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Expressive Writing Can Increase Working Memory Capacity

Kitty Klein and Adriel Boals
North Carolina State University

The effect of emotional disclosure through expressive writing on available working memory (WM) capacity was examined in 2 semester-long experiments. In the first study, 35 freshmen assigned to write about their thoughts and feelings about coming to college demonstrated larger working memory gains 7 weeks later compared with 36 writers assigned to a trivial topic. Increased use of cause and insight words was associated with greater WM improvements. In the second study, students (n = 34) who wrote about a negative personal experience enjoyed greater WM improvements and declines in intrusive thinking compared with students who wrote about a positive experience (n = 33) or a trivial topic (n = 34). The results are discussed in terms of a model grounded in cognitive and social psychological theory in which expressive writing reduces intrusive and avoidant thinking about a stressful experience, thus freeing WM resources.

The beneficial effects of emotional disclosure through expressive writing about traumatic or stressful experiences have been widely reported (Smythe, 1998). Compared with individuals assigned to write about trivial topics, experimental participants who wrote about their deepest thoughts and feelings showed reductions in physician visits (Pennebaker & Francis, 1996), improvements in immune function (Pennebaker, Kiecolt-Glaser, & Glaser, 1988), increased antibody production (Petrie, Booth, Pennebaker, Davison, & Thomas, 1995), and increases in psychological well-being (Lepore, 1997; Murray & Segal, 1994) for several months after the expressive writing intervention. There is considerable speculation about how writing might achieve such benefits. In contrast to earlier theorizing, which emphasized the cathartic release of thoughts and feelings associated with stressful experiences (e.g., Pennebaker, 1989), current explanations focus on the cognitive changes produced by expressive writing (Pennebaker, 1997). Although there is a long tradition of examining self-reported cognitive activity in the wake of stressful events (e.g., Horowitz, 1975), the cognitive changes associated with expressive writing are inferred from analysis of the linguistic characteristics of writers' essays. Across writing episodes, participants whose essays contained increases in words reflecting causality and insight (Pennebaker & Francis, 1996; Pennebaker, Mayne, & Francis, 1997) experienced the greatest health and behavioral benefits. Pennebaker et al. (1997) believe these linguistic changes reflect the cognitive processes associated with encoding and storing features of the experience "in a more organized, coherent, and simplified manner . . . that reduces the associated emotional arousal" (p. 864). The purpose of our experiments was to investigate directly how expressive writing might affect cognitive processing, and in particular whether working memory capacity is affected by expressive writing.

Working memory (WM) is a fundamental cognitive process, often conceived as a limited capacity system (Pennington, 1994). The central executive function of WM (Baddeley & Hitch, 1974) is responsible for the controlled processing and attention (Engle, Tuholski, Laughlin, & Conway, 1999) needed for higher order processes such as comprehension, reasoning, planning, and problem solving (Wickelgren, 1997). Measures of controlled processing, often called WM capacity tests, require the simultaneous storage and processing of information. Compared with simple short-term memory tasks, controlled attention tasks elicit different patterns of prefrontal cortex activation (Jonides et al., 1997). There are substantial and reliable correlations between controlled processing measures and higher order cognitive tasks, such as general fluid intelligence (Engle, Tuholski, et al., 1999). These relationships stand in sharp contrast to the weaker associations between higher order cognitive tasks and traditional short-term memory tasks (Engle, Kane, & Tuholski, 1999). Not surprisingly, WM capacity measures are also strongly related to performance tasks used to assess frontal lobe damage and dysfunction (Lehto, 1996; Welsh, Satterlee-Cartmell, & Stine, 1999).

To the extent that people can direct attention to task-relevant materials and operations, they will perform well on tasks requiring executive functions (Roberts & Pennington, 1996). However, in a limited capacity system, irrelevant distractors compete with task-relevant demands for attentional resources. Inhibiting responses to off-task demands leaves fewer resources for the task at hand (Stoltzfus, Hasher, & Zacks, 1996). The rationale for our research is that among the irrelevant demands that compete for resources are cognitions about ongoing stressful events and that expressive writing about these experiences reduces their draw on resources. Support for these assumptions comes from a diverse literature, including the laboratory writing paradigm (Pennebaker, 1997),

Kitty Klein and Adriel Boals, Department of Psychology, North Carolina State University.

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Correspondence concerning this article should be addressed to Kitty Klein, Department of Psychology, Box 7801, North Carolina State University, Raleigh, North Carolina 27695. Electronic mail may be sent to kitty_klein@ncsu.edu.

Wegner's (1994) theory of mental control, and theories about individual differences in WM capacity (Engle, Kane, & Tuholski, 1999), particularly the importance of inhibitory processes in accounting for these differences (Stoltzfus et al., 1996).

The idea that attentional resources must be shared between task-relevant and -irrelevant cognitions has received empirical support (Antrobus, 1968; Rapee, 1993; Teasdale et al., 1995; Teasdale, Proctor, Lloyd, & Baddeley, 1993). There is also experimental evidence (Darke, 1988; Sorg & Whitney, 1992) that ego-threatening manipulations impair performance on traditional WM tasks, and correlational evidence that people experiencing larger numbers of stressful life events, as well as people who report more intrusive and avoidant thinking about stressful events, are disadvantaged on WM tasks (Klein & Boals, in press). These WM impairments presumably arise because thoughts associated with the stressful experimental or life situations compete with ongoing task requirements for attentional resources.

Wegner and others (Petrie, Booth, & Pennebaker, 1998; Wegner, 1988, 1992) have proposed that people want to inhibit thoughts involving negative emotion, losses, and stressful events. Wegner's (1994) ironic processing model holds that the detection of such unwanted thoughts is an automatic process, but attempts to inhibit these cognitions require attentional resources. When there is competition for resources, inhibition is less successful. Studying under cognitive load leads to better memory for items participants are told not to remember compared with studying without a cognitive load (Wegner & Erber, 1992). Compared with no-load conditions, reaction times are longer on a modified Stroop task under load when the target words are related to events people were told to inhibit (Wegner, Erber, & Zanakos, 1993).

Wegner has also addressed the effects of directed suppression on the cognitive representation of events. Wegner, Quillian, and Houston (1996) found that people told not to think about a brief videotape subsequently were less able to remember the order of the taped events compared with people told to rehearse the tape mentally. These findings led Wegner et al. to conclude that not thinking about longer episodes causes a loss of coherence in the memory representation for the events involved, making them even more difficult to suppress. Clinicians have often noted a similar loss of coherence in accounts of trauma survivors (Foa & Kozak, 1986; Foa, Steketee, & Rothbaum, 1989). Creating a narrative about these events is associated with improved outcomes (Foa, Molnar, & Cashman, 1995). We argue here that narrative creation also frees the claims of stressful events on attentional processes.

On the basis of the cognitive and social psychological theories outlined above, our first experiment was designed to test the hypothesis that the production of a coherent narrative about a stressful experience would lead to improvements on a WM task. People experiencing similar stressful situations who write about a nonstressful topic should not experience equivalent WM benefits, because memory representations of nonstressful events are presumed to exert only minimal draws on cognitive resources.

We further hypothesized that WM improvements would be associated with the linguistic changes Pennebaker et al. (1997) noted as evidence of coherence in expressive writers' essays. Specifically, increases in the use of cause and insight words were predicted to be associated with increases in WM scores. If writing leads people to represent a stressful situation with propositions that have causal or temporal relatedness, a cohesive mental model can be built that contains all the information initially stored as separate events (Radvansky & Zacks, 1991). The result of moving from many representations to a single mental model of the event will be that fewer resources are required for its inhibition, with the consequence that more resources will be available for other WM requirements (Cantor & Engle, 1993).

The WM task we used in these studies is a widely used dual-task span measure (Turner & Engle, 1989) consisting of a series of information-processing and storage operations that vary in their WM requirements. The task measures "the capacity for controlled, sustained attention in the face of interference or distraction" (Engle, Kane, & Tuholski, 1999, p. 104). Performance on such complex span tasks reflects individual differences in currently available WM resources (Chiappe, Hasher, & Siegel, 2000). In other words, the task is sensitive not only to relatively stable individual differences in WM resources but also to competition for these resources from off-task demands. At any point in time, these off-task demands will vary between people. They will also vary within a person across time as external and internal conditions change. There are at least two experiments that have sought to demonstrate within-person changes on WM tasks in response to an experimental manipulation. Blackwood, MacHale, Power, Goodwin, and Lawrie (1998) reported that patients with chronic fatigue syndrome showed greater WM decreases following exercise than did matched healthy controls. Lane (1997) found some support for similar effects of brief caffeine deprivation on habitual coffee drinkers. In the present experiment, we measured WM three times in an attempt to link changes in attentional processes to the expressive writing manipulation.

In addition to investigating the effects of writing on available WM, these experiments examined the effects of such disclosure on our participants' grade point averages (GPAs). At present the only evidence that expressive writing directly affects any sort of cognitive processing comes from studies in which writing about coming to college produced marginal but consistent GPA improvements (Pennebaker, Colder, & Sharp, 1990; Pennebaker & Francis, 1996). GPA is related to WM span (Turner & Engle, 1989), and WM is further related to processes that can affect GPA, such as following directions and vocabulary acquisition (Engle, Carullo, & Collins, 1991). Although far from conclusive, the relationships between writing and GPA, and between WM and GPA, suggest that if the manipulation improves WM there should be a concomitant increase in GPA.

Finally, there is some evidence that expressive writing has more beneficial effects on health for men than for women (Smythe, 1998). Although not a primary question in the present study, the data were examined to determine whether such gender differences appear on WM processes.

Experiment 1

Method

Participants. Thirty male and 47 female first semester college freshmen, ages 18–19 years, participated for partial course credit. Participants were assigned randomly to one of two conditions: an experimental group asked to write about a stressful event, in this case, their deepest thoughts and feelings about coming to college (n = 39), or a control group asked to write about a nonstressful event, time management (n = 38).

Materials. Turner and Engle's (1989) arithmetic operation-word memory span task (OSPAN) and procedure was used to assess participants' WM. The OSPAN task has high internal consistency (.75) and reliability (.88) and is stable across time (Klein & Fiss, 1999). Following Engle's method, we had participants read a simple arithmetic equation (e.g., (9 × 1) − 9 = 1) on the computer followed by a one-syllable word (e.g., *back*). Participants indicated verbally whether the answer given to the problem was true or false and read the word aloud. The experimenter then advanced the program to the next operation. After sets of two to seven problems, participants were prompted to write down as many of these words as possible from the previous set. In all, three sequences containing one set of each size were presented, for a total of 81 operations. The operations and words were selected from the pools developed by Cantor and Engle (1993). Additional one-syllable words matched for frequency were also generated for use in subsequent administrations of the task. Different equations and words were used in each sequence and each time the test was administered. WM scores were the total number of words recalled that were associated with correctly solved equations.

To assess college freshmen's levels of anxieties about coming to college, we used the College Adjustment Test (CAT; Pennebaker et al., 1990). The CAT is a 19-question survey designed specifically to assess college freshmen's levels of homesickness, loneliness, and college-related difficulties.

Procedure. The participants were tested individually in six separate experimental sessions during the fall semester of their freshman year. The first session was scheduled 3–4 weeks after classes began. The next four sessions were scheduled during the 5th, 6th, and 7th weeks of the semester. The final session was held during the 13th and 14th weeks of the 15-week term. A timeline displaying the experimental sessions is presented in the upper panel of Figure 1. There were two experimenters, one man and one woman. All the writing sessions were supervised by the male experimenter; both experimenters ran the WM test sessions. Experimenters were unaware of the condition to which a participant was assigned.

At the first session, all participants gave informed consent and took the first WM test followed by the CAT. Three writing periods lasting 20 min each were scheduled during the following 2-week period. Before each writing period, the participant received an envelope containing a printed copy of standard instructions (Pennebaker et al., 1990; Pennebaker & Francis, 1996). In the expressive writing condition the instructions asked students to write about their deepest thoughts and feelings about coming to college and do their best to "tie it all together" at the end of their essays. The control condition instructions asked students to write about everything they had done that day and describe how they might have done a better job, concluding with a plea that their description be as objective as possible. When students had completed their essays, they placed them in the envelope. All writers were told they did not have to turn in their essays if they did not wish, but none refused.

At the fifth session, scheduled 1 week after the third writing period, participants took a second WM test. Six weeks after this test, all participants completed a third version of the WM task, took the CAT, and completed a questionnaire asking them about their essays and their reactions to writing. All participants received an explanation of the study at the final session.

Near the middle of the subsequent spring semester, we made four attempts to reach each participant by telephone. We asked them to send us written permission to obtain their GPAs directly from university records. We also asked them three questions adapted from the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983). These items asked how often the participant had felt nervous, calm, or stressed during the past week, rated on a 4-item response scale ranging from *never* to *very often.*

Results

Altogether, 71 (92%) of the participants completed all six experimental sessions. Data from 6 participants (3 from each condition) who did not attend one or more of the experimental sessions were not analyzed. The final sample sizes for the experimental group and the control group were 36 (23 women and 13 men) and 35 (20 women and 15 men), respectively.

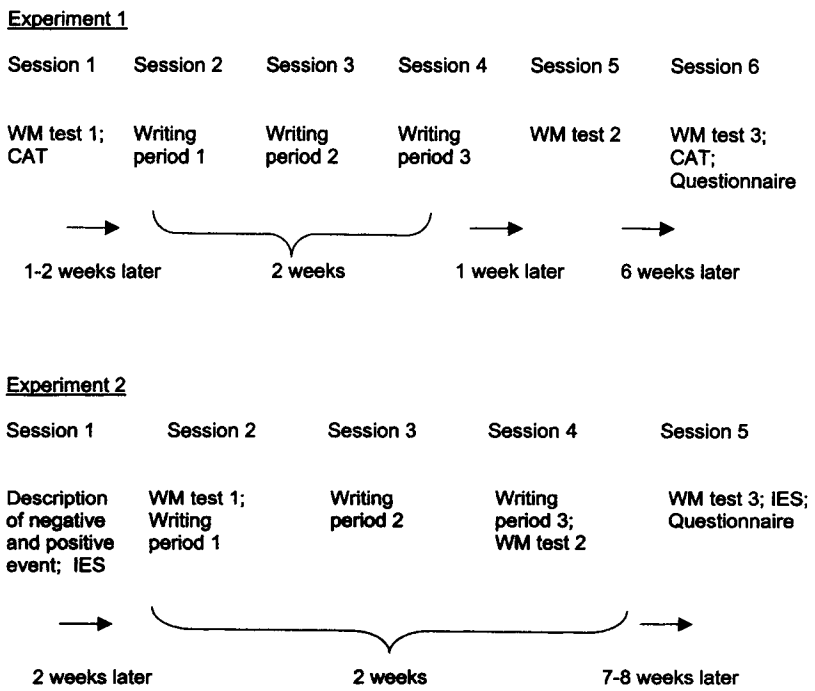

Figure 1. Timelines for Experiments 1 and 2. WM = working memory; CAT = College Adjustment Test; IES = Impact of Events Scale.

We were able to establish telephone contact with 30 experimental group participants and 29 control group participants, giving us self-reports of stress from 83% of the writers. One of the experimental group participants refused to give permission to access his grades, and 3 of the control group participants failed to send written permission. Three students who gave permission to access their grades withdrew from the university or had late grade reports for the spring semester, preventing their inclusion in the GPA analyses. The GPA analyses were thus performed on data from 27 experimental group members and 25 control group participants.

Effects of expressive writing on WM. Raw WM scores are presented in Table 1. Prior to condition assignment, there were no differences in WM scores (mean number of words correctly recalled = 54.5) as a function of gender or writing topic. In line with the analyses used by Pennebaker et al. (1990) and King and Miner (2000), we used the prewriting WM scores as predictors to calculate residual WM scores for the WM tests administered 1 week and 6 weeks after writing. To the extent that the postwriting scores are completely predicted by the prewriting scores, residual scores will be 0. Residuals in excess of 0 indicate better performance than what would have been predicted from the prewriting score; residuals less than 0 indicate poorer than predicted performance. We subjected the two residual scores to a 2 (writing condition) × 2 (gender) × 2 (time) repeated measures multivariate analysis of variance (MANOVA). The only significant multivariate effect was the interaction between condition and time, $F(1, 63) = 7.49$, $p < .01$. The interaction indicated that the groups displayed differential changes in residual WM scores from the test administered 1 week postwriting to that administered 6 weeks later. The residual WM scores are presented in Figure 2. One week after writing, the expressive writers' WM scores were lower than would have been expected on the basis of their initial WM test results, and the control group's WM scores were higher than predicted, but this difference was not significant. Six weeks later, residual WM scores for the experimental group increased to a level greater than predicted, whereas the control group's residual scores decreased.

In the analysis of the residual scores, the only other effect to approach significance was the interaction between condition, time, and gender, $F(1, 63) = 3.26$, $p < .08$. Examination of the raw change scores indicated that men assigned to the control group showed the least improvement ($M = 0.93$ words) from the second to the third WM tests, and men assigned to the experimental group showed the greatest improvement ($M = 5.4$ words). There was less difference in the change scores between women assigned to the control group ($M = 3.4$ words) and women assigned to the experimental group ($M = 4.4$ words).

Analysis of essay content. We assessed linguistic characteristics using a text analysis program, the Linguistic Inquiry and Word Count (LIWC; Pennebaker & Francis, 1999). As shown in the first panel of Table 2, there were significant differences (all $ps < .0001$) in the use of word categories of particular interest for this study. Similar to the data reported by Pennebaker and Francis (1996), the expressive writers used a greater percentage of negative, positive, cause, and insight words than did the control group writers.

The relationship of cognitive word changes to WM changes. To test the prediction that increased use of cause and insight words would be associated with subsequent increases in WM, we added the percentages of cause and insight words used in the first and third essays and computed the difference. Differences greater than 0 indicated an increase in the use of causal words; differences less than or equal to 0 indicated a decline. The mean differences for the expressive writing group ($M = 0.37$, $SD = 1.57$) and for the writing control group ($M = 0.23$, $SD = 0.97$) did not differ significantly, and there was no difference in the percentage of individuals in the expressive writing condition who increased their use of cognitive words (60%) compared with the writing control group (56%). A 2 (direction of cognitive change) × 2 (writing condition) analysis of variance on the raw WM change scores from the second to the third administrations of the task indicated main effects of direction of cognitive change, $F(1, 67) = 3.92$, $p < .05$, and condition, $F(1, 67) = 4.25$, $p < .04$, but not their interaction. In the control group, writers who decreased their use of cognitive words from Essay 1 to Essay 3 showed smaller WM gains ($M = 1.3$ operations) compared with writers who increased their cognitive word use ($M = 3.5$ operations). Similar differences occurred in the experimental group. Experimental group participants who decreased their use of cognitive words showed smaller WM gains ($M = 3.7$ operations) than did experimental writers who increased their cognitive word use ($M = 5.2$ operations) from Essay 1 to Essay 3. Essay 1 to Essay 2 difference scores were unrelated to WM changes.

In contrast to the association between changes in cognitive word usage and WM gains, there was no relationship between WM changes and changes in the use of emotion words from Essay 1 to Essay 3 or from Essay 1 to Essay 2.

Self-reports of writing and reactions to the experiment. We analyzed responses to the questionnaire administered during the last session to examine how participants perceived their essays and their reactions to the experiment. Participants in the writing conditions did not differ in the frequency with which they made phone calls or sent e-mail to family and friends about their feelings and

Table 1
Mean Unadjusted Working Memory Scores at Each Test Time: Experiments 1 and 2

	Experiment 1[a]			Experiment 2[b]		
Topic	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
Time management	54.6 (6.8)	59.0 (6.30)	61.2 (7.6)	43.4 (7.9)	43.6 (9.3)	44.2 (8.2)
Coming to college	54.4 (8.4)	57.8 (8.2)	62.7 (8.8)			
Negative experience				42.5 (8.5)	46.2 (8.3)	47.6 (8.3)
Positive experience				41.7 (7.1)	43.8 (6.5)	44.0 (6.3)

Note. Standard deviations are in parentheses.
[a] Maximum possible correct = 81. [b] Maximum possible correct = 75.

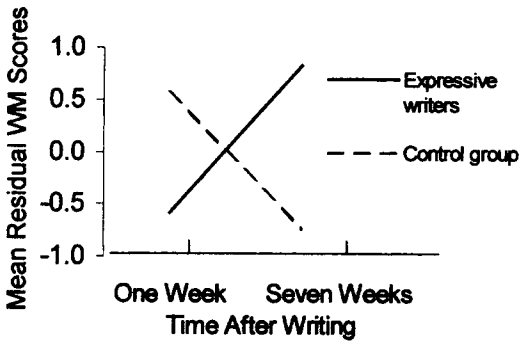

Figure 2. Mean residual working memory (WM) scores as a function of writing topic and time: Experiment 1.

experiences, or in their judgments of the value of the experiment, or how well organized they thought their essays were. As Table 2 shows, the experimental group indicated they had disclosed more personal information and revealed their emotions more than control group participants. Students assigned to write about their deepest thoughts and feelings also reported they had thought more and talked more about the topic before the experiment and had wanted to talk about the topic more since the experiment.

We next examined the correlations between self-reports of disclosure and WM scores. The only variable related to pretest WM scores was how extensively students said they had talked about the topic prior to the experiment, $r(68) = .31$, $p < .01$. Students who had talked more about the topic had higher WM scores at the beginning of the experiment. The only self-rating related to working memory measured one week after completing the final essay was how much personal information the writer claimed to have disclosed, $r(69) = .28$, $p < .02$. Final session working memory scores obtained 7 weeks after writing were higher for participants who said they had disclosed more personal information, $r(69) = .24$, $p < .05$, revealed more emotions, $r(69) = .36$, $p < .01$, and believed their essays were more well-organized, $r(69) = .27$, $p < .03$.

Finally, consistent with the findings of Pennebaker et al. (1990), the groups did not differ in their initial or final CAT scores, nor was there any relationship between either adjustment score and any of the WM measures. Adjustment scores did predict the degree to which students said they had felt stressed, calm, or nervous when queried 4 months later during the telephone interview, $r(53) = .56$, $p < .0001$. The self-reports of stress were not related to experimental condition, WM, or either GPA index.

Relationship of WM changes and GPA. We conducted a repeated measures ANOVA using condition and WM changes from the second to the third time of testing on participants' GPAs for the fall and spring semesters. Overall there was a nonsignificant decline in GPAs from the fall semester during which the experiment was conducted ($M = 3.18$, $SD = 0.70$) to the following spring semester ($M = 2.97$, $SD = 0.88$). This decline did not differ as a function of condition. Using condition and WM changes as predictors in a MANOVA on the fall and spring GPAs produced only a significant multivariate main effect of WM, $F(1, 48) = 4.95$, $p < .03$. Students showing greater improvement in WM scores between the second and third WM tests earned higher GPAs for both the experimental semester, $r(53) = .23$, $p < .10$, and the following spring, $r(50) = .29$, $p < .04$. The same MANOVA using the final WM score as the predictor produced no significant findings.

Table 2
Mean Number and Percentage of Words in Each Linguistic Category and Mean Ratings of Essay Characteristics: Experiments 1 and 2

	Experiment 1		Experiment 2		
Essay topic	Time management (n = 36)	Coming to college (n = 35)	Time management (n = 34)	Negative personal event (n = 34)	Positive personal event (n = 33)
			LIWC categories		
Mean number of words	296.4_b (89.6)	356.2_a (89.3)	352.6 (118.1)	345.0 (102.6)	357.3 (119.4)
Emotion processes					
Negative emotion (%)	0.34_a (0.65)	2.00_b (0.71)	0.36_a (0.40)	2.30_b (0.67)	1.00_c (0.59)
Positive emotion (%)	1.3_a (0.59)	3.0_b (0.65)	0.84_a (0.34)	2.6_b (0.85)	3.8_c (1.1)
Cognitive processes					
Causal terms (%)	0.53_a (0.35)	1.10_b (0.35)	0.30_a (0.27)	1.30_b (0.47)	1.20_b (0.50)
Insight terms (%)	0.74_a (0.41)	2.40_b (0.65)	0.56_a (0.30)	2.70_b (0.86)	2.60_b (0.93)
			Self-ratings of essay[a]		
Disclosing information	4.2_a (1.5)	5.2_b (1.0)	5.0_a (1.4)	5.7_b (1.0)	5.5_b (1.0)
Revealing emotions	3.4_a (1.4)	5.5_b (1.0)	3.5_a (1.7)	5.7_b (1.0)	5.4_b (0.9)
How well organized	3.4_a (1.4)	3.4_a (1.5)	3.7_a (1.6)	3.4_a (1.4)	3.6_a (1.0)
Experiment's benefits	3.7_a (1.4)	4.4_b (1.4)	3.4_a (1.5)	4.1_b (1.5)	4.1_b (1.3)
How upsetting to write			2.2_a (1.6)	3.6_b (2.0)	2.0_a (1.2)

Note. Within each experiment, means with different subscripts differ significantly, $p < .05$. Standard deviations are in parentheses. LIWC = Linguistic Inquiry and Word Count.
[a] Response scales ranged from 1 (*not at all*) to 7 (*a great deal*).

Discussion

Our results supported both hypotheses: Expressive writing improves available WM, and the linguistic changes associated with increased narrative coherence are also related to WM improvements. Seven weeks after the writing sessions, participants assigned to write about their deepest thoughts and feelings about coming to college exhibited WM improvements compared with the control group who wrote about time management. There was a trend in the data suggesting that men may have profited more from the manipulation than women, although this difference did not reach conventional levels of statistical significance. WM increases were related to higher GPAs earned during the semester of the experiment as well as the subsequent semester.

As was expected, students who wrote about coming to college used more cognitive insight words as well as more emotion words. Our hypothesis that increases in the use of the cognitive words from Essay 1 to Essay 3 would predict increases in WM was supported. Changes in the percentage of cognitive words from Essay 1 to Essay 2 were not related to WM change, echoing Pennebaker and Francis's (1996) finding that only the Essay 1 to Essay 3 cognitive word differences were related to health outcomes. Changes in the percentages of emotion words across essays were unrelated to increases in the delayed posttest WM scores. The latter findings are congruent with previous work (Pennebaker et al., 1997) in which cognitive rather than emotional changes were the best predictors of improved general functioning. The data also support Smythe's (1998) contention that if writing influences health by evoking changes in cognitive processes, changes in measures of cognitive functioning should be closely tied to writing and to the cognitive effects of writing.

Analysis of self-reports of essay characteristics lends further support to the rationale underlying the experiment. Individuals who said they had talked about the essay topic before the experiment had higher initial WM scores, and writers who reported high levels of disclosure of personal information and emotions in their essays had higher WM scores at the final session.

As reported by Pennebaker and others, the effects of the experimental manipulations are surprisingly long lasting. For the students assigned to write about their deepest thoughts and feelings, WM capacity increased across the 7 weeks of the experiment. Just how long the effects of writing persist should be explored in further research.

The results of the experiment have implications for both cognitive approaches to WM processes and social psychological perspectives on emotional disclosure. With the exception of caffeine deprivation (Lane, 1997) and exercise (Blackwood, MacHale, Power, Goodwin, & Lawrie, 1998), there has been little effort devoted to the question of whether measured WM can increase or decrease as a consequence of other variables. The data we report is perhaps the first to show that a psychosocial manipulation can alter available WM capacity and that these changes persist and have consequences for other important outcomes, such as academic performance.

The relevance of our results for social psychological theory is that they point to a possible mediator of the disclosure–health relationship reported in so many previous studies. To the extent that production of a coherent narrative about a stressful experience frees WM resources for more effective coping, the increased availability of these resources can be marshaled to help cope with life stressors that otherwise manifest themselves in various health problems.

The data showing that WM increases are related to academic performance have practical implications. Although WM itself has been related to academic achievement (Turner & Engle, 1989), our findings suggest that it is not necessarily the absolute level of WM that predicts better performance, but the improvement in the ability to store and transform information. There is, however, an alternative to this interpretation. It may be that students who best followed the writing prompts, as indexed by their own reports and by the linguistic analyses of their essays, are more likely to follow directions generally. There are, in fact, data supporting a link between WM and following directions (Engle et al., 1991). Thus, the effectiveness of expressive writing may not be tied to a freeing of attentional resources but may reflect the ability or motivation to follow instructions.

Despite significant differences in the rates of WM improvement as a function of writing topic, the groups did not differ on the final measure of WM. Such a pattern of results provides only modest support for the thesis that expressive writing can affect available WM capacity. One reason for these results may have been the instructions for the control group, which asked writers to describe how they had spent the day and then to decide how they might better have spent their time. Although there were significant differences in the use of cognitive insight words, the linguistic categories Pennebaker et al. (1997) used as markers of narrative cohesion, our instructions may have inadvertently encouraged the formation of more cohesive cognitive representations in the control group writers. Further evidence for this suspicion is the finding that participants in both writing groups showed similar increases in cognitive insight words across essays.

Another factor that may have contributed to the equivalence of the groups' final WM scores was the choice of experimental topic. In Experiment 1 all participants in the experimental condition wrote on the same topic, "coming to college." The topic has been a standard in expressive writing research (Pennebaker, Colder, & Sharpe, 1990; Pennebaker & Francis, 1996), allowing us the luxury of direct comparisons of our data with those reported elsewhere. However, college is not equally stressful for all freshmen, and it is possible that our manipulations were more effective for some writers than for others.

Experiment 2

Given these theoretical and methodological concerns, we conducted a second experiment focusing on these and other issues. The first issue we address is whether the WM improvements demonstrated by expressive writers in Experiment 1 can be attributed to a decline in thoughts about the stressful experience. Although first-semester freshmen writing about coming to college did evidence greater increases in available WM than did freshmen writing about how they spent their time, the assumption that these benefits are the consequence of reduced resource competition from stressful thoughts was not addressed directly. We have suggested that thoughts about stressful events compete for attentional resources, either through their intrusiveness or through people's effortful attempts to avoid them. We also proposed that expressive writing reduces this competition for WM resources through a

decline in intrusive and avoidant thinking. Thus, our first hypothesis was that expressive writing produces less intrusive and avoidant thinking, which in turn leads to WM improvements.

The cognitive and social psychological explanations for how irrelevant and unwanted thoughts disrupt cognitive activities have a direct counterpart in the clinical literature (Horowitz, Field, & Classen, 1993; Janoff-Bulman, 1992). Horowitz demonstrated that stressful events produce intrusive thoughts and that people often attempt to avoid such thoughts. Horowitz claimed that unwanted thoughts occur both effortfully and automatically until the stressful event has been effectively integrated into an individual's schema. While clinicians disagree (Greenberg, 1995) on whether intrusive thoughts indicate ineffective coping, or whether their presence is necessary for an individual to make a satisfactory poststressor adjustment, their ubiquity following stressful events is well documented. Directly relevant to our hypothesis is the evidence that intrusive thoughts are related to poorer performance on cognitive tasks such as proofreading (Baum, Cohen, & Hall, 1993).

Not surprisingly, a number of investigators have hypothesized that expressive writing should reduce reports of unwanted thoughts. In some experiments, emotional disclosure through expressive writing or talking has produced declines in such cognitive activities (Segal, Bogaards, & Chatman, 1998; Segal & Murray, 1994). In other research, disclosure has had no effect on intrusive or avoidant thinking, but the level of these thoughts has moderated the effects of disclosure on physical or psychological symptoms (Lepore, 1997; Lepore & Greenberg, in press) and on immune system function (Lutgendorf, Antoni, Kumar, & Schneiderman, 1994). If emotional disclosure improves WM through a reduction in intrusive and avoidant thinking, expressive writers should report fewer intrusive and avoidant thoughts after writing, and participants reporting fewer unwanted thoughts should experience greater WM gains.

The second question we address is whether the creation of a coherent narrative about a positive life-changing experience has similar effects on WM and intrusive thinking as does writing about a negative experience. Typically, general or specific negative emotional events are studied in the expressive writing paradigm, although two recent experiments have examined the effects of potentially positive events and the positive aspects of negative events. Páez, Velasco, and González (1999) assigned one group to write expressively about a social event. Compared with writers about disclosed and undisclosed traumatic events, this group showed less avoidant, but not less intrusive, thinking about the event before writing. They did not differ in intrusive or avoidant thinking after writing, and writing had no effect on changes in intrusive and avoidant thinking for any group. King and Miner (2000) compared mood, essay content, and physical health of students instructed to write about a traumatic experience, about the perceived benefits of a traumatic experience, about both the trauma and its benefits, or about a control topic. Overall, there were few differences between the experimental conditions. Compared with the control group, individuals in all three expressive writing conditions were lower in positive affect after writing, used more negative emotion words and words referring to cognitive mechanisms in their essays, and had fewer health center visits 3 months after writing. Compared with the other expressive writers, students assigned to write only about perceived benefits used more words referring to cognitive mechanisms in their essays.

Whereas researchers investigating the effects of expressive writing generally focus on adverse events, the cognitive and social psychological theories on which our research was based focus on less emotional topics. Cognitive psychologists interested in inhibitory processes in WM have rarely addressed the valence of the experience responsible for off-task cognitions. For example, Stoltzfus et al. (1996) provide "what to have for dinner" as an example of task-irrelevant cognitions that must be inhibited to do well on WM tasks. Rosen and Engle (1998) examined people's ability to suppress previously learned paired associates as a function of their WM capacity. Likewise, much of Wegner's work with directed suppression requires participants to inhibit thoughts about nonemotional stimuli such as white bears (Wegner, Schneider, Carter, & White, 1987) and fictitious cities (Wegner, 1992). In one experiment in which Wegner did require the suppression of emotional experiences, both positive memories (of personal success) and negative memories (of personal failures) had equal slowing effects on a modified Stroop task in which the words to be ignored were related to the target memory. Similarly, Roemer and Borkovec (1994) report no differences in subsequent thought occurrence about negative, positive, or neutral topics following a period of directed suppression.

It would appear that neither the cognitive nor social psychological accounts of the inhibition of unwanted thoughts require such thoughts to involve negative emotions, although prevailing theories about emotional disclosure (e.g., Páez et al., 1999) emphasize its ability to reduce negative emotions. Thus our second question is whether expressive writing about positive topics produces equivalent changes in WM and thought intrusion, as does writing about negative topics.

A third feature of Experiment 2 is the inclusion of participants' reports of how much they reveal in their essays as a predictor of WM and intrusive thinking. In Experiment 1, self-reports of disclosure correlated with postwriting WM scores. Individual differences in disclosure have been assessed in a number of writing studies and appear to moderate the effects of the manipulated variable. Lutgendorf et al. (1994) reported marked variability in the intensity of the disclosure in their study and found that the more participants said they revealed their feelings, the greater their improvement in immune function following disclosure. Similarly, Pennebaker et al. (1988) found that experimental writers who reported that they had written about topics they had previously held back enjoyed greater immune benefits than low disclosers. According to Kelley, Lumley, and Leisen (1997), the greatest benefits occur in participants "who access their most affectively charged memories (especially memories inhibited from prior processing); experience fully the negative affect and accompanying physiological arousal . . . actively attempt to reconstruct, make sense of, or alter the meaning of the experience" (p. 337). In Experiment 2, we predicted that participants with the highest self-disclosure ratings would experience the greatest declines in intrusive thinking and the greatest increases in WM capacity.

Finally, in Experiment 2 we attempted to redress concerns about the topics and instructions used in Experiment 1. Although rates of improvement differed significantly between expressive writers and the control group, the groups did not differ significantly on the final test of WM. As noted earlier, one reason for these results may have been the prompt for the control group, which asked writers to describe how they might better have spent their time. In Experi-

ment 2, the control group's instructions warned against any disclosure of emotions and did not ask for any evaluation of the day's schedule. As a further precaution against the development of a coherent narrative, we asked the control group to describe different days each time they wrote.

We were also concerned that the stressfulness of the topic used in Experiment 1, "coming to college," could vary widely among participants. In Experiment 2 participants in the two experimental conditions themselves nominated the topic of their essays: an experience that has had an extremely negative or extremely positive impact on their lives.

Finally, as in Experiment 1, we examined the WM results to determine whether men and women benefit equally from the manipulations.

Method

Participants. One hundred twenty-one college students completed the first session in exchange for partial course credit in their introductory psychology course. Of these, 10 did not wish to continue in the study because they had already completed the course research requirement and 5 declined to continue for other reasons. Altogether, 106 students (60 women and 45 men) participated in the first writing session.

Thirty-five students were randomly assigned to write about time management, 36 to write about the negative event they had described at the first session, and 35 to write about the positive event they had described at the first session. Subsequently we eliminated data from 5 participants (1 assigned to the control group, 2 from the group assigned to write about a negative event, and 2 from the group assigned to write about a positive event) who did not keep all their appointments. Thus, after assignment to writing condition, 95% (n = 101) of the participants participated in all sessions: 34 (19 women and 15 men) in the control group, 34 (20 women and 14 men) in the negative topic group, and 33 (20 women and 13 men) in the positive topic group.

Materials. We used Horowitz's Impact of Events Scale (IES; Horowitz, Wilner, & Alvarez, 1979) to measure reactions to the memories associated with both the positive and the negative stressful life events participants described at the first session. The IES consists of 15 items and asks how often during the past 7 days participants had the reactions listed. The response scale ranges from 0 (*not at all*) to 5 (*often*). Seven of these items ask about the frequency of undesired memory intrusions, and 8 items ask about the frequency of avoiding thoughts of these experiences. The Intrusive and Avoidance subscales are highly correlated (Creamer, 1995; Weiss & Marmar, 1997). The developers report test–retest reliabilities of .89, with internal reliability estimates ranging from .79 to .92. Depending on the analysis, we used two different scores from the IES. Following Horowitz et al. (1979) and Lepore and Greenberg (in press), we added the scores from the Intrusive and Avoidant subscales to compute the IES scores for each event participants described. We also computed the IES total impact score by summing the IES scores for the two events.

To measure WM we used Turner and Engle's (1989) OSPAN task as described in Experiment 1 with the exception that we used three repetitions of the five operations of set sizes three to seven for a total of 75 operations. The 2-operation sets were eliminated because in Experiment 1, all participants successfully recalled both words from these easy-to-remember small sets.

Procedure. Participants were tested in five sessions during the spring semester. The first session was scheduled 3 to 5 weeks after classes began; the next three sessions occurred during the 5th through 8th weeks. The final session was scheduled during the 13th and 14th weeks of the semester. There were three experimenters, one man and two women, who ran both the writing sessions and WM test sessions. Experimenters were unaware of the condition to which a participant was assigned.

At the first session, attended by groups of 2 to 15 people, we asked for brief written descriptions of two major events from their lives, one that had had a very positive impact and one that had had a very negative impact; when each event began; and when (if) it had ended. A copy of the IES followed these instructions for both the positive and negative event requests. Half of the participants were asked to describe a positive event first; half were asked first about a negative event.

Approximately 2 weeks later, we administered the OSPAN test in individual sessions. Participants were then randomly assigned to one of three writing topics: the positive experience they had described at the first session, the negative experience, or how they spent their time. Participants in the two experimental groups were given an envelope containing a verbatim typed copy of the positive or negative experience they had described and written instructions for their essay. Instructions for the expressive writers emphasized that they should "dig down to your very deepest thoughts and feelings about the positive [negative] event . . . and try to 'tie it all together' at the end of the writing."

The control group received an envelope containing instructions that asked them to describe how they had spent the previous day, how they had spent the current day, or what they planned to do the following day. Each control group member wrote about a different day for each essay. The instructions emphasized that the essays should describe how they spent their time as factually and unemotionally as possible. When students had completed their essays, they placed them in the envelope.

Two additional writing sessions of 20 min each were scheduled within the next 2 weeks. As in Experiment 1, writers were told they did not have to turn in their essays if they did not wish, but none refused. At the end of the last writing session, we again administered the WM task.

At the last experimental session, scheduled 7 to 8 weeks after the last writing session, each participant took a third WM test and then completed the IES for both the positive and the negative event they had described at the first session. A final questionnaire asked students about their essays and their reactions to the experiment. After asking for written permission to access their semester grades directly from university records, we debriefed participants and thanked them for their participation. The second panel of Figure 1 presents the timeline for this experiment.

Results

Effects of expressive writing on WM. There were no differences in WM scores at the first testing session as a function of writing assignment, gender, or self-ratings of disclosure (M = 42.4 words). As in Experiment 1, we used these prewriting WM scores to predict the WM posttest scores and then calculated residual WM scores for the two posttests. We used these residual scores in a 3 (writing condition) × 2 (gender) × 2 (time) repeated measures MANOVA with self-disclosure ratings as a fourth, quantitative, independent variable. None of the multivariate statistics were significant. There were no significant differences in residual scores on the WM test administered immediately after writing. On the WM test given 7–8 weeks later, there was a main effect of condition, $F(2, 90) = 3.30$, $p < .04$. Figure 3 presents the residual scores from this analysis. Participants who wrote about a negative event had higher than predicted final session scores, and these residual scores were greater than those of participants who wrote about a positive event, $p < .02$, or about time management, $p < .11$, who did not differ from each other. For these latter two groups, the final WM scores were lower than would have been predicted on the basis of their prewriting scores.

We next assessed the comparability of the OSPAN scores obtained in Experiment 2 and those obtained in Experiment 1. Because the two-operation sets were not used in Experiment 2, and

because performance was at ceiling on these sets in Experiment 1, we added 6 points to the initial WM score of each participant in the present study. A t test indicated that the Experiment 1 mean (54.6 words) and the adjusted Experiment 2 mean (48.4 words) on the first WM test did not differ significantly.

Effect of expressive writing on intrusive and avoidant thinking. Analysis of the first session IES scores indicated that prior to assignment to condition, the groups did not differ in intrusive and avoidant thinking about either negative, $F(2, 98) = 0.82, p < .44$, or positive events, $F(2, 98) = 0.95, p < .38$.[1] To examine the question of whether writing about negative or positive topics would have similar effects on intrusive and avoidant thinking, we first computed simple difference scores between pre- and postwriting IES scores for the negative events and for the positive events. We subjected these difference scores to a repeated measures MANOVA using writing condition and disclosure as between-subjects variables and valence (positive vs. negative) of the event being described as the repeated measures variable. The analysis produced a three-way interaction between writing condition, valence (positive vs. negative) of the event being described, and disclosure, $F(2, 93) = 3.93, p < .02$. Examination of the univariate tests indicated no differences in IES difference scores for positive events as a function of condition or disclosure. For the IES difference scores for negative events, there were significant effects of experimental condition, $F(2, 93) = 5.00, p < .01$; of self-ratings of disclosure, $F(1, 93) = 9.79, p < .003$; and of the Condition × Disclosure interaction, $F(2, 93) = 5.28, p < .005$. As shown in Figure 4, IES scores for the negative event declined in all groups, and this decline was significantly greater in the group assigned to write about the negative event.

To explore the interaction, we examined the correlation between the IES difference scores for the negative event and emotional disclosure ratings separately for each writing condition. Self-ratings of emotional disclosure were related to changes in IES scores only for individuals assigned to write about a negative event. For these participants, disclosure ratings and the decline in intrusive and avoidant thoughts were correlated for both the negative event, $r(31) = .62, p < .0001$, and the positive event, $r(31) = .36, p < .05$. The more that the negative event writers reported they had revealed in their essays, the greater the decline in their IES scores.

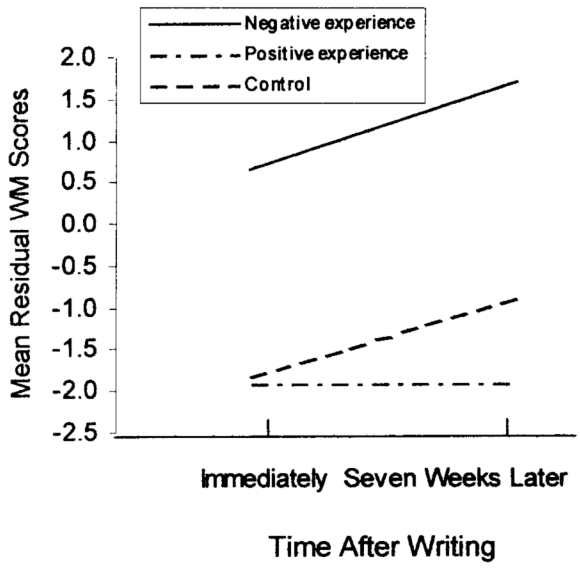

Figure 3. Mean residual working memory (WM) scores as a function of writing topic and time: Experiment 2.

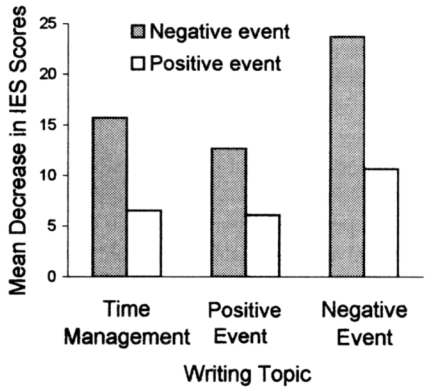

Figure 4. Mean decreases in intrusive and avoidant thoughts for positive and negative events as a function of writing topic. IES = Impact of Events Scale.

The relationship of intrusive thinking and WM. Given the effects of writing condition on both IES scores and WM, our next analysis examined the relationship between IES and WM. IES scores for positive and negative events were highly correlated at both pretest, $r(99) = .35$, and posttest, $r(99) = .49$, both $ps < .001$. Because our model predicts that intrusive and avoidant thinking from any source, either positive or negative, can impair working memory, we summed the IES scores for the positive and negative events obtained at the final session to produce a single combined index of the impact of these events.

To test the prediction that expressive writing increases WM function through the reduction of off-task cognitions related to stressful events, we conducted a series of analyses as recommended by Baron and Kenny (1986). The first ANOVA indicated that both condition, $F(2, 93) = 2.99, p < .05$, and self-rated disclosure, $F(1, 93) = 4.21, p < .04$, affected the IES total impact scores observed in the final experimental session. The IES total impact index did not differ between the control group ($M = 36.9$, $SD = 18.3$) and the writers assigned to a positive topic ($M = 39.5$, $SD = 26.6$). Both groups reported significantly more intrusive and avoidant thinking ($p < .03$) compared with participants who had written about a negative topic ($M = 24.2$, $SD = 26.3$). Higher self-disclosure ratings were associated with higher IES impact scores reported at the final session, $r(99) = .23, p < .02$.

The next step in the test of mediation requires the demonstration that levels of intrusive and avoidant thoughts are related to WM. An analysis of covariance (ANCOVA) using the IES total impact scores as a quantitative independent variable and covarying initial WM scores indicated that lower IES impact scores were associated with higher scores on the final WM test, $F(1, 93) = 9.46, p < .003$.

[1] A more complete report of the IES data for positive and negative events is available from Kitty Klein.

The final step in the test that intrusive thinking is a mediator of the effects of expressive writing on WM requires the demonstration that when intrusive/avoidant thinking is entered as a predictor of WM, the effects of writing condition and self-ratings of disclosure are reduced. Initial WM scores were covaried. The ANCOVA on the posttest measure of WM using the impact scores, experimental condition, and disclosure ratings as predictors indicated that the condition effect found previously was no longer present. The only significant effect was that of the IES total impact scores, $F(1, 93) = 6.95$, $p < .009$, thus supporting the hypothesis that intrusive thinking mediates the effects of expressive writing on WM.

Analysis of essay content. An informal reading of the essays revealed a wide variety of topics for both the positive and the negative prompts. Among the negative experiences were death of a parent, sibling, or grandparent; wrecking an automobile; loneliness; and a parent's drinking problem. The positive experiences included events such as winning an athletic contest, a trip to Europe, living in one's first apartment, and having an adult mentor.

As in Experiment 1, we analyzed the essays using Pennebaker and Francis's (1999) LIWC text analysis program. We then conducted a MANOVA repeated measures analysis of the LIWC variables of interest across the three essays, using writing condition and self-rated disclosure as independent variables. The variables analyzed were the percentages of positive emotion words, negative emotion words, words denoting cause, and words denoting insight. Overall means are presented in the second panel of Table 2. In contrast to Experiment 1, there were no differences in the length of the essays as a function of writing condition. Not surprisingly, participants who wrote about a positive topic used a greater percentage of positive emotional words than did writers of negative events or control condition writers, $F(2, 93) = 5.17$, $p < .007$. The converse was true for negative emotion words, $F(2, 93) = 10.98$, $p < .001$. Writers about both negative events and positive events used more causal words compared with the control group writers, $F(2, 93) = 7.93$, $p < .001$. Control group writers also used a smaller percentage of insight words than the negative event group or the positive event group, $F(2, 93) = 9.42$, $p < .001$, who did not differ from each other.

The only linguistic category directly sensitive to self-rated disclosure was causal word use, $F(1, 93) = 5.55$, $p < .02$. Writers who said they had revealed more personal information used a greater percentage of causal words.

The relationship of cognitive word changes and WM changes. As in Experiment 1 we categorized individuals into two categories on the basis of whether the percentage of cause and insight words increased or decreased from Essay 1 to Essay 3. The average increase in the use of these words from Essay 1 to Essay 3 was very small and did not vary as a function of essay topic ($M = 0.07\%$). The percentage of individuals showing an increase in the use of cognitive words across essays was equivalent in the groups assigned to write about time management (41%), a negative event (56%), or a positive event (49%). A 2 (direction of cognitive word change) × 3 (writing condition) repeated measures analysis of the Time 2 and Time 3 WM scores produced no significant effects. In a similar analysis, we examined the relationship of positive and negative emotion words to changes in WM and found that WM did not differ as a function of whether writers increased their use of emotion words.

In a further test of the relationship of word use to WM, we considered each of the linguistic variables separately. We conducted a series of four repeated measures MANOVAs on the raw WM scores with experimental condition and linguistic category change from Essay 1 to Essay 3 as the predictor variables. Two of the categories, negative emotion word increases, $F(4, 184) = 2.63$, $p < .04$, and causal word increases, $F(4, 184) = 3.40$, $p < .03$, interacted with time of the WM tests and condition. These interactions indicated that the relationship of changes in the linguistic variables to changes in WM differed between the three conditions. To dissect these interactions we looked at the correlations between word use changes and WM changes from the immediate posttest to the final session 7 to 8 weeks later. The pattern of correlations indicated that increased use of causal words was positively related to WM increases for the negative experience writers, $r(32) = .30$, $p < .08$, but negatively related to WM increases for the control group, $r(32) = -.29$, $p < .10$. For writers about positive topics, causal word increases were unrelated to WM differences, $r(31) = .04$, $p > .8$.

Correlations between increases in negative emotion word use and WM change also differed between the groups. For the control group and for writers about negative events, there was no relationship between changes in the use of negative emotion words and WM change, $r(32) = .05$ and $r(32) = .02$, respectively. For writers about positive topics, a decline in the use of negative emotion words predicted WM increases, $r(31) = -.23$, $p < .19$.

Given the support for the earlier hypothesis that the reduction of intrusive and avoidant thinking mediates the relationship between writing and WM, we looked at the relationship between IES scores and writers' use of cognitive words. None of the correlations between the final session's combined IES index and changes in the use of cognitive words approached significance.

Self-reports of writing and reactions to the experiment. As shown in Table 1, at the end of Experiment 2, writers assigned to positive or negative events reported they had disclosed more personal information, revealed their emotions more, and believed the experiment to have been more beneficial than did writers assigned to the control condition. Writing about a negative event was more upsetting than writing about either a positive event or time management. Furthermore, the more upsetting the writing was, the lower were the WM scores at all three administrations of the WM task, $F(1, 95) = 8.34$, $p < .004$.

None of the three items assessing participants' judgments of their writing was related to their IES scores at the beginning of the experiment. However, individuals reporting more intrusive and avoidant thinking at the end of the experiment said they disclosed more personal information, $r(99) = .20$, claimed to have revealed more emotional information, $r(99) = .22$, and found it more upsetting to write, $r(99) = .27$, all $ps < .05$.

None of the self-reports were associated with the linguistic categories of interest in this study.

Relationship of WM changes and intrusive thinking to GPA. Ninety-four participants (93%) gave us permission to retrieve their grades from the previous (fall) and current (spring) semesters. Six students were new transfers or had not been in school the previous fall, leaving 88 participants with grades available for both spring and fall. GPAs increased from the fall ($M = 2.86$, $SD = 0.87$) to the spring ($M = 2.91$, $SD = 0.79$). There was no relationship between WM improvements from the second to the third WM test

and GPAs for the previous semester or the experimental semesters. There was, however, a positive relationship between WM improvements and improvements in GPA, $F(1, 86) = 4.95, p < .03$. Students showing the greatest improvements in WM capacity showed the largest increases in GPA, $r(86) = .22$. This relationship did not differ as a function of condition.

Consistent with the correlations between WM and intrusive thinking, students reporting more intrusive and avoidant cognitions about negative events at the last session of the experiment earned significantly lower spring grades, $r(91) = -.32, p < .002$. Reported thoughts about positive events were unrelated to GPAs.

Discussion

The results of Experiment 2 lend further support to the proposal that expressive writing can produce sizable and lasting improvements in available WM resources. These benefits were limited to people who wrote about a negative experience; writing about a positive life-changing event or about daily routines had very little effect, or even negative effects, on WM scores. Expressive writing produced its largest effects 8 weeks after writing. In contrast to Experiment 1, there were significant differences in final WM scores, with people assigned to the control group and the positive event group performing more poorly than people who wrote about their negative experiences. Unlike in Experiment 1, there was no evidence of any gender effects on WM capacity.

Expressive writing did affect reports of intrusive and avoidant thinking about negative events. Individuals assigned to write about a negative experience showed the greatest decline in intrusive and avoidant thinking about the negative event they described at the first session. They were also the only group in which reported self-disclosure was linked to declines in intrusive and avoidant thinking. Decreases in unwanted thoughts about positive experiences did not vary as a function of experimental condition.

Our analysis further indicated that the WM improvements enjoyed by expressive writers may be mediated by a decline in intrusive and avoidant thinking about negative stressful experiences. Participants who reported lower levels of unwanted cognitions at the final session had higher final WM scores and also showed the greatest improvement in WM scores. When we examined WM scores as a function of both intrusive/avoidant thinking and experimental condition, the effects of the manipulation were substantially reduced.

The results from both the WM measures and reports of unwanted thoughts coincide to suggest that writing about a positive experience has little effect on either variable. The ineffectiveness of writing about a positive experience can be contrasted with King and Miner's (2000) data. In their study, writing about the positive aspects of a negative experience produced health benefits similar to those achieved by writing only about the negative experience. At least in regard to cognitive processing, writing about positive events is ineffective. It would be interesting to know whether writing about positive experiences would have similar null effects on health.

In Experiment 2, writers about positive and negative experiences used equivalent amounts of cause and insight words that have been used to define narrative coherence. Although the essays were equally coherent, writing about a positive event had effects equivalent to unemotional writing about daily events. The finding that intrusive thoughts about the positive event showed small and equivalent declines regardless of essay topic lends further support to the inefficacy of writing about positive experiences.

Results for the linguistic analyses were not as straightforward as those obtained in Experiment 1. Compared with Experiment 1, participants showed smaller increases in the use of cause and insight words across essays. For the negative event writers, WM improvements were linked to increases in the use of causal words; the opposite was true for the control group, whose WM scores declined as their use of causal words increased. This interaction mirrors one Pennebaker and Francis (1996) obtained for the relationship between causal word change and illness. Pennebaker and Francis explained the positive relationship between causal word increases and illness in their control group as an instance of trying to find too much meaning in meaningless events. Perhaps a similar explanation applies to the effects observed on WM in Experiment 2.

As in Experiment 1, WM improvements were associated with academic performance. Students who showed the largest increases in WM showed the greatest GPA improvements, regardless of what they wrote about. The level of intrusive and avoidant thinking about negative events reported at the last experimental session was strongly predictive of the GPAs obtained; there was no relationship between unwanted thoughts about positive experiences and GPA.

Consideration of participants' reports of how much they revealed in their essays did improve the predictability of some measures, although generally there were condition main effects qualified by Condition × Self-Disclosure interactions. In the case of WM, self-disclosure ratings obtained at the end of the experiment did not predict final WM scores or improvements in WM. In regard to intrusive thinking, self-disclosure interacted with experimental condition. Self-reported disclosure of writers assigned to the negative event condition was related to declines in unwanted thoughts about both the negative topic of their essays and about the positive event described at the first session.

Several of the methodological and theoretical concerns raised in Experiment 1 are addressed by the present findings. Eliminating the request for control group writers to "see how they might have done a better job of time management" was apparently effective in that the control group in Experiment 2 showed no improvement in WM. Furthermore, the differences between the groups on the final measure of WM were significant.

A second question left unanswered in the first experiment was whether the GPA benefits of expressive writing are simply the consequence of adhering to instructions as opposed to a reduction in intrusive thinking about stressful events. In Experiment 2, the similar percentages of cause and insight words in both positive and negative topic essays suggests that both groups of writers followed the prompt's directions to "tie it all together." Nonetheless, writing about a positive experience had no effect on WM, suggesting that simply following directions is not a viable alternative explanation for the link between WM increases and GPA.

The failure to find any WM or intrusive thinking effects from writing about a positive event poses some difficulty for the theoretical rationale underlying this research. We have assumed that the more coherent the mental model representing a stressful experience is, the less it will compete with primary task demands for WM resources. We also assumed that the linguistic markers we

have used to identify increases in narrative coherence across essays index the coherence of the cognitive representations of the stressful events described. The present data suggest that this model, with its emphasis on the cognitive features of event representation, is not entirely adequate. Specifically, the data supported the model only for people who wrote about negative experiences in their lives. People assigned to write about a positive event, whose essays showed linguistic coherence equivalent to those who wrote about a negative event, did not experience a concomitant increase in WM scores. Apparently, constructing a coherent account of a negative event frees WM resources to a greater extent than constructing an account of a positive event. Whether this difference is the consequence of positive events' having less cognitive impact or whether there is something unique about writing about negative experiences requires further investigation.

General Discussion

The findings from these two experiments shed new light on available WM capacity and markedly expand the benefits of expressive writing to this widely studied cognitive process. We have shown that usable WM is not a static variable but can change as a function of a psychosocial manipulation, with such changes reflecting variations in intrusive and avoidant thoughts about off-task topics. We drew on theories of WM processes, control of unwanted thoughts and emotional disclosure to develop our hypotheses. According to many cognitive psychologists, WM is a limited capacity system in which resources must be used to inhibit off-task cognitions in order to do well on the task at hand (Engle, 1996; Roberts & Pennington, 1996). Clinical reports (e.g., Foa et al., 1989; Horowitz et al., 1993) suggest that unwanted thoughts about stressful experiences are particularly difficult to inhibit, a viewpoint echoed in the theory of ironic processes (Wegner, 1994). Although the data support our proposal that creating a narrative "packages" stressful experiences into manageable mental models that make fewer demands on cognitive resources than do the original fragmented representations, this explanation requires further research.

First, our standard for narrative coherence relies on Pennebaker's (1997) definition of narrative: an increase in cognitive word use. Other researchers have offered various criteria for what constitutes a "good" narrative in the context of how people tell stories about their experiences (e.g., Barclay, 1996; Meichenbaum & Fitzpatrick, 1993; Wong & Watt, 1991). It would be interesting to apply other narrative coding schemes to our students' essays to learn whether writing similarly affected these measures.

A second limitation of the present findings is our use of a single measure of WM capacity, Turner and Engle's (1989) OSPAN task. The task has good psychometric properties (Klein & Fiss, 1999) and correlates highly with other complex dual-span measures of controlled processing (Engle, Tuholski, et al., 1999). A drawback of the OSPAN, as well as other WM tasks designed to assess individual differences, is that they must be administered by highly trained experimenters in close physical proximity to the participant. In the first study reported here, two experimenters were used; three experimenters were used in the second study. Variability in a single experimenter's behavior as well as between-experimenter differences can easily produce error variance in WM scores. Thus, our data might have been even stronger had we been able to use a mechanized controlled attention task.

There are also challenges to our assumption that narrative development is responsible for the decline in intrusive and avoidant thinking that leads to increased WM. One strong contender for how writing might affect WM is that writing about stressful experiences may make attitudes toward these experiences more accessible. Highly accessible attitudes are automatically activated from memory whereas, less accessible attitudes require effortful processing (Fazio, Roskos-Ewoldson, & Powell, 1994). It is possible that less accessible attitudes are heavy consumers of cognitive resources. If emotional disclosure increases attitude accessibility, resources would be freed for other tasks, such as the WM task used in our experiments. This line of reasoning meshes with the results from Fazio and Powell (1997). These investigators demonstrated that given equivalent levels of self-reported stress, college freshmen with more accessible attitudes toward college subsequently report better physical and psychological health. Fazio and Powell make essentially the same argument for accessibility that we make here for WM, namely that attitude accessibility frees cognitive resources to cope more effectively with other stressors. In further research, accessibility and WM could be contrasted as the most likely potential mediators of the writing–health relationship.

An important extension of our work is the possibility that changes in available WM are at least in part responsible for the widely documented writing–health relationship. Resources claimed by unwanted thoughts could impair problem solving to the extent that proactive coping and appropriate responses to subsequent stressors become unlikely. As a consequence, more stress is produced, and this continued stress produces decrements in psychological and physical health. Writing about a stressful experience might attenuate the stress–illness cycle by means of its effects on WM. Obviously, in the absence of health data, the present results cannot be interpreted as evidence for such mediation. However, our findings that writing affects available WM capacity and that the linguistic variables associated with health outcomes have similar relationships with WM suggest such a possibility. Whether the WM increases we observed are of sufficient magnitude or duration to support more effective problem solving and possible attendant improvements in health outcomes requires further study.

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