recall more dimensions of the traumatic experience. It would also follow that heightened accessibility over time would become automatic, thereby associated with less effortful, conscious processing of the written trauma.

A third cognitive factor relevant to writing about a trauma is that the mere act of writing or talking alters the way the event is represented in memory. By putting the events and their associated emotions into language format, they would be linguistically coded (cf. Schooler & Engstler-Schooler, 1990). Indeed, a basic assumption of conversation is that when ideas are communicated via language, they require coherence, self-reflection, and the use of multiple perspectives (Clark, 1993). Coherence subsumes several characteristics, including structure, use of causal explanation, repetition of themes, and an appreciation of the listener's perspective. Conversations also involve the conveying of stories or narratives that require an ordered sequence of events (Labov & Fanshel, 1977). From a linguistic perspective, use of certain categories of words should reflect these cognitive dynamics. For example, individuals who analyse the cause and meaning of an event should use causal words and phrases; words such as because, reason, cause, etc. Similarly, people who are trying to understand or, in some way, work through an event should use words associated with insight; words such as realise, understand, reconsider.

In addition to using language to understand and explain events, translating emotions into language alters inchoate feeling states into conscious verbal labels. In fact, recent research hints that the mere labelling of an emotion may actually reduce its perceived intensity (Berkowitz & Troccoli, 1990; Keltner, Locke, & Audrain, 1993, study 4; Schwarz, 1990). In everyday speech, the labelling of emotional experience should be apparent by simply analysing the use of emotion words (e.g. angry, sad, happy, love).

The purpose of the present study was to attempt to identify the degree to which each of the above cognitive processes could account for health and behavioural changes associated with writing about emotional events. Attending a residential university for the first time is a massive upheaval in students' lives. They must adapt to new friends, classes, financial situations, and role changes. In the study, students in their first semester at the university were asked to write about either their deepest thoughts and feelings about coming to college or about superficial topics for 20 minutes a day for three consecutive days. In the weeks before and after writing two cognitive tasks were administered that tapped schematic judgements and construct accessibility relevant to coming to college. In addition, the essays were analysed by judges and a computer-based text analysis program. Finally, long-term measures of physician visits, grade point average, and psychological adjustment were collected.

The schematic judgement task used a reaction time (RT) procedure wherein participants were presented one of several types of master phrases, such as "going to the zoo" or "coming to college". Once the master phrase appeared on a computer screen, a series of schema-relevant and schema-irrelevant words, as well as several emotion words were presented. The students' task was to decide if the target words were relevant or irrelevant to the master phrase. The logic of this procedure was that if individuals held solidified schemas about coming to college, they should respond more quickly to the target words than if they did not hold clear schemas (Markus, 1977). If writing about college truly helps to solidify schemas about college, we would hypothesise that students would make faster judgements about college words after writing compared to controls. Further, if having more solid schemas was less effortful, we would expect changes in reaction times would correlate with long-term health and adjustment measures.

In theory, people who write extensively about coming to college should have richer mental representations of college. As such, college-related concepts and themes should be more cognitively accessible and retrieved more efficiently compared to people who have not written about college (see Higgins, 1989). As a proxy measure of accessibility, students were asked to generate as many words as they could about coming to college and a control topic two days before the first RT task and four days after the second. It was hypothesised that writing about college would result in students' generating more college-relevant words than control words. To the degree that writing influences cognitive accessibility, it was predicted that change in accessibility would be correlated with the various long-term measures.

The third primary hypothesis of this research revolves around the use of language. That is, to what degree does using emotion words and words

suggestive of cognitive processing predict long-term health and behaviour change? In a recent pilot study, essays from three previous writing studies were subjected to a text analysis program and were found to be related to long-term health change (Pennebaker, 1993). Overall, it was found that the more negative emotion words and the fewer positive emotion words used, the more people writing about traumas improved. In addition, the more that they increased their use of words related to causation and insight from the first to the last day of writing, the better their health became. Indeed, these cognitive changes suggested that the construction of a narrative may be central to the value of writing (cf. Meichenbaum & Fong, 1993).

In the present study, language use was assessed in two ways. First, a text analysis program, called LIWC (Linguistic Inquiry and Word Count, from Francis & Pennebaker, 1993), was developed that assessed the degree to which individuals' essays used specific types of emotional and cognitive words. Second, judges rated each of the essays along similar dimensions in order to evaluate the validity of LIWC. Finally, both LIWC and judges' ratings of emotional and cognitive dimensions were used to predict long-term changes in health, grades, and adjustment.

METHODS

Subjects

All the new students, including freshmen and transfers, were recruited from the first author's introductory psychology course to participate in two projects as part of the course requirement. The first project was explained as an exercise in learning about and testing reaction time (RT) equipment on two occasions separated two months apart. The second project dealt with "writing and the college experience". Students participated in both projects even though, in fact, the data were analysed as part of the same study.

Overall, 72 new students (44 females, 28 males) completed all three days of writing and the two RT tests. Partial data sets for an additional 18 students were excluded from the final analyses for the following reasons: did not complete all three days of writing assignments ($N = 4$), dropped the course and/or did not complete the final RT test ($N = 11$), dropped out of school before the end of the second semester ($N = 3$). Attrition was unrelated to experimental condition. Although the RT data for five participants were lost due to equipment failure, their other data were retained in the analyses. Sixty-four of the students were freshmen and eight were new transfers.

Procedure

The experiment was conducted during the Fall academic semester that spanned from approximately 1 September to 17 December. The RT and thought generation tests were conducted one month into the semester and again during the first week of December. The writing phase of the experiment lasted three consecutive days during the last week of October. Follow-up questionnaires were collected during the last day of writing and, again, on the last day of classes in December. Health centre visits, grade point average (GPA), and other archival data were tabulated by health centre employees and the registrar at the end of the school year the following May.

Writing Manipulation. Individuals who volunteered for the study met in a large lecture room on three consecutive days immediately after class. Participants were randomly assigned to condition based on the last digit of their social security numbers (odd = control group; even = experimental). Before writing each day, the experimenter distributed a "writing instructions" sheet to all participants. On the sheet, the students were assured that their writing would be anonymous and confidential. In addition, all volunteers were informed that they would write for 20 minutes each day and that they should write continuously the entire time without worrying about grammar or spelling. As a precaution, all participants were told that during the course of the experiment that some people might feel mildly sad or upset. If this happened, individuals were encouraged to talk with the instructor or individuals in the student counselling service. Those in the experimental condition read the following:

> For all three writing days of this experiment, your task is to write about your very deepest thoughts and feelings about coming to college. In your writing, try to let yourself go and to write continuously about your emotions and thoughts related to leaving home, coming to [college], and preparing for the future. You can write about leaving your friends, family, or high school, or about adjusting to a new social and academic world here. You could also focus on classes, your future, your parents' or your own expectations. The primary task, however, is for you to reflect on your most basic thoughts and emotions about coming to college.

Participants randomly assigned to the control condition read that their task was to:

> . . . describe in writing any particular object or event of your choosing. In your writing, try to describe some object or event as objectively and as dispassionately as you can . . . without mentioning your emotions, opinions, or beliefs.

Individuals received the same writing instruction sheet every day along with plain lined paper on which to write. After all participants had received their instruction sheet and paper, the experimenter announced that they could begin writing. At the end of 20 minutes, the participants stapled their writing instructions to their essay and placed them in a large box by the exit. To maintain confidentiality, everyone was given a two-digit identification code that was used throughout the study rather than their names or social security number.

Reaction Time Tasks. In order to measure schemas surrounding college-relevant experiences, all subjects participated in two similar RT tasks approximately one month before and one month after writing. People were tested individually in the investigator's laboratory area in a separate building. The students were seated in front of a computer monitor and keyboard. Across the top of the screen in capital letters was one of five master phrases that were presented in the same order: "driving a car", "getting up in the morning", "having a birthday", "coming to college", and "going to the zoo". Below the master phrase in the centre of the screen, a series of stimulus words or brief phrases were presented one after another. The participants' task was to respond by pressing one of two buttons to indicate whether or not each stimulus word was associated with the particular master phrase.

For each master phrase, 60 stimulus words were presented to which the participants had to respond. After they had responded to each of the 60 stimulus words below the master phrase, the next master phrase would appear. Of each group of 60 stimulus words, 20 were master phrase-relevant, 20 master phrase-irrelevant, and 20 were emotion words (10 positive and 10 negative). Relevant, irrelevant, and emotion words were presented in a prearranged random order which was consistent across all five master phrases. The same master phrases and word sets were used for both reaction time test sessions.

As an example, when the master phrase "coming to college" was on the screen, participants had to decide whether terms, such as classes, hard exams, education, study (all examples of relevant words), or nutmeg, monkey bars (irrelevant words), or nervous, optimistic, angry (emotion), were relevant or irrelevant to coming to college. College-relevant words were selected from the most frequently generated words that subjects had written down in the thought-generation task administered earlier in the semester. Note that exactly the same emotion words were used for each of the five master phrases. In addition, the first 60 responses for the initial master phrase (driving a car) were not analysed to allow subjects the opportunity to become familiar with the paradigm. The dependent measure was median RT for each of the classes of words (relevant, irrelevant,

positive emotion, and negative emotion) for each subject. Note that analyses were computed for mean RTs for each class of words which resulted in identical results as the more conservative median scores. Across the two administrations, 91% of the target-relevant words were correctly identified and 7% of the master phrase-irrelevant words were falsely identified as relevant. Analyses for percentage correct identification for relevant versus irrelevant words yielded no condition main effects or interactions and, hence, will not be discussed further.

Thought-generation Task. In the classroom, two days before the initial RT task and four days following the final RT task, students participated in each of the two identical thought-generation tasks. Participants were told that two phrases would be called out by the experimenter. They would have two minutes for each phrase in order to write down as many words as they could think of that were related to it. The first phrase was "having a birthday", the second was "coming to college". There was a 1-minute rest period between the two phrase tests.

Archival Data: Grades, Health Centre Visits, etc. During the first day of classes, students interested in participating in the present study signed a release form that allowed the experimenters to collect academic and health records for research purposes only. Academic records, including college board scores (e.g. Scholastic Aptitude Tests), first and second semester college hours attempted, and GPAs were provided by the University Registrar. College board scores were unavailable for six subjects in the control group and five in the experimental. These students were excluded from the GPA analyses.

Health centre visits for illness were tabulated by health centre personnel by date of visit. Illness was defined as any presenting complaint that could be attributable to an acute infection or other internal cause unrelated to injury. Regular check-ups, health prevention (e.g. flu shots) or maintenance (allergy shots), or other routine tests (PAP smears) were not counted as illness visits. Because students were occasionally referred to another physician or were instructed to return to the physician in one week for a routine check-up, more than one visit for the same complaint in an 8-day period was coded as a single visit.

Self-reports. Following the last day of writing, all students completed a brief post-experimental questionnaire that assessed their moods and beliefs concerning their essays and the experiment. The questionnaire, which has been used in other writing studies (see Pennebaker, 1989 for a summary), asks volunteers to rate the degree to which their essays were personal, emotional, and the overall value of the experiment for them.

Finally, 6 weeks later on the last day of classes, participants completed a final questionnaire that asked them to rate how well they had adjusted to college. In addition, subjects responded to two open-ended questions asking them to explain what they thought the experiment was about and to explain any positive or negative effects the experiment may have had on them.

Debriefing. During the four months that the experiment was ongoing, participants knew that they could not be told about the study so as not to compromise the results. Further, they were asked not to discuss the study with others. On the final day of class after all questionnaires and tasks were completed, the instructor described the entire experiment to the students. Preliminary results were announced and the participants' views were openly discussed during the 1-hour session. After the session, students were encouraged to visit the instructor and experimenters to discuss their perceptions and feelings concerning the study.

Text Analysis Procedure

All essays in both conditions were analysed both by the computerised text analysis program and by a panel of four independent judges. Procedures for both are discussed as follows.

LIWC Development. The LIWC program consists of a main text processing module and an external support dictionary. The text processing module performs functions which involve the control and flow of text processing and the management of the auxiliary dictionary file. The dictionary file is composed of over 2000 words and/or wordstems that are assigned to one or more of the 61 subdictionaries or scales. Each of the subdictionaries, then, is composed of groups of related words that tap a particular dimension of language, such as negative emotion or positive emotion. LIWC calculates the total number of words, sentences, percentages of unique words, and dictionary words. The sums of each of the scales are converted to percentage of total words.

The dictionaries were initially generated by groups of judges, Roget's Thesaurus, dictionaries, emotion and other types of questionnaires, as well as analyses of words used by previous samples of participants writing about emotional and control topics. After lists of words were compiled, at least three judges independently determined if each word should go into each category. A word was retained if two or more judges agreed on its inclusion (Pass 1). On Pass 2, at least three new judges evaluated each of the words within a broader category (e.g. all negative emotion words or all cognitive strategies words) that had previously been agreed upon during Pass 1 and

assigned them to one or more of the subcategories. Reliabilities among judges were computed on each pass. Percentage agreement among the three judges was 93.1% for Pass 1 and 98.1% for Pass 2 (see Francis & Pennebaker, 1993). The primary LIWC categories and sample words can be seen in Table 1.

Judges' Ratings of Essays. Four judges (3 females, 1 male) independently rated each of the essays along 12 dimensions relevant to LIWC and the current study. The experimental and control essays were rated in random order without designations of subject characteristics or condition. For each dimension for each essay, judges used a 7-point unipolar scale

TABLE 1
Primary LIWC Categories

LIWC Category	*Definitions*	*Examples*	*Words in Scale*[a]
Emotion Processes			
Negative Emotion	General expression of negative feelings	angry, sad, wrong	541
Anger	Expression of hostility, rage, opposition	angry, fight, rude	145
Depression	Expression of sadness, sorrow	sad, grief, worthless	119
Positive Emotion	General expression of positive feelings or attributions	happy, elegant, joy	328
Optimism	Expression of self-confidence, hope	pride, win, certainty	79
Cognitive Processes			
Insight	Self-reflection and the search for understanding about the nature of an experience or one's self	realise, see, understand	116
Causation	A cognitive process reflecting the search for causes or reasons	because, why, thus	52
Acceptance	Reflecting a sense of closure; understanding of thoughts and feelings surrounding an experience	accept, finish	59
Tentativeness	Lack of certainty	maybe, possible	60
Linguistic Factors			
Word Count	Raw number of words		
Word Length	% of words greater than 6 letters in length		
Unique Words	% of unique words (type/token ratio)		
Self-references	First person singular or plural	I, me, our	19
Past Tense	Common past tense verbs	did, felt, was	83
Negations	Use of forms of "no, not, nothing"	no, can't, never	41

[a] Words in Scale refers to total wordstems in the scale. One wordstem, such as "angr*", will count angry, angriest, angrier, and all other "angr-" words with this stem in this category.

ranging from 1 = "not at all" of the quality to 7 = "a great deal." As seen in the last row of Table 3 (p. 618), the reliability of the judges using Cronbach alphas was acceptably high for all scales. The one exception was the rating for Acceptance, wherein one judge's ratings correlated negatively with the others'. For this scale, only the three remaining judges' scores were used.

RESULTS

Five categories of data were analysed. The first four focused on the direct effects of the manipulations, including the manipulation checks based on self-reports, long-term health and academic changes, the laboratory-based cognitive measures, and the linguistic differences. The final section examined the mediating effects of the cognitive and linguistic dimensions on long-term health and grade changes.

Manipulation and Mood Checks

Immediately after writing on the third day, participants rated their essays along several dimension. Simple one-way analyses of variance (ANOVAs) were computed on the responses with group assignment as the independent variable. As can be seen in Table 2, subjects in the experimental group rated their essays as significantly more emotional [$F(1, 70) = 118.4$, $P < 0.01$], and personal [$F(1, 70) = 59.3$, $P < 0.01$] than controls. Interestingly, these ratings are virtually identical to the Pennebaker et al. (1990) study wherein participants were tested individually in a much more personally intensive setting.

As further evidence of the impact of the study, those in the experimental condition were far more likely than controls to endorse the item: "How important has it been that your essays were anonymous" [$F(1, 70) = 32.7$, $P < 0.01$] (see Table 2). When asked: "Other than receiving extra credit, to what degree has this experiment been valuable or meaningful for you," experimental participants rated the study as more meaningful [$F(1, 70) = 10.8$, $P < 0.01$]. Unlike previous studies, the experiment did not find significant differences in self-reports of sadness or happiness after the third day of writing.

Recall that individuals were not debriefed until the last day of classes, approximately 6 weeks after the writing phase of the study. Just prior to debriefing, participants were asked to write down what they thought the study was about. Overall, the majority of students in both conditions believed that the writing samples were themselves the focus of the study. Approximately 40% believed that the study dealt with looking at students' attitudes, emotions, and daily behaviours as they related to adjusting to college. Another 18% of the students focused on the links between emo-

tions, memory, and reaction time as the primary purpose of the study. Only 2 of the 72 subjects were fairly accurate in guessing the nature of the study: That writing was being used to affect psychological and physical health. The remaining responses reflected a mixture of guesses from "don't know" (5%) to vague hypotheses such as "emotion" to "making connections quickly to different things" to ". . . see if people have stable personalities".

Long-term Physical Health and Academic Performance

Previous studies have found that writing about upsetting experiences improves physical health. Further, this effect persists until individuals are debriefed. A *t*-test comparing pre-writing health centre visits indicated that the two groups did not differ [$t(70) = -0.28$, $P = 0.77$].[1] A 2 (condition) × 3 (time: 2 months before study, 2 months after study, semester following debriefing) repeated-measures ANOVA was computed on mean number of health centre illness visits per month. As predicted, those in the experimental condition demonstrated a drop in visits in the two months following the experiment as evidenced by the condition by time interaction [$F(2, 140) = 2.83$, $P = 0.06$]. As seen in Fig. 1, a contrast using the mean-square error term indicated that illness visits were lower for the experimental subjects than the controls in the two months following the study [$t(70) = 2.21$, $P < 0.05$]. No other effects approached significance.

By way of comparison with the Pennebaker et al. (1990) study, which used a very similar methodology, the overall effect size for the two months following the writing was Cohen's $d = 0.52$ in the present study compared with $d = 0.36$ in the earlier study, which are not significantly different from each other, $Z = 0.52$, n.s. The combined effect size is highly significant, $Z = 2.92$, $P < 0.01$.

[1] Measures of illness visits reflect a skewed distribution in that, over the course of a year, 26.4% of students never visited the health centre. During the 2 months preceding and following the writing, 50% never went to the health centre. Ultimately, we are interested in changes in visits from before to after writing. Logically, we assume that a person who visited a physician one time prior to the writing and one time in the 2 months afterwards was influenced by the study to the same degree as a person who did not visit the doctor at all during this time. With highly skewed data such as this, analyses of covariance adjusting for pre-experimental visits are inappropriate (Ghiselli, 1964). Because no differences emerged for pre-writing illness visits, all subsequent discussions of health centre change are based on the mean visits per month in the 2 months after writing minus the period before writing. Note that this difference score is normally distributed and accurately taps our conceptual definition of health change.

TABLE 2
Means of Self-reports Concerning Writing Samples

Variable	*Experimental*	*Control*	*Significance*
Essay Characteristics			
Personal	5.6	3.1	0.001
Emotional	5.4	2.1	0.001
Difficulty of writing	2.8	3.1	0.324
Importance of anonymity	4.3	2.0	0.001
Value of experiment	4.4	3.2	0.002
Attained insight	4.7	3.1	0.001
Mood and Adjustment			
Sad	3.3	3.6	0.422
Happy	4.5	4.1	0.204
Adjustment to college	5.3	4.7	0.088
Sample Characteristics			
Percent freshmen	86%	92%	0.412
N	35	37	

Self-reports were completed on the last day of writing and are based on 7-point unipolar scales where 7 = a great deal.

Significance levels were computed from simple one-way ANOVAs.

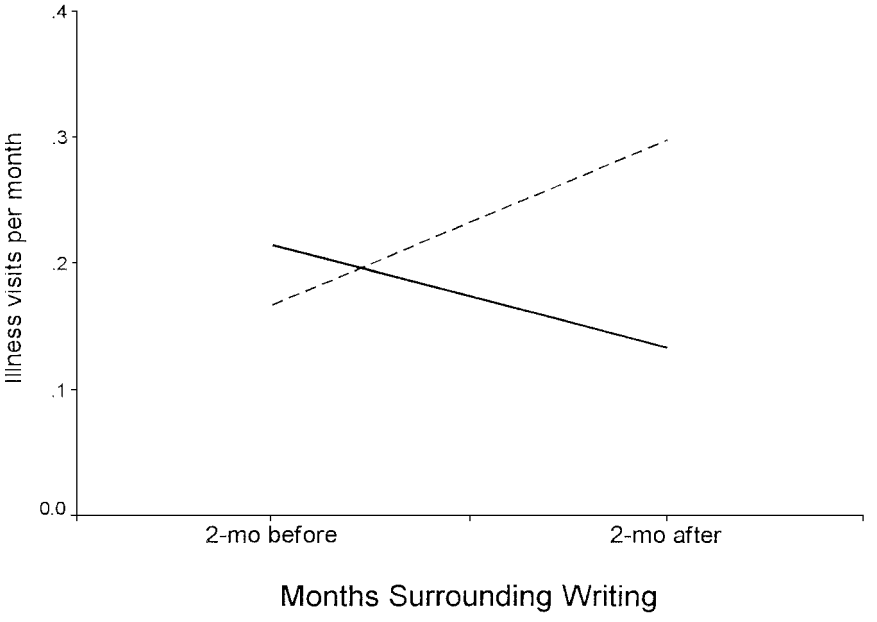

FIG. 1. Health centre visits for illness. (——, experimental; -------, control.)

Grade point averages, hours attempted, and Scholastic Aptitude Test (SAT) scores were collected for each subject for the semester in which the study was conducted and the subsequent spring semester. Initial multiple regressions were computed on each semester's GPA controlling for hours attempted and SAT scores. Corrected GPAs were then subjected to a simple 2 (condition) × 2 (semester) repeated-measures ANOVA. As can be seen in Fig. 2, GPAs increased for experimental participants from the first to second semester compared to controls. Although the condition by semester interaction was only marginally significant [$F(1, 59) = 3.39$, $P = 0.07$], the effect was in the predicted direction and consistent with the trend found in the Pennebaker et al. (1990) study (effect sizes: current study $d = 0.48$; earlier study $d = 0.31$, which are not significantly different, $Z = 0.52$, n.s. The combined effect size for the two studies is significant, $Z = 1.91$, $P = 0.028$.

Reaction Time and Thought-generation Tasks

Recall that one of the primary goals of this research was to isolate possible cognitive mediators of the writing–health relationship. From a statistical perspective, the more powerful test of changes in information processing

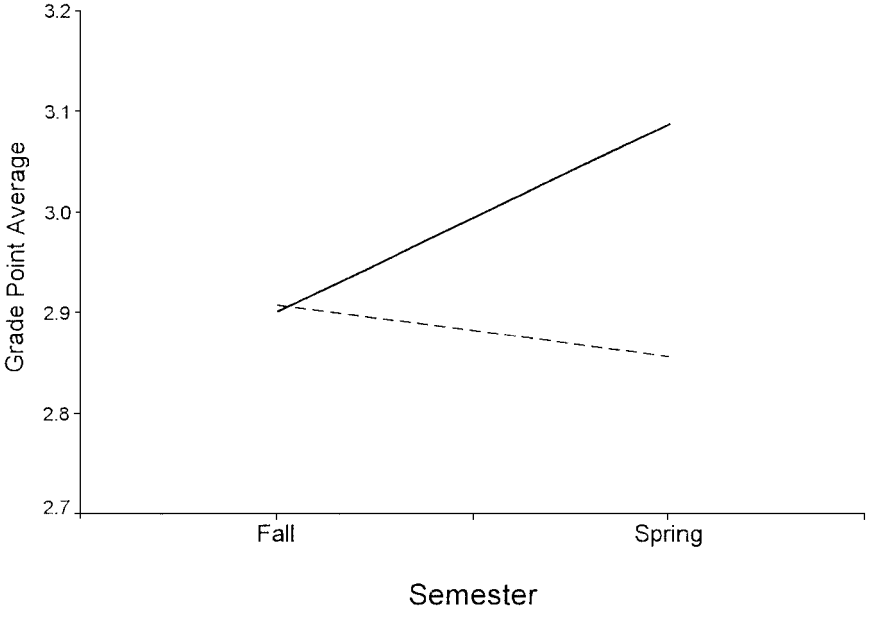

FIG. 2. Grade point average by semester. (———, experimental; -------, control.)

was the RT paradigm that served as an indicator of changes in the solidification of schemas relevant to coming to college.

For the RT task, both response direction and time to respond were coded for each stimulus that participants saw. Both classes of measures were analysed by way of 2 (condition) × 2 (college-related vs. non-college-related) × 2 (cognitive vs. emotion terms) × 2 (time: before vs. after writing) between–within repeated-measures ANOVAs. Additional analyses broke the responses to the emotion words into positive versus negative. Although numerous main effects and interactions emerged, no significant condition by time simple or higher-order interactions were found. In short, there was no evidence to suggest that type of response or reaction time changed from before to after the writing as a function of condition.

This is not to say that the RT task did not yield interesting findings. Differences emerged among new students in their overall reaction times to college-relevant words in comparison to words unrelated to college. Specifically, new students were able to identify whether affectively neutral words were related to college more quickly than any other word category—suggesting that college terms were cognitively available. In comparison, when volunteers attempted to decide whether a group of positive and negative emotions were related to coming to college, the students were slower in their responses as evidenced by the college-noncollege by emotion-cognition words interaction [$F(1, 64) = 37.8$, $P < 0.01$]. Interestingly, this effect diminished over time [$F(1, 64) = 6.82$, $P = 0.01$]. New students, then, apparently begin to react to college words and emotions in ways similar to neutral phrases over the course of their first semester at college.

In addition to the RT test, participants completed the thought-generation task one month before and one month after the writing sessions. During two consecutive 2-minute blocks, students were asked to generate as many words or phrases as they could related to "having a birthday" and "coming to college". A simple 2 (condition) × 2 (phrase type) between–within repeated-measures ANOVA on the number of words/phrases generated yielded no significant main effect or interaction.

Text Analyses

Two strategies were adopted for the text analyses. First, a comparison of judges' ratings with LIWC categories was made. Second, LIWC categories were compared between control and experimental conditions. Note that both the judges' ratings and LIWC analyses were made for all three essays for all participants.

Initial simple Pearson correlations between judges' ratings and LIWC dimensions for all 72 participants yielded strong relationships in the predicted directions. These numbers were misleading, given that experi-

mental and control subjects wrote about very different topics. A more conservative strategy involved analysing the experimental subjects' essays only. As depicted in Table 3, correlations between judges' ratings and the relevant LIWC dimensions averaged $r = 0.54$ across the 10 dimensions rated by the judges.[2]

To determine the degree to which LIWC scores and judges' ratings changed over the days of writing as a function of condition, a series of 2 (condition) × 3 (day) between–within ANOVAs were computed. As depicted in Table 4, virtually all LIWC scales and judges' ratings are significantly different as a function of condition. The differences in both emotion and cognitive process variables can be construed as manipulation checks as participants in the two conditions were instructed to write on different topics. More interesting, however, is the fact that experimental subjects wrote more words, shorter words, more self-references, and negations.

Testing for Cognitive and Linguistic Mediators

One of the strengths of the present design is that it allows us to test the degree to which our measures of cognitive and language processes may predict health and grade changes. Unfortunately, the large number of variables relative to the sample size precludes a strong test of all possible mediating paths. Instead, a series of six multiple regressions were computed: three on changes in health centre visits, and another three on changes in GPA. For each of the two criterion variables, separate analyses were computed using the RT variables, thought generation changes, and linguistic factors.

As noted earlier (see Footnote 1), the primary health variable of interest was the change in physician visits from before to two months after the writing. For the first set of analyses, health centre change was computed by subtracting pre-writing from post-writing illness visits, which yielded a normally distributed illness change score. Unlike health centre visits, GPA was normally distributed for both semesters. A GPA residual score was computed on the second semester GPA using first semester as the covariate. Illness change and adjusted second semester GPAs, then, served as the criterion variables.

[2] Note that there are 61 different LIWC categories, most of which are not directly relevant to the current project. For exploratory purposes, the judges also rated the degree to which the essays focused on specific content domains of bodily states (e.g. symptoms and health), friends, and family. Correlations between judges' ratings and these dimensions were also significant; body = 0.86, friends = 0.69, family = 0.78. Internal reliability of judges' ratings were also high (body = 0.67, friends = 0.91, family = 0.93).

TABLE 3
Correlations Between Judges' Ratings and LIWC Categories for Experimental Subjects

	Judges' Ratings									
LIWC dimension	*Negative*	*Anger*	*Depression*	*Positive*	*Optimistic*	*Insight*	*Cause*	*Accept*	*Tentative*	*Past*
Emotion Processes										
Neg. Emotion	***56***	28	57**	−44**	−49**	37**	33	−44**	43**	26
Anger	67**	***75***	36**	−57**	−55**	−15	−03	−71**	47**	−06
Depression	41**	03	***66***	−40**	−41**	36**	39**	−28	14	29
Pos. Emotion	−17	−25	00	***38***	36**	01	−01	13	13	−04
Optimistic	−31	08	−06	43**	***48***	18	14	38**	−23	16
Cognitive Processes										
Insight	03	−12	20	−03	−10	***59***	47**	12	03	08
Cause	22	11	20	−05	−16	34**	***35***	−15	04	32
Accept	−35**	−35**	−14	35**	36**	25	−05	***44***	−10	−15
Tentative	20	27	03	−25	−20	03	02	−28	***41***	−45**
Linguistic Factors										
Word Count	04	09	12	16	12	−06	−11	−08	12	18
Word Length	−06	−14	07	−04	−15	36**	26	14	09	−05
Unique	16	10	08	−32	−33	−02	09	−16	21	−26
Self	16	−03	30	06	−05	−03	−17	−09	27	07
Past	−12	−20	−05	22	11	09	−04	17	−33	***76***
Negate	16	10	07	−25	−15	16	15	−19	27	−29
Judges' Reliability										
Alphas	93	89	89	89	89	93	88	86	77	87

Pearson correlations are based on mean ratings across each subjects' 3 essays for experimental subjects only ($N = 35$). Judges' reliability data is based on all 72 subjects from four independent judges. Correlations coefficients in bold and italics are predicted.

**$P \leq 0.05$ (2-tailed).

TABLE 4
Text Analytic Dimensions as a Function of Condition

	Experimental			*Control*			
	Day 1	*Day 2*	*Day 3*	*Day 1*	*Day 2*	*Day 3*	*Effects*
Emotion Processes							
Neg. Emotion	2.01	1.78	2.01	0.56	0.61	0.74	C
Anger	0.35	0.31	0.45	0.07	0.10	0.08	C
Depression	0.54	0.38	0.42	0.18	0.17	0.21	C
Pos. Emotion	3.10	3.33	3.17	1.44	1.35	1.29	C
Optimism	0.73	1.00	0.70	0.40	0.41	0.42	C,C× D*
Cognitive Processes							
Insight	3.37	3.17	3.63	1.27	1.23	1.12	C
Causation	1.14	1.17	0.95	0.77	0.53	0.63	C
Acceptance	1.08	1.03	1.11	0.52	0.49	0.42	C
Tentativeness	3.13	3.56	3.45	1.47	1.68	1.51	C
Linguistic Factors							
Word Count	492	468	449	393	386	389	C,D,C× D*
Word Length	13.2	13.5	14.1	16.7	15.1	15.6	C,C× D*
Unique	44.1	46.0	46.5	47.4	47.5	46.6	C× D
Self-reference	12.55	11.56	11.55	3.84	4.97	3.74	C,C× D
Past tense	5.77	4.88	4.69	2.53	2.55	1.97	C,D
Negations	2.46	2.25	2.43	0.75	0.86	0.67	C
Judge Ratings							
Neg. Emotion	4.87	4.52	4.49	1.26	1.45	1.47	C,C× D*
Pos. Emotion	3.49	3.66	3.60	1.32	1.44	1.33	C
Insight	4.82	4.39	4.77	1.10	1.09	1.18	C,D,C× D
Causation	4.22	3.90	4.10	1.46	1.58	1.33	C,C× D*
N		35			37		

Mean LIWC categories are based on percentage of total words across the three days of writing (except Word Count = total words/essay; Word Length = % words over 6 letters).

Effects refer to significant effects ($P \leq 0.05$), where C = Condition main effect, D = Day main effect, C× D = Condition × Day interaction, * refers to an effect associated with a $P < 0.10$.

To see if the solidification of schemas, as measured by changes in RT performance, accounted for changes in health or GPA, both adjusted mean RTs to the college target words at time two were adjusted using subjects' pre-writing college RTs. These adjusted RTs served as the predictors for both health and GPA changes. An initial 3-step forced-entry hierarchical regression analysis was performed on the full sample entering condition, then adjusted RT, and finally the interaction term (Aiken & West, 1991). Neither the overall analysis [$F(3, 66) = 1.11$], nor any of the separate entries attained significance.

Analyses on the adjusted GPAs using the RT measures, however, yielded more intriguing results. The overall analysis yielded a significant global equation [$F(3, 51) = 3.11$, $P = 0.03$]. This was entirely attributable to the independent contribution of the adjusted RT main effect [$F(2, 52) = 6.65$, $P < 0.001$], rather than the condition main effect ($P = 0.14$) or interaction term ($P = 0.56$). In the final equation, only the RT beta (-0.33) was significant, indicating that the faster the college RTs at the end of the semester, the higher the subsequent semester's grades. Separate analyses by condition indicated that only experimental subjects' RTs were ultimately related to grades [$F(1, 25) = 7.44$, $P = 0.01$ (beta = -0.48)], rather than controls [$F(1, 26) = 1.26$, $P = 0.27$ (beta = -0.21)].

Similar analyses were computed using changes in the thought-generation task. The residual percentage of adjusted college-relevant words (relative to total generated words) at time two controlling for pre-writing percentage served as the predictor variable for both health and GPA change measures. No effects for either the full sample or the experimental group emerged (all Ps < 0.50).

Analyses of the mediating effects of the text variables produced promising and somewhat unexpected effects. Recall that previous pilot work suggested that two features of language may be related to long-term health change: Emotion and change in cognitive word use. Specifically, the expression of a high rate of negative emotion words and few positive emotions over the three days of writing was posited to be associated with greater health improvement. Secondly, the increase (as opposed to the chronic level) in the use of insightful and causal language over the three days was hypothesised to be associated with better health. To test this hypothesis, a preliminary 3-step hierarchical regression analysis was computed with the full sample. Overall, the full analysis yielded a highly significant equation [$F(9, 62) = 2.86$, $P < 0.01$]. In examining the incremental changes of each step of the regression, neither the condition main effect ($P = 0.35$) nor the language main effect ($P = 0.94$) approached significance. The entire effect is due to the condition by language interaction, incremental [$F(4, 62) = 6.05$, $P < 0.001$].

Because of the significant interaction of condition and language, separate regression analyses were computed using illness change as the criterion and four language factors as the predictors for each condition. The language factors were related to health centre change both for subjects in the experimental condition [$F(4, 30) = 2.94$, $P = 0.037$], and for those in the control condition [$F(4, 32) = 3.22$, $P = 0.02$]. Inspection of the beta weights from the two analyses in Table 5 reveals that the direction of effects for all four variables is different for each language variable for the two conditions. As predicted, subjects in the experimental condition were more likely to evidence health improvements if they increased their use of insight-related

words from the first to the last day of writing. A similar trend was found for causal words. Use of negative emotion words was unrelated to health changes. Most unexpected, however, was the finding that the more subjects in the experimental condition used positive emotion words, the better their health became after writing. For subjects in the control condition, greater illness rates after writing were associated with the use of increasing insight words, relatively more positive emotion, and fewer negative emotion words.

Finally, a series of regression analyses was computed to examine if the use of the various language dimensions predicted long-term changes in either the RT measures or thought-generation variables. No significant effects of any type were found. In addition, regression analyses using the judges' ratings as predictors of health change [$F(9, 62) = 1.40$, $P = 0.21$], and GPA [$F(9, 46) = 1.64$, $P = 0.13$] failed to yield significant results as well as significant changes as a function of unique contribution to the equations both for the overall model and independent analyses as a function of condition.

TABLE 5
Beta Weights for Illness Change with Language Dimensions as Predictors by Condition

	Condition	
LIWC Dimension	*Experimental*	*Control*
Insight change	– 0.33***	0.38***
Causal change	– 0.17	0.17
Negative Emotion	0.03	– 0.24
Positive Emotion	– 0.41***	0.26*
Adjusted *R*-square	0.19**	0.20**

Standardised beta weights are derived from the separate regression analyses for each condition. The change in illness-dependent measure is scored such that the higher the score, the more illness visits after the experiment. The insight and causal change scores refer to rate of insight and causal word usage on the last day of writing minus the first day of writing.

Negative and Positive Emotion refer to the mean number of emotional words across the three days of writing.

***$P \leq 0.01$; **$P \leq 0.05$, *$P \leq 0.10$.

DISCUSSION

In line with previous experiments using the same general paradigm, new students who wrote about their deepest thoughts and feelings about coming to college evidenced improved physical health and academic performance compared to control subjects who wrote about superficial topics. The findings are consistent with earlier formulations that suggest that the failure to translate upsetting experiences into language can result in psychological conflict and stress-related health problems.

From a practical perspective, the present experiment indicates that a relatively benign intervention of having individuals write about an important psychological event *en masse* can produce meaningful health improvements and higher grade point averages. This study, combined with others (e.g. Esterling et al. 1994; Francis & Pennebaker, 1991; Greenberg et al., in press; Murray et al., 1988; Pennebaker et al., 1990; Spera et al., 1994), suggests that a simple writing strategy could aid students attempting to adapt to a new school, employees coping with significant transitions, or other individuals facing personal upheavals.

Without question, the most theoretically promising findings of the present study emerged from the analyses of the language variables. The text analysis program, LIWC, examined the essays on a word-by-word basis. LIWC proved to be an efficient system in providing indexes of both cognitive and emotional processes. That word choice was highly correlated with judges' overall impressions suggests that this strategy is a valid technique for the investigation of language use. Admittedly, such a strategy fails to capture people's use of irony, metaphor, and other subtle ways of communicating. In addition, it can misclassify certain meanings as it cannot control for the context of speech. Despite mistakes in some language classifications, the large number of words that people generate allows for a certain degree of error. For example, experimental subjects wrote, on average, over 1400 words over the 3 days of writing of which 3.2% were categorised as positive emotions. In this case, of the approximately 45 positive emotion words captured by LIWC, only a small number of misclassifications would have occurred. A probabilistic system such as this, then, is certainly as valid as a judge-based system that requires multiple judges who, themselves, are prone to error.

The LIWC analyses, unlike those of the judges, indicated that word use within and across essays was related to long-term health changes. As predicted, the more that experimental students increased their use of insight-related and causal words, the more their health improved. Words such as these indicate that the students were attempting to understand and find causal meanings for their college-related experiences. Further, the trend over time suggests that they were attempting to construct coherent narra-

tives. Completely unexpected were the opposite findings for the participants in the control condition. Among the students who were asked to describe trivial events, the more they invoked insight-related words and attempted causal explanations, the more their health declined. These results raise the intriguing possibility that a certain individual difference may be at work. Perhaps a particular subgroup of people naturally seek meaning and understanding in their lives. If given the opportunity to analyse important experiences, they benefit. If they are not given such a chance—as with our control subjects—they may be prone to trying to find meaning in events or experiences that are ultimately meaningless. Such a process, then, could well be maladaptive.

The emotion language analyses were unexpected. First, use of negative emotion words was unrelated to long-term health changes. Among experimental participants, on the other hand, the more they used positive emotion words in describing their deepest thoughts and feelings, the more their physical health improved—a finding that contradicts earlier, albeit cruder analyses (Pennebaker, 1993). Interestingly, these results are congruent with research among cancer patients wherein the more that they express joy, the better their prognosis (Levy, Lee, Bagley, & Lippman, 1988). As with the cognitive findings, an opposite pattern emerged with the controls. That is, among students writing about superficial topics, the more they used positive emotion words and the less they relied on negative emotions, the more doctor visits they made after the study. This pattern is reminiscent of the repressive coping style, wherein individuals who work to put on a positive impression tend to have poorer health (e.g. Jamner, Schwartz, & Leigh, 1988). It is imperative that in future research, a variety of personality indicators be collected to compare with language use.

It is perplexing that the language dimensions were correlated with health changes but not grade improvements even though, in general, the writing technique itself was associated with greater academic performance. It is possible that other dimensions of writing, not directly associated with cognitive or emotional language, may be correlated with grades. One promising direction would be to explore the nature of ongoing cognitive work in the months following the study. That is, do people who write about emotional experiences subsequently ruminate about them less, which ultimately allows them to focus more efficiently on their school work? A related issue is that writing may stimulate a variety of thoughts and emotions in the weeks or months after the study. Language within the study may bring about short-term improvements in health whereas the mere act of writing may cause subsequent cognitive processing that ultimately influences other domains of people's lives (cf. Wegner & Erber, 1993).

Ultimately, the language results should be viewed in the context of the writing paradigm itself. It is now well established that writing about

emotional experiences brings about important physical and psychological change across multiple samples. The language that people use is but one part of the experimental paradigm. Participants generally choose the topics and the directions they agree to disclose. To a large degree, the chosen topics, which influence language, may be the driving force influencing health change rather than language itself. The analysis of language, then, may merely reflect important cognitive and emotional processes rather than necessarily influencing the underlying processes. Despite this causal conundrum, further analysis into natural speech and written language is warranted by social psychologists.

Although unexpected, the finding that reaction time measures associated with coming to college correlated with improvements in grade point average is of interest. We have conceptualised the reaction time task as a method with which to tap the degree to which people solidify their schemas about the entire coming-to-college experience. Although the writing task did not appear to influence this measure, the results from the regression analyses offer promising directions for future research. Those participants who evidenced the greatest drops in reaction times—presumably those who had developed better schematic ways of organising the college experience—were the subjects who evidenced the greatest improvements in grades from the first to the second semester. Although this pattern was stronger for the subjects in the experimental condition, it appears that students who were able to categorise efficiently the multiple facets of their college world may be more adept at studying and negotiating the various psychological demands of entering a new social and academic life (cf. Higgins, Vookles, & Tykocinski, 1992).

This experiment joins several others in demonstrating that translating emotional experiences into language has beneficial physical and psychological health consequences. Unlike other writing or disclosure projects, however, this is the first to begin to isolate some of the processes that mediate the writing–health link. Because of the large number of variables employed, the language and cognitive findings should be viewed as preliminary rather than definitive. For example, the reaction time results related to grades were relatively small. The linguistic analyses, although relatively strong, included a large number of language dimensions. Both the language and reaction time measures are new and have not previously been linked to real-world behaviours such as physician visits or college grades. In short, we view this paper and the new language and cognitive measures as a potential opening to further investigations.

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