Do gains in working memory capacity explain the written self-disclosure effect?

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Klein and Boals (2001) concluded that expressive writing about negative life events improves health by reducing intrusive thoughts, as measured by the Impact of Events Scale (IES), and thus freeing working memory (WM) capacity. We replicated their WM gain and rejected the possibility that it reflected task practice alone. We extended their work by showing that such WM effects and reductions in self-reported health symptoms can be observed within a short time frame of a week in a normal population of college students and can occur without reductions in IES scores. Two alternative explanations are discussed of how WM gains can be observed in the written self-disclosure effect without reductions in the frequency of intrusive thoughts and avoidance attempts.

Keywords: Self-disclosure; Working memory; Expressive writing; Intrusive thoughts; Health.

It is well established that written self-disclosure of negative experiences can improve health outcomes (Pennebaker, 1997). In an important contribution to understanding the mechanism involved, Klein and Boals (2001) reported that the writing intervention frees working memory (WM) capacity by reducing intrusive thoughts. Pre- and post-intervention measurement of Turner and Engle’s (1989) WM operation span (OSSPAN) showed a gain after expressive writing. Klein and Boals concluded that the expressive writing intervention improved health by reducing the frequency of intrusive thoughts and freeing WM capacity (see also Klein, 2002).

Klein and Boals found no reliable increase in WM capacity in the control condition. Yet, one might expect such a gain from mere practice on the task. In fact, a subsequent test-retest reliability study of OSPAN showed such a practice effect (Klein & Fiss, 1999). We sought to determine whether the purported gains in WM capacity are limited to expressive writing and are not an artefact of task practice.

A second motive for the present study was to determine whether expressive writing can rapidly improve aspects of health and gains in WM capacity. Klein and Boals (2001) followed the procedure typically used in studies of the written self-disclosure effect by taking post-test measurements 11–12 weeks after the pre-test measurements. Three expressive writing sessions were distributed over a two-week period that began...
one to two weeks after the pre-test measurements. It is known from the literature that writing sessions distributed over a longer period of time yield larger self-disclosure effects than closely spaced sessions (Smyth, 1998). Therefore, it was of interest to determine whether WM gains could be observed in a short-time frame of a week from pre-test (Day 1) to post-test (Day 8) measurements, with writing taking place on Days 1, 3, and 5 of the study.

Our study was in general modelled after the procedures used in the negative event condition of Experiment 2 in Klein and Boals’ (2001) report. College students selected a negative life event of their own choosing. Those assigned to the intervention group wrote expressively about this negative event on three occasions. Students in the control group wrote on the topic of managing their time in college. The students completed the Impact of Event Scale (IES) and the OSPAN test before and after the writing sessions. Unlike the Klein and Boals’ study, we attempted to use the Pennebaker Inventory of Limbic Languidness (PILL) to measure health changes over the short duration of our study.

Another important difference is that we asked all participants to recall the negative life event on Day 1 and Day 8. We wished to assess whether the event’s representation in long-term memory could be altered over the course of only one week by expressive writing. Specifically, we examined changes in cognitive insights about the event and the use of emotion words, positive and negative, using LIWC (Pennebaker, Francis, & Booth, 2001). Written narratives have been found to become more coherent over time as long-term memories are altered from sensory-affective representations to organised, linguistic representations (Pennebaker, 1993; Pennebaker, Mayne, & Francis, 1997). This design could have attenuated differences between the control and intervention groups, given that all participants provided a written recollection of the event, albeit not under expressive writing instructions, at the outset of the experiment.

METHOD

Participants
A total of 61 undergraduates taking introductory psychology at Saint Louis University completed participation in the study; 32 were randomly assigned to the control group and 29 to the intervention group. An additional 18 participants, 11 given the intervention group instructions and 7 given the control group instructions, began the study but failed to complete all of the sessions. These incomplete data sets were not analysed. All received course credit for the number of sessions in which they participated. Because of an error in record keeping, precise demographic information cannot be provided, but all participants were college students in the range of 18–22 years of age, with approximately half female.

Materials

**OSPAN.** An arithmetic operation-word memory span task (OSPAN) was used to measure WM via computer (Turner & Engle, 1989). In this task, a sequence of math problems are presented. Each problem is shown with a right/wrong answer and a one-syllable word, e.g., \((8 \times 2) - 8 = 8\) home. Individuals determine the correctness of the math problem and silently read the word. After each problem set, individuals recall the set of words just presented. The total WM score is the total number of words accurately recalled in correct serial order for correct math problems only.

**PILL.** To assess health improvements over a short period of time, a subset of items were selected from the Pennebaker Inventory of Limbic Languidness (PILL) inventory of symptoms (Pennebaker, 1982). This is a 54-item inventory that measures physical health symptoms such as chest pains, indigestion, and headaches. Individuals report the frequency of each symptom during the last week. The total score reflects the number of symptoms that were experienced more than three days a week. An examination of the items in the PILL raised a potential problem with its use in such a short-time frame of one week.
Participants in both the intervention and control group might check some symptoms at both the pre-test and a week later at the post-test because of an acute health problem (e.g., having a cold or the flu). To reduce error variance in the measure for our purposes, we excluded 35 PILL items such as running nose, congested nose, sore throat, nausea, chills, eyes water, itchy eyes or skin, ringing in the ears, temporary deafness, strong reactions to insect bites, sunburn, bleeding nose, boils, and swollen ankles. We instead selected a subset of 19 items that might be potentially sensitive to a reduction in self-reported health problems from Day 1 to Day 8 of our study. These were: choking sensations, coughing, out of breath, chest pains, racing heart, insomnia or difficulty sleeping, upset stomach, indigestion, heartburn or gas, abdominal pain, diarrhoea, constipation, stiff or sore muscles, back pains, tightness in the chest, sweat even in cold weather, headaches, and hands tremble or shake. Because we examined only a subset of PILL items, the psychometric properties of our measure likely did not match those of the complete PILL. However, our revised measure correlated reliably with the complete PILL scores in both the control group ($r = .89$ at pre-test and $r = .95$ at post-test, $p < .001$) and the intervention group ($r = .89$ at pre-test and $r = .74$ at post-test, $p < .001$).

**Event recall.** Each participant recalled in writing a negative event from their past in as much objective detail as possible for 15 minutes. Our goal was to obtain a factual record of the event and to assess whether the language used in recalling it changed from pre- to post-test. The total number of words, the percentage of emotion words, and the percentage of cognitive words were tallied using LIWC (Pennebaker et al., 1997).

Participants were instructed to recall a “personal event that has somehow negatively affected you and your life”. They were told to use their discretion in selecting the event and to provide only information that they felt comfortable revealing. The events selected by participants reflected a wide range of negative life experiences, including the death of a friend or relative, serious illness in the family, personal failures in school, personal relationship difficulties, serious personal property loss, making significant life changes, personal injuries in accidents, witnessing family violence, and suffering emotional and sexual abuse.

Once the event was selected, they were asked to write about the details of the event: “when it occurred, what the event entailed, who it involved, and if or when the event had ended”. So as not to elicit expressive writing, they were encouraged to “leave out subjective reactions such as your opinions, emotions, and feelings and focus on the objective detail of the event”.

**IES.** The Impact of Event Scale (IES) was administered to measure the degree to which the recalled event caused intrusive thoughts and avoidance attempts (Horowitz, Wilner, & Alvarez, 1979). Individuals rated on a 4-point scale 15 items on the frequency of intrusive thoughts or attempts to avoid such thoughts during the last 7 days. A total score was calculated by summing scores (coded as 1–4) on all items. Subscale scores for Intrusiveness and Avoidance were similarly calculated.

**Writing intervention.** Participants wrote freely on their assigned topic in three separate writing sessions each lasting 20 minutes. Participants in the Control Group were assigned to write about their time management of daily activities, whereas those in the Intervention Group wrote expressively about their deepest thoughts and feelings concerning the negative event. These conditions replicated those of Klein and Boals (2001) and many other studies on the written self-disclosure effect.

**Procedure**

Our procedure examined the impact of expressive writing over a short time frame of 8 days in comparison to 11–12 weeks in the Klein and Boals’ experiments. The study consisted of four sessions. In Session 1 (Day 1), the pre-intervention measurements were taken. The OSPAN test was first
administered, followed by the PILL. Next, all participants recalled a negative event from their life. The IES was then administered to assess the impact of the recalled event in terms of intrusive thoughts and avoidance attempts. Finally, they were given 20 minutes to write either about the event or about time management, depending on the condition to which they were assigned. Session 2 took place on Day 3 of the study and consisted of a 20-minute writing session at home. At Session 3, participants returned to the lab on Day 5 of the study to turn in their writing from Session 2 and wrote a third and final time for 20 minutes. Session 4 took place on Day 8. The following post-test measures were administered in order: OSPAN, PILL, event recall, and IES, duplicating the pre-intervention procedures.

Only participants who completed all four sessions, including the one at home, were included in the analyses.

RESULTS

A two-way (condition × time) repeated-measures analysis of variance (ANOVA) on our modified PILL score indicated a significant main effect of time, $F(1, 59) = 8.46, p < .01$, with a reduction in symptoms from pre- to post-intervention. However, this reduction was larger for the expressive writing condition than for the control condition, as indicated by a reliable time × condition interaction, $F(1, 59) = 7.48, MSE = 3.96, p < .01, \eta^2_p = .112$. As shown in Table 1, modified PILL scores were reduced by 52% in the intervention group. By comparison, the reduction in the control group was 2%. Thus, a written self-disclosure effect was observed soon after the writing intervention. Self-reported health problems showed a decrease on Day 8 of the study after three sessions of expressive writing about a negative life event on Days 1, 3, and 5.

The OSPAN measure of WM capacity increased reliably as a function of practice from pre- to post-intervention for both groups, consistent with the view that practice plays some role in the WM gains (Table 1). Averaged across both conditions, the scores rose from an initial mean of 52.7 to 54.3, $F(1, 59) = 14.81, MSE = 6.36, p < .001$. Importantly, however, the intervention condition showed a 5% gain in OSPAN scores from pre- to post-intervention compared with a mere 1% gain from practice in the control condition. The time × condition interaction was reliable, $F(1, 59) = 4.81, p < .05, \eta^2_p = .075$. We can reject, therefore, the possibility that the WM gains reported by Klein and Boals were an artefact of task practice. Although the OSPAN scores did improve slightly from practice, expressive writing caused a significantly larger increase in WM capacity than was found in control participants.

Writing expressively about the negative life event did not selectively reduce the frequency of intrusive thoughts and avoidance attempts.

Table 1. Means (and standard errors) for pre- versus post-test measurements

<table>
<thead>
<tr>
<th>Measure</th>
<th>Control group Pre-test</th>
<th>Control group Post-test</th>
<th>Intervention group Pre-test</th>
<th>Intervention group Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pill Items</td>
<td>3.09 (0.56)</td>
<td>3.03 (0.64)</td>
<td>3.90 (0.61)</td>
<td>1.86 (0.35)</td>
</tr>
<tr>
<td>OSPAN Total</td>
<td>52.94 (0.93)</td>
<td>53.66 (0.89)</td>
<td>52.34 (0.92)</td>
<td>55.07 (0.60)</td>
</tr>
<tr>
<td>IES Total</td>
<td>31.38 (1.91)</td>
<td>29.09 (1.85)</td>
<td>34.86 (1.78)</td>
<td>32.69 (1.96)</td>
</tr>
<tr>
<td>Intrusiveness</td>
<td>15.09 (1.04)</td>
<td>13.91 (1.01)</td>
<td>16.72 (1.06)</td>
<td>15.69 (1.10)</td>
</tr>
<tr>
<td>Avoidance</td>
<td>16.28 (1.08)</td>
<td>15.19 (1.08)</td>
<td>18.14 (1.19)</td>
<td>17.00 (1.24)</td>
</tr>
<tr>
<td>Positive</td>
<td>1.33 (0.15)</td>
<td>1.33 (0.16)</td>
<td>1.55 (0.15)</td>
<td>1.40 (0.13)</td>
</tr>
<tr>
<td>Negative</td>
<td>1.52 (0.19)</td>
<td>1.37 (0.16)</td>
<td>1.46 (0.16)</td>
<td>1.68 (0.23)</td>
</tr>
<tr>
<td>Cognitive</td>
<td>5.85 (0.33)</td>
<td>5.83 (0.46)</td>
<td>6.72 (0.44)</td>
<td>6.96 (0.34)</td>
</tr>
</tbody>
</table>

Notes: Intrusiveness = IES Intrusiveness Subscale; Avoidance = IES Avoidance Subscale; Positive = LIWC Percent Positive Emotion Words; Negative = LIWC Percent Negative Emotion Words; Cognitive = LIWC Percent Cognitive Words.
Instead, IES scores decreased from pre- to post-test for both groups, as shown in Table 1. The pre-intervention IES scores did not differ reliably between groups \((p = .19)\). Averaged over both groups, there was a reliable drop in IES scores over time from 33.0 to 30.8, \(F(1, 59) = 9.38, \text{MSE} = 16.09, p < .01\), and this decline occurred for both the Intrusiveness and the Avoidance subscales. Participants overall reported a decrease in intrusive thoughts over time, from a mean of 15.9 at pre-intervention to 14.8 intrusions one week later, \(F(1, 59) = 5.65, \text{MSE} = 6.64, p < .05\). Avoidance mean scores decreased over time as well from 17.2 to 16.0, \(F(1, 59) = 6.33, \text{MSE} = 5.98, p < .05\). No other effects were reliable for either the IES as a whole or for the Intrusiveness and Avoidance subscales. Of key importance, there was no interaction of time \(\times\) condition. Neither intrusive thoughts nor avoidance attempts decreased more in the intervention condition relative to the control condition.

We collected participants’ written recollections of the negative event at pre- and post-test to determine whether expressive writing altered their long-term memory representations. With LIWC, we analysed the use of cognitive words reflecting insight and causality, and emotion words, both positive and negative. As can be seen in Table 1, the means did not vary much from pre- to post-test. The only reliable source of variance was a main effect of condition for cognitive words. The intervention group used more cognitive words at both pre- and post-test in their event recall than did the control group, \(F(1, 59) = 4.37, \text{MSE} = 6.95, p < .05\). The interaction of time \(\times\) condition was unreliable.

Individual differences on the IES, OSPAN, and recollection LIWC measures within each group were examined by analyzing correlations among these variables with respect to changes from pre-test to post-test. Only one correlation proved reliable. Increases in intrusive thoughts over time were positively correlated with increases in avoidance attempts in the control condition \((r = .40, p < .05)\). Control participants who had gains in intrusive thoughts through the course of the study also had gains in attempts to avoid thinking about the negative event. But, for those who wrote expressively, there was no reliable relation between changes in intrusive thoughts and changes in avoidance attempts \((r = .18)\). The writing intervention seemed to weaken the relation between intrusive thoughts and efforts to suppress them.

Finally, in an attempt to replicate the relationship of cognitive word changes in the expressive writing texts to WM changes reported by Klein and Boals (2001), participants in each group were categorised in terms of whether their use of cognitive words (causal and insight terms) increased or decreased from the first to the third writing sample. A significant interaction emerged between condition and change in cognitive terms, \(F(3, 57) = 11.81, p < .001\). The OSPAN scores at post-test were higher among those who increased their usage of cognitive terms in expressive writing over time \((M = 55.9, SD = 3.2; n = 17)\) in comparison to those who decreased their usage of cognitive terms in the intervention group \((M = 53.9, SD = 3.0; n = 12)\), as found by Klein and Boals in their Experiment 1. However, in our results, the opposite pattern was found within the control group, such that higher WM scores were found among those who decreased usage of cognitive terms \((M = 55.7, SD = 3.7; n = 19)\) compared with individuals who increased their use \((M = 50.7, SD = 5.39; n = 13)\). Klein and Boals, by contrast, found the same pattern in the control group as in the intervention group in their first experiment and no reliable differences in a second experiment. Thus, our findings strengthen the case for a link between WM improvements and the use of causal and insight words in expressive writing.

**DISCUSSION**

Our results replicate the finding of Klein and Boals (2001) that the written self-disclosure effect is associated with a gain in WM capacity. We were able to rule out the possibility that such gains reflect simple practice in taking the OSPAN test used to measure WM capacity. Although both
groups showed some improvement from the first to the second time the OSPAN was taken, the gains were reliably larger in the expressive writing than in the control group. Our main result at odds with Klein and Boals’ work is that the writing intervention did not selectively reduce the frequency of intrusive thoughts and avoidance attempts. Instead, participants in both the intervention and control groups reported decreases in intrusive thoughts and avoidance attempts from pre- to post-test.

Our results demonstrate that the written self-disclosure effect and augmentation of WM capacity can occur within one week, with three writing sessions distributed a day apart. It is important to note that we obtained these effects with a normal population of college students who wrote expressively about a negative life event; we are not contending that they generalise to a clinical population of trauma victims.

Interpretations
Our failure to observe a reliable reduction in intrusive thoughts and avoidance attempts only in the intervention group while still replicating the written self-disclosure effect could be interpreted as support for Lepore’s (1997, p. 1034) contention that expressing “one’s stressor-related thoughts and feelings promotes emotional adaptation to stressors by blunting the emotional impact of intrusive thoughts”. He found that depressive symptoms were reduced by expressive writing in college students as an exam date approached, not by reducing the frequency of intrusive thoughts, but by blunting their negative emotional impact. There are several possible reasons for such emotional changes. For example, perhaps repeated exposure to stressful intrusive thoughts causes habituation (Bootzin, 1997; Foa & Kozak, 1986) or it induces a cognitive reappraisal of the intrusive thoughts as less threatening (Lepore, Greenberg, Bruno, & Smyth, 2002). In either case, the intentional processing of a negative experience, through writing or talking about it, may lessen the emotional cost of remembering the event.

It is important to note that the literature concerning the effects of expressive writing on the IES is mixed and difficult to interpret at present. Our data and those of de Moor et al. (2002) and Lepore (1997) found no effect on either subscale of the IES. Lutgendorf and Antoni (1999) found that the intervention reduces intrusions but has no effect on avoidance attempts. By contrast, others have revealed the opposite pattern (Greenberg, Wortman, & Stone, 1996; Smyth, True, & Souto, 2001), whereas some studies indicated reductions in both subscales (Klein & Boals, 2001; Schoutrop, Lange, Hanewald, Davidovich, & Saloman, 2002).

Plainly, more research is needed to understand the relationship of intrusive thoughts and avoidance attempts to the written self-disclosure effect. Our study adds to the complexity by suggesting that working memory gains might be obtainable even when there is not a reduction in IES scores caused by expressive writing.

If further research confirms that WM gains can indeed occur without reductions in intrusive thoughts and avoidance attempts, then how could such an outcome possibly be understood? One interpretation focuses on the individual difference findings and advances the theme that expressive writing reduces the cost of intrusive negative memories. As evidenced in the control group, increases in intrusive thoughts were linked to increases in avoidance attempts. This same pattern of individual differences was not observed in the expressive writing group. One might argue that WM capacity was freed by expressive writing because the intervention eliminated the typical positive relationships between intrusive thoughts and efforts to suppress recollection. Expressive writing may not reduce the frequency of intrusive thoughts, but it could still aid WM capacity by reducing the cognitive, as well as emotional, costs of dealing with event memories that appear unbidden. The resulting gain in WM capacity could then be the causal factor in subsequent health improvements.

An alternative interpretation questions whether WM capacity is a mediator of the written self-disclosure effect. This view suggests that gains in WM capacity might be a consequence rather than a
cause of the broad health improvements reported in
the literature with written self-disclosure. It could
be that health improvements must first occur
through a process of coping with intrusive thoughts
and reducing their emotional costs. Then, once
expressive writing improves health, there may be a
general improvement in cognitive functioning that
includes gains in WM capacity. In other words,
gains in OSPAN performance may reflect a general
improvement in cognitive functioning rather than a
specific improvement in WM capacity per se. Includ-
ing multiple measures of cognitive function-
ing would be a way to test this speculation.

Limitations

Arguably, our IES findings are flawed because
participants were asked to report intrusive thoughts
and avoidance attempts over the past seven days,
which overlapped with the writing intervention on
Days 1, 3, and 5 of the study. However, our data
showed a reliable decrease in intrusive thoughts by
all participants, suggesting it was sensitive to
changes over time. The possibility remains,
though, that had the IES been administered, say,
two weeks later, then the intervention group would
have revealed a larger reduction than the control
group.

Another limitation of our study is that we
asked all participants to recall the negative life
event on Day 1; we aimed to assess whether the
event’s representation in long-term memory was
changed by expressive writing. However, this was
an undesirable feature of the design to the extent
that participants treated event recall as an oppor-
tunity to write their deepest thoughts and feelings
about the event. If that were the case, then even
the control participants had one dose of the
expressive writing intervention. We minimised
this possibility by using instructions that stressed
recalling the event as objectively as possible rather
than expressing one’s feelings about it. Still, it is
possible that our design attenuated the magni-
tudes of the written self-disclosure effect and the
associated increase in WM capacity.

Finally, our use of a subset of 19 PILL items as
a way to measure short-term changes in health is a
limitation of our method because the subset may
not reflect the psychometric properties of the
complete PILL. Although the subset scores were
positively correlated with the complete PILL
scores, the reliability and validity of our selective
measure have not been established. Further
replications of the WM gain associated with
expressive writing over a long enough period of
time for appropriate use of the complete PILL are
needed.

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