Writing About Testing Worries Boosts Exam Performance in the Classroom

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Two laboratory and two randomized field experiments tested a psychological intervention designed to improve students' scores on high-stakes exams and to increase our understanding of why pressure-filled exam situations undermine some students' performance. We expected that sitting for an important exam leads to worries about the situation and its consequences that undermine test performance. We tested whether having students write down their thoughts about an upcoming test could improve test performance. The intervention, a brief expressive writing assignment that occurred immediately before taking an important test, significantly improved students' exam scores, especially for students habitually anxious about test taking. Simply writing about one's worries before a high-stakes exam can boost test scores.

For many students, the desire to perform their best in academics is strong. Consequences for poor performance, especially on exams, include poor evaluations by mentors, teachers, and peers; lost scholarships; and relinquished educational opportunities. Yet despite the fact that students are often motivated to perform their best, the pressure-filled situations in which important tests occur can cause students to perform below their ability instead (*1*).

The expression "choking under pressure" is used to describe what happens when people perform more poorly than expected given their skill level when there are large incentives for optimal performance and negative consequences for poor performance (*2*). Choking is a serious problem given that poor exam performance affects students' subsequent academic opportunities. It also limits potentially qualified students from participating in the talent pool tapped to fill advanced jobs in disciplines where the workforce is dwindling [e.g., science, technology, engineering, and mathematics workforce in the United States (*3*)]. Here we demonstrate how a 10-min. pre-exam intervention, derived from psychological theories of stress and performance, can prevent choking and enhance exam scores, particularly for students who habitually become anxious in testing situations.

Several studies have shown that, when students feel an anxious desire to perform at a high level [i.e., performance pressure (*4*)], they worry about the situation and its consequences (*5*, *6*). These worries compete for the working memory (WM) available for performance. WM is a short-term memory system involved in the control and regulation of a limited amount of information immediately relevant to the task at hand (*7*). If the ability of WM to maintain task focus is disrupted because of situation-related worries, performance can suffer (*8*).

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Worries not only occur in intense academic situations but are a major component of depression and other clinical disorders (*9*). Expressive writing, in which people repeatedly write about a traumatic or emotional experience over several weeks or months, has been shown to be an effective technique for decreasing rumination in depressed individuals (*10*). Writing may alleviate the burden that worries place on WM by affording people an opportunity to reevaluate the stressful experience in a manner that reduces the necessity to worry altogether (*11*).

We reasoned that, if worries lead to poor test performance and writing helps regulate these worries, then giving students the opportunity to express their thoughts and feelings about an impending examination would enhance test performance. This is a somewhat counterintuitive idea given that drawing attention to negative information typically makes it more rather than less salient in memory (*12*, *13*). However, if expressive writing helps to reduce rumination, then it should benefit high-stakes test performance, especially for students who tend to worry in testing situations.

Moreover, the benefits of writing therapy are traditionally seen over multiple writing sessions spanning weeks or months. In these situations, people write about an event that occurred in the past (*11*), and thus substantial reflection time is likely necessary to bring different aspects of the event to mind and explore them in detail. However, we reasoned that, if a threatening situation is immediately forthcoming, the details should be salient. Thus, one bout of writing should be sufficient to impact performance. Such a finding would show that minimal class or exam time is needed to achieve expressive writing benefits.

Across two laboratory studies and two randomized field experiments, we investigated expressive writing as a test-taking intervention (*14*). In the laboratory studies, students took a math test under conditions designed to elicit either lower or higher levels of performance pressure. We predicted that math performance would be worse under high-pressure compared with low-pressure situations (*8*) but that allowing students to write about their exam-related thoughts immediately before the test would eliminate this choking-under-pressure effect (study 1). In study 2, we tested whether it is writing about the test per se that prevents choking or whether writing about any topic (e.g., a mundane event in one's life) can prevent choking under pressure. In studies 3 and 4, we extended our laboratory results to the classroom and asked for whom the benefits of expressive writing would be most pronounced. Ninth-grade students were randomly assigned to an expressive writing or control condition immediately before the first final exam of their high school career. If expressive writing alleviates the impact of worries on performance, then students most prone to worry during exams (i.e., students highest in test anxiety) should benefit most from the writing intervention.

We began by creating a high-stakes testing environment in the laboratory. In study 1, college students ($N = 20$) took two short tests composed of Gauss's modular arithmetic. Modular arithmetic is advantageous as a laboratory task because, although it is based on common mathematical

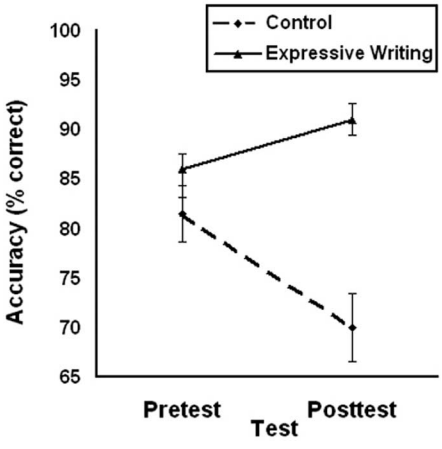

Fig. 1. Math accuracy in study 1. Error bars are SEM.

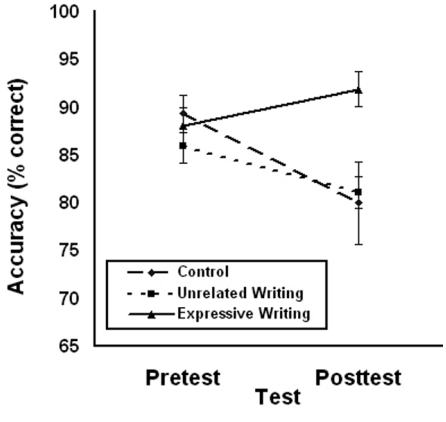

Fig. 2. Math accuracy in study 2. Error bars are SEM.

procedures, most students have not seen it before; thus, previous task experience is controlled.

Before taking the first math test (pretest), students were simply told to perform their best. After completing the pretest, students were given a high-pressure scenario based on common pressures: monetary incentives (which stand in for scholarships associated with high test scores) and peer pressure and social evaluation (which comes from judgments of test scores from admissions committees, teachers, parents, and peers).

Students were informed that, if they performed at a high level, they would receive a monetary reward. Students were also told that this award was dependent on high-level performance of both themselves and a partner they were paired with, a "team effort." Students were then informed that their partner had completed the experiment and improved. Thus, the current participant was entirely responsible for winning (or losing) the money. Students were also told that their performance would be videotaped and that teachers and students would watch the tapes. This scenario has been repeatedly demonstrated to increase feelings of pressure and anxiety (*8*). These feelings do not differ as a function of math ability, and thus this factor is not confounded with response to pressure.

After the high-pressure scenario was described, students spent 10 min either sitting quietly (control group) or engaged in our writing intervention (expressive writing group). The expressive writing group was asked to write as openly as possible about their thoughts and feelings regarding the math problems they were about to perform. Everyone then took the math posttest.

Our main performance measure was math accuracy. Problem-solving time did not differ as a function of group (*15*). Pretest math performance did not differ across the control and expressive writing groups as revealed by a *t* test [$t(18) = 1.14$, $P = 0.27$] (Fig. 1). However, in the posttest, the expressive writing group performed significantly better than the control group [$t(18) = 5.55$, $P < 0.01$, Cohen's $d = 2.48$]. Control participants choked under pressure, showing a 12% accuracy drop from pretest to posttest [$t(9) = 4.87$, $P < 0.01$, $d = 1.14$], whereas students who expressed their thoughts before the high-pressure test showed a significant 5% math accuracy improvement from the pretest to posttest [$t(9) = 2.74$, $P < 0.03$, $d = 0.58$] (*16*).

From study 1, it is unclear whether writing about one's test-related thoughts per se prevents pressure-induced failure or whether any writing might alleviate the relation between pressure and performance. Perhaps writing, regardless of content, distracts students' attention from the situation and thus benefits performance. We tested this notion in a second laboratory study ($N = 47$) that replicated study 1 and included another condition where some students wrote about an unrelated unemotional event (unrelated writing group) before the posttest.

Before receiving our high-pressure scenario, math performance did not differ as a function of group as revealed by a one-way analysis of variance (ANOVA) [$F_{2,44} = 0.74$, $P = 0.48$] (Fig. 2). However, this was not true in the posttest [$F_{2,44} = 5.56$, $P < 0.01$]. Students in the control and unrelated writing groups showed a significant 7% drop in accuracy from pretest to posttest [$t(30) = 3.35$, $P < 0.01$, $d = 1.17$]. This drop did not differ across groups [$t(29) = 1.07$, $P = 0.29$]. In contrast, the expressive writing group showed a significant 4% gain in accuracy from pretest to posttest [$t(15) = 2.09$, $P = 0.05$, $d = 0.47$].

Analysis of writing content showed that students in the expressive writing group revealed significantly more anxiety-related words (e.g., worried, fearful, nervous) than students in the unrelated writing group [$F_{1,29} = 6.31$, $P < 0.02$]. Students in the expressive writing group also had a significantly greater proportion of sentences expressing negative thoughts and worries (e.g., "I am afraid I am going to make a mistake") than students in the unrelated writing group [$F_{1,30} = 20.96$, $P < 0.01$]. If writing about negative thoughts and worries underlies performance differences among the expressive writing and unrelated writing groups, then taking these sentences into account should eliminate the differences in performance from the pretest to posttest seen for these writing groups. This is exactly what was found. Specifically, when the proportion of worry-related sentences was taken into account, the significant writing group (expressive writing, unrelated writing)–by–test (pretest, posttest) interaction [$F_{1,30} = 9.30$, $P < 0.005$], demonstrating that changes in math performance across test depend on writing group, became nonsignificant [$F_{1,29} = 2.88$, $P = 0.10$] (*17*). Writing about negative thoughts and worries accounts for choking-under-pressure differences across the unrelated and expressive writing groups.

If expressive writing benefits test performance by reducing intrusive thoughts and worries, then students most prone to worry during exams (i.e., students highest in test anxiety) should show the largest writing benefit. Moreover, if test anxiety, over and above knowledge and ability, causes some students to score poorly on exams, then expressive writing should eliminate the negative relation commonly seen between test anxiety and performance. Obtaining this latter result would highlight the importance of introducing classroom interventions that ensure all students (regardless of test anxiety) have the opportunity to demonstrate their knowledge on important tests.

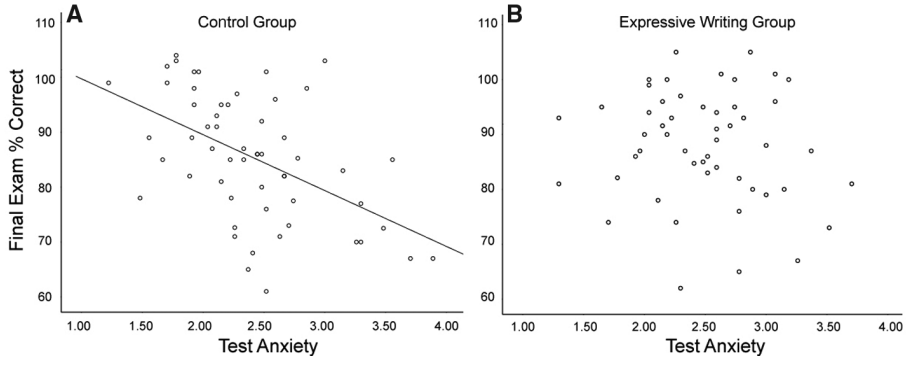

Fig. 3. Scatterplot of the relation between test anxiety and final exam performance for students in the control condition (**A**) and the expressive writing condition (**B**) combined across studies 3 and 4. Some scores top 100% because of possible extra credit.

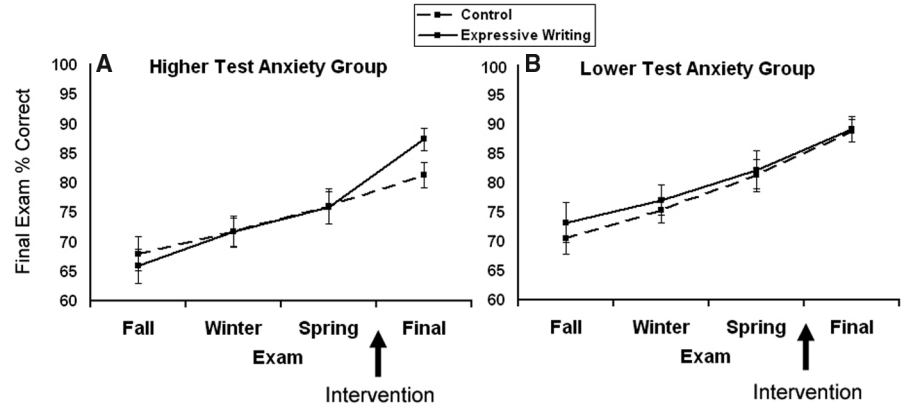

Fig. 4. Exam performance for students higher (**A**) and lower (**B**) in test anxiety. Error bars are SEM.

We tested these predictions in studies 3 and 4, immediately before ninth-grade students' first final high-school exam. This is an especially pressure-filled exam, because year-end grades often serve as the first data point in averages used for college admissions, and final exams contribute substantially to this grade point.

We performed the same intervention twice, 1 year apart, with separate ninth-grade cohorts in the same school. Students taking ninth-grade biology participated (study 3 had 51 students across three biology teachers; study 4, 55 students across three teachers).

Six weeks before the final exam, we measured students' test anxiety, the degree to which students worry in reaction to evaluative situations. In their home rooms (independent of biology), students were given a standard measure of test anxiety designed to tap into their habitual tendency to feel tension, apprehension, or anxiety in testing situations (*18*). Students were asked to rate items such as "During tests, I find myself thinking about the consequences of failing" (1 was "not typical of me," and 4 was "very typical of me").

Conveniently, within each year, all biology exams were administered in one final exam session in the same room. Students were randomly assigned (within teacher) to either an expressive writing or a control condition. Immediately before the exam, proctors asked students to put away their materials and prepare for a short assignment. Students received an envelope with their name on it. These envelopes contained a sheet of paper with specific instructions.

About half of the students were given instructions to write about their thoughts about the upcoming exam (expressive writing condition). The other half were asked to think about a topic that would not be covered on the exam (control condition). This particular control was chosen because students often report introspecting on possible exam topics immediately before a test (*19*), and we were attempting to mimic normal exam conditions as closely as possible. Students were given 10 min to complete the assignment. They then returned the instruction sheet to the envelope and gave the envelope to a proctor (*20*). Everyone then began their exams.

We obtained students' final exam scores as well as their midterm exam scores for the fall, winter, and spring quarters. We first examined the correlations between test anxiety and final exam performance separately in each study and then combined across both studies. The higher students' test anxiety, the lower their final exam score in the control condition [for study 3, $r(26) = -0.45$ and $P < 0.02$; study 4, $r(30) = -0.48$ and $P < 0.01$; combined, $r(56) = -0.51$ and $P < 0.01$] (*21*) but not in the expressive writing condition [study 3, $r(25) = -0.07$ and $P = 0.73$; study 4, $r(25) = -0.19$ and $P = 0.36$; combined, $r(50) = -0.14$ and $P = 0.33$]. Across both studies, the correlations between test anxiety and final exam scores were significantly different from each other in the expressive writing and control conditions [Z(two-tailed) = –2.09, $P < 0.04$ (*22*)] (Fig. 3).

Why was there a negative relation between test anxiety and exam performance in the control, but not the expressive writing, condition? If writing alleviates the impact of worries on performance, then highly test anxious students should benefit most from writing. If so, then writing about one's worries may allow those higher in test anxiety to perform up to the level of low-test-anxious students, eliminating the relation commonly seen between test anxiety and performance.

To test this possibility, we next divided students across both studies into groups (median split) on the basis of whether they were lower or higher in test anxiety. In terms of higher test anxious students, there was no difference in fall, winter, or spring midterm exam scores [all P values > 0.60] before our writing intervention (Fig. 4A). However, after the intervention, on the final exam, those who expressively wrote outperformed controls by 6% [$t(52) = 2.08$, $P < 0.05$, $d = 0.57$] (*23*) and performed similarly to lower-test-anxious students, regardless of writing condition [$t(78) = 0.66$, $P = 0.52$]. Higher-test-anxious students in the expressive writing condition received a B+ on a standard grading scale; those in the control condition received a B–. In contrast, lower-test-anxious students showed no difference as a function of writing condition across the midterms [P values > 0.53] or final exam [$t(50) = 0.09$, $P = 0.93$] (Fig. 4B). The differential impact of writing on lower- and higher-test-anxious students is similar to study 1's finding, whereby writing did not affect performance in a low-pressure situation. If lower- as compared to higher-test-anxious students worry less about exams and thus express fewer worries in their writing, worry less during the exam, or both, their performance should be less influenced by expressive writing.

We demonstrate that a short expressive writing intervention reduces performance deficits commonly associated with high-pressure testing situations. The benefits of expressive writing are especially apparent for students who are habitually anxious about taking tests. Expressive writing eliminates the relation commonly seen between test anxiety and poor test performance. Moreover, it is not any writing that benefits performance, but expressing worries about an upcoming high-pressure situation that accounts for enhanced exam scores under pressure.

Past work in school settings demonstrates that asking African American students to reaffirm their values across the school year reduces the racial achievement gap by year's end (*24*, *25*). This is true for women and the gender gap in science classes as well (*26*). Moreover, helping students repeatedly make connections between the curriculum and their personal lives has been shown to increase motivation and academic success in science classes among students who profess low interest to begin with (*27*). The current research shows that interventions designed to boost school performance are not restricted to students who are members of stigmatized groups or who are already disengaged from course material. Rather, for those students who are most anxious about success, one short writing intervention that brings testing pressures to the forefront enhances the likelihood of excelling, rather than failing, under pressure.

References and Notes

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14. Materials and methods are available as supporting material on *Science* Online.
15. See tables S1 and S2 for reaction time data.
16. We also ran another group of participants ($N = 20$) in study 1 who did not receive a high-pressure scenario before the posttest. Math accuracy was relatively high and did not differ from the pretest to posttest, nor did it differ as a function of whether students expressively wrote before the posttest. Thus, an accuracy drop from the pretest to posttest occurred only for students given our high-pressure scenario who did not write. See supporting online material (SOM) text for details.
17. See table S4 for details.
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20. Proctors were two biology teachers. Teachers and students were blind to the study purpose. Teachers were blind to the particular instructions students received.
21. Correlations remained significant when controlling for prior midterms and teacher (SOM text).
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Supporting Online Material

www.sciencemag.org/cgi/content/full/331/6014/211/DC1
Materials and Methods
SOM Text
Tables S1 to S6
References

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