

Effect of humor on state anxiety and math performance

THOMAS E. FORD, BRIANNA L. FORD, CHRISTIE F. BOXER,
and JACOB ARMSTRONG

Abstract

An experiment tested the hypothesis that exposure to humorous material prior to taking a difficult math test can inhibit the amount of anxiety associated with the test, and thus enhance performance. In keeping with our hypothesis, participants performed better on a math test after first being exposed to funny cartoons versus non-humorous poems or nothing at all. Mediation analyses suggest that state anxiety mediated the relationship between exposure to humorous cartoons and math performance. Participants who were first exposed to cartoons performed better on the math test because they felt less anxiety while taking the test.

Keywords: anxiety, humor, math performance.

Laughter gives us distance. It allows us to step back from an event, deal with it and then move on.

—Bob Newhart

As any college student will affirm, taking a test can be stressful experience. In fact, apprehension associated with taking a test can at times feel overwhelming. By merely anticipating a difficult test, a student can experience intense anxiety and their minds can be invaded by fearful thoughts of failure and self-doubt that interfere with concentration.

In the present research, we consider the possibility that having a “good laugh” prior to taking a test can actually inhibit anxiety and prevent performance impairment. Specifically, we tested the effect of exposure to humorous

stimuli on math test performance and anxiety associated with taking the test. We propose that exposure to humor prior to taking a difficult test can inhibit anxiety associated with the test and, consequently, enhance performance. We present evidence that exposure to 10 humorous cartoons while anticipating taking a math test reduced participants' state anxiety and enhanced test performance relative to exposure to 10 interesting but non-humorous poems or exposure to nothing at all.

1. Anxiety and test performance

Psychological and educational research has consistently shown that anxiety is negatively related to performance on (a) actual course examinations in classroom settings (e.g., Carrier and Jewell 1966; Daniels and Hewitt 1978; Marso 1970; Mazzone et al. 2007) and (b) tests of cognitive-intellectual skills contrived in the laboratory (e.g., Arkin et al. 1982; Ashcraft 2002; Ashcraft and Kirk 2001). Daniels and Hewitt (1978), for instance, found that college students who scored high on Sarason and Gordon's (1953) Test Anxiety Questionnaire performed worse on 4 regular course exams than students who were categorized as having moderate or low test anxiety.

The deleterious effect of anxiety appears to be greater for more difficult tests. Arkin et al. (1982) found that participants who were low in test anxiety were better at solving anagrams than those who were high in test anxiety, but only if the anagrams were difficult. The negative effect of test anxiety was attenuated on an easy anagram test. Similarly, Daniels and Hewitt (1978) found that the performance advantage of low anxiety students over high anxiety students was greater for difficult exam questions than it was for easy questions.

Anxiety affects performance by interfering with the cognitive processes in working memory that are required to complete cognitive-intellectual skills tests (e.g., Arkin et al. 1982; Ashcraft 2002; Ashcraft and Kirk 2001; Eysenck and Calvo 1992). Eysenck and Calvo's (1992) processing efficiency theory proposes that highly anxious people are more likely to experience an intrusion of task-irrelevant thoughts and worry which can usurp the limited capacity of working memory. Consistent with Eysenck and Calvo's processing efficiency theory, Arkin et al. (1982) found that, while solving difficult anagrams, highly anxious participants experienced greater "cognitive interference" (task-irrelevant thoughts such "I thought about how poorly I was doing.") compared to less anxious participants. Furthermore, Ashcraft and colleagues (Ashcraft 2002; Ashcraft and Kirk 2001) found that math anxiety undermines perfor-

mance on math tests by disrupting the processes involved in developing problem solving strategies to apply to math problems.

2. Humor, anxiety, and test performance

Exposure to humorous material facilitates coping with stressful events by reducing state anxiety and negative affect in general (e.g., Berk 1998; 2000; Cann et al. 2000; Isen et al. 1987; Newman and Stone 1996; Yovetich et al. 1990). Yovetich et al. (1990), for instance, found that participants who were exposed to a humorous audiotape experienced less anxiety in a stressful situation—waiting to receive electric shock—in comparison to participants in a non-humorous audiotape condition or a “no tape” control condition.

Since exposure to humorous material reduces state anxiety, and lower levels of state anxiety are associated with better performance on tests of cognitive-intellectual skills, it follows that exposure to humorous stimuli could enhance performance on such tests. However, studies on the effect of exposure to humorous stimuli on test performance have produced inconsistent results. Some studies have shown that exposure to humorous stimuli enhances performance on actual course exams (Berk 2000; Friedman et al. 2002; Smith et al. 1971) and on non-course related tasks that require creative problem solving (e.g., Isen et al. 1987; Ziv 1976). Other studies have shown no such benefits of exposure to humorous stimuli (e.g., McMorris et al. 1985; Perlini et al. 1999).

In the first systematic investigation of the effect of exposure to humorous material on test performance, Smith, et al. (1971) gave students with varying degrees of test anxiety either a humorous multiple choice midterm exam (one third of the questions were designed to be humorous) or a non-humorous exam (none of the questions were designed to be humorous). Smith et al. found that highly anxious students performed better on the humorous exam than on the non-humorous exam, and they performed equally as well on the humorous exam as students who had either moderate or low levels of anxiety. Furthermore, highly anxious students performed worse on the non-humorous exam than those who had moderate or low levels of anxiety.

Smith et al.’s findings suggest that humorous exams can benefit students who have high test anxiety. However, subsequent studies have *failed* to show that humorous exams alleviate test anxiety or improve performance (e.g., McMorris et al. 1985; Perlini et al. 1999). Based on failures to replicate Smith et al.’s findings, Perlini et al. (1999) concluded, “. . . efforts to introduce humor to examinations to alleviate test anxiety may be misdirected . . .” (p. 12).

The attempts to replicate Smith et al.'s (1971) findings may have been equivocal because of a shared methodological artifact. Each of the studies on test performance in actual classroom settings has embedded humor into content of the test on which performance was measured. However, some research suggests that humor alleviates state anxiety if it is presented *prior to* the anxiety-evoking event while one anticipates the event. Cann et al. (2000) found that exposure to a humorous videotape reduced the amount of anxiety experienced in response to a stressful event only when it was presented *prior to* the stressful event. Humor served a preventive function, inhibiting anxiety evoked by the anticipated stressful event. Perhaps, then, exposure to humor prior to taking a difficult test can enhance performance by inhibiting anxiety. Berk and Nanda (2006) addressed this possibility. Specifically, Berk and Nanda (2006) gave graduate students in a biostatistics course tests over course material that contained either (a) humorous instructions presented before the test, (b) content-relevant humor in test questions, or (c) humorous test instructions and humorous questions. Consistent with Cann et al. (2000), Berk and Nanda (2006) found that only humorous instructions presented before the test positively affected performance. However, none of the humor manipulations affected test anxiety, thus the study failed to support the hypothesis that anxiety reduction mediates the effect of humor on test performance.

Berk and Nanda (2006) may not have provided a fair test of the mediating role of anxiety. The graduate student participants showed very low levels of test anxiety before taking the exams and before the induction of the humor manipulation. They knew about the exams well in advance and had the opportunity to prepare for them. In addition, the course instructor employed several strategies, unrelated to humor, that were designed to minimize test anxiety. As Berk and Nanda suggested, the pre-manipulation levels of test anxiety were so low that there was little room for humor interventions to reduce anxiety further. Thus it remains possible that exposure to humor prior to taking a test can enhance performance, in part, by inhibiting anxiety associated with the test.

3. The present study: Overview and hypothesis

On the basis of the stress-reducing effect of humor, we hypothesized that exposure to humorous material prior to taking a difficult math test can inhibit the amount of state anxiety associated with the anticipated test, and thus enhance performance. Accordingly, we told participants that they would take a difficult

math test. Before giving the test, however, we asked participants to read either 10 cartoons, 10 short poems or nothing at all. Participants then completed the math test and a measure of state anxiety associated with taking the test. We predicted that participants in the cartoon condition would report less test anxiety and perform better on the math test than participants in either the poem condition or the control condition.

4. Method

4.1. Participants

Thirty-three men and fifty-one women enrolled in psychology and sociology courses completed the experiment individually in exchange for extra credit. We randomly assigned participants to 1 of 3 conditions with humor manipulation (cartoon, poem, control) serving as the between-subjects variable.

4.2. Procedure

An experimenter greeted the participants as they arrived at the laboratory. The experimenter informed participants that they would be invited to participate in two separate but unrelated studies. The experimenter gave the participant an overview of the two studies. In the cartoon and poems conditions, the experimenter explained that the participant would be asked to first complete a cartoon (poem) evaluation survey in which they would simply read and evaluate 10 cartoons (poems). The experimenter explained that upon completing the cartoon (poem) evaluation survey, participants would be invited to complete a difficult 20-question “word problem” test for the second study. Participants in the control condition were simply invited to complete the word problem test.

In the cartoon condition, participants read 10 cartoons from McPherson’s 2004 “Close to Home” calendar. In the poem condition, participants read 10 poems collected from the internet. In both conditions, participants rated how funny and how interesting they perceived each cartoon or poem using scales ranging from 1 (not at all) to 7 (extremely). Participants in all conditions then completed the word problem test. The word problem test consisted of 20 questions taken from the quantitative section of practice SAT tests. Importantly, the questions were not simply numerical or algebraic problems.

Rather, they required the formulation of strategies to solve them. Also, before administering the test, the experimenter told all participants that their responses would be completely anonymous and confidential. The experimenter also encouraged participants to try to answer each question and to avoid guessing.

After collecting the tests, the experimenter administered a “post-test questionnaire.” The post-test questionnaire contained 8 items designed to assess state anxiety while taking the test. Seven items were adapted from Spielberger et al.’s (1970) state anxiety scale. Participants rated the extent to which they felt: anxious, comfortable, jittery, worried, at ease, nervous, and calm while taking the test. The eighth item asked participants to rate how afraid they were that they would perform poorly on the test. Responses to each item were made on rating scales ranging from 1 (not at all) to 7 (very much). Cronbach’s alpha for the eight-item measure (after reverse-scoring comfortable, calm, and at ease) was .92. Therefore, we averaged responses to the eight items to form an aggregate measure of state anxiety.

After participants had completed the post-test questionnaire, the experimenter probed the participants for suspicion of the true purpose of the study and debriefed them. None of the participants indicated suspicion. Data from participants were excluded from analyses if (a) procedural mistakes were made by an experimenter, (b) participants did not take the math test seriously (i.e., simply circled responses without trying solve the problems), (c) participants chose not to complete the math test, or (d) participants completed less than five out of twenty problems correctly. Overall, data were analyzed for 33 participants to the cartoon condition, 28 participants in the poem condition and 23 participants in the control condition.

5. Results

5.1. *Humor manipulation check*

We performed separate 2 (humor manipulation: cartoon, poem) \times 2 (sex of participant) ANOVAs on the mean ratings of how humorous participants perceived the 10 cartoons or poems, and on ratings of how interesting they perceived the cartoons or poems. As expected, analyses of the humor ratings revealed a significant main effect of the humor manipulation, $F(1, 57) = 88.99$, $p < .01$. There were no other significant effects. Overall, participants rated the cartoons as funnier ($M = 4.41$, $SD = 1.03$) than the poems ($M = 1.88$, $SD =$

0.99), Cohen's $d = 2.50$. In addition, there were no significant effects in the analysis of how interesting participants perceived the cartoons and poems. Importantly, participants perceived the poems to be equally as interesting ($M = 4.17$, $SD = 0.92$) as the cartoons ($M = 4.07$, $SD = 0.97$), $F(1, 57) < 1.00$.

5.2. Test performance

Following procedures described by McIntyre, Paulson, and Lord (2002), we adjusted scores on the test for guessing. Because each question had 4 response options, we subtracted one-fourth the number of incorrect answers from the number of correct answers. We then subjected the adjusted score to a 3 (humor manipulation) \times 2 (sex of participant) ANOVA.

Table 1. Analysis of Variance table for the adjusted performance score on the math test

	Sum of Squares	df	Mean Squares	F	Sig.
Humor Manipulation	164.60	2	82.30	4.46	.015
Sex of Participant	108.90	1	108.90	5.90	.017
Humor manipulation * Sex of Participant	16.85	2	8.43	0.456	.64
Residual	1440.42	78	18.47		
Total	1749.48	83	21.08		

There was a significant main effect of the humor manipulation, $F(2, 78) = 4.46$, $p < .05$. In keeping with our hypothesis, planned comparisons revealed that participants performed better on the math test in the cartoon condition ($M = 11.93$, $SD = 4.48$) than in the poem condition ($M = 9.13$, $SD = 4.42$), $t(81) = 2.46$, $p < .05$, Cohen's $d = .63$ or in the control condition ($M = 8.97$, $SD = 4.34$), $t(81) = 2.47$, $p < .05$, Cohen's $d = .67$.

There was also a significant main effect of sex of participant, $F(1, 78) = 5.90$, $p < .05$. Overall, men performed better ($M = 11.8$, $SD = 4.46$) than women ($M = 9.14$, $SD = 4.45$), Cohen's $d = .60$. The interaction effect was not significant, $F(2, 78) < 1.0$.

5.3. State anxiety

We performed a 3 (humor manipulation) \times 2 (sex of subject) ANOVA on the eight-item aggregate measure of state anxiety.

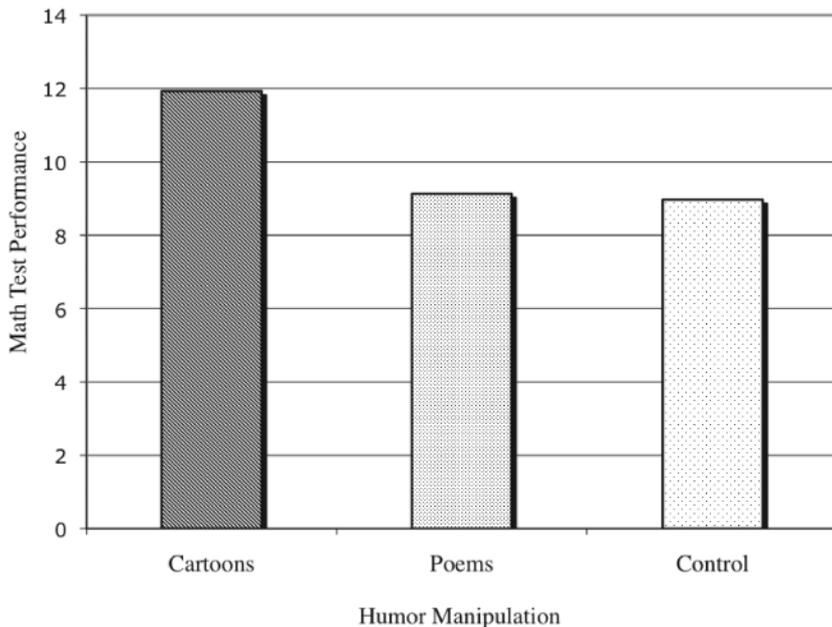


Figure 1. Mean number of test items answered correctly, adjusted for guessing, as a function of the humor manipulation.

Table 2. Analysis of Variance table for the state anxiety scores

	Sum of Squares	df	Mean Squares	F	Sig.
Humor Manipulation	18.09	2	9.046	6.095	.003
Sex of Participant	3.346	1	3.346	2.255	.137
Humor manipulation * Sex of Participant	0.930	2	0.465	0.313	.73
Residual	114.286	77	1.484		
Total	1749.48	83	21.08		

As predicted, there was a significant main effect of the humor manipulation, $F(2, 77) = 6.10, p < .01$. Planned comparisons revealed that participants reported experiencing less state anxiety while taking the math test in the cartoon condition ($M = 2.77, SD = 1.16$) than in the poem condition ($M = 3.71, SD = 1.39$), $t(80) = 3.03, p < .01$, Cohen's $d = -.74$ or in the control condition ($M = 3.93, SD = 1.05$), $t(80) = 3.46, p < .01$, Cohen's $d = -1.04$. There were no other significant effects.

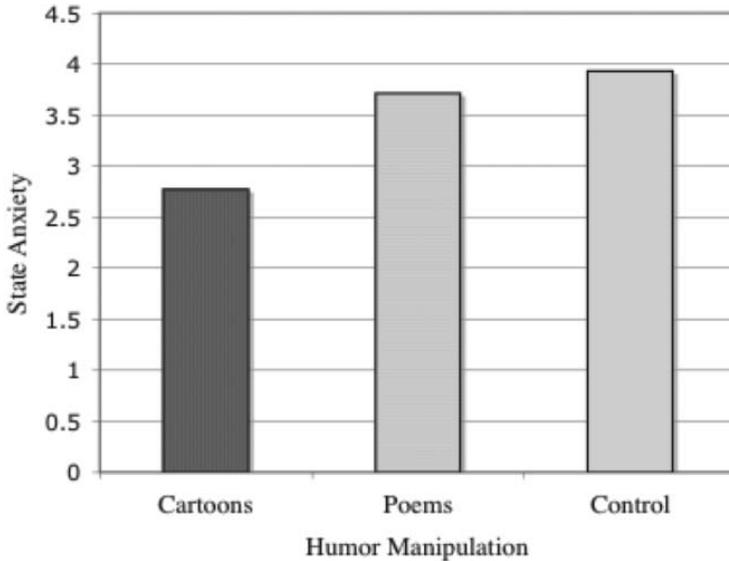


Figure 2. Mean state anxiety scores as a function of the humor manipulation.

5.4. Mediation analyses

We predicted that state anxiety would mediate the relationship between exposure to humorous stimuli and test performance. To test this hypothesis, we performed a path analysis following the procedures described by Baron and Kenny (1986, see Figure 3).

As displayed in Figure 3, we first regressed math performance on the humor manipulation. This direct effect was significant ($\beta = -.28, t = -2.61, p < .01$). We then regressed responses on the state anxiety measure on the humor manipulation ($\beta = .35, t = 2.90, p < .01$). Finally, we regressed math performance on both the humor manipulation and the state anxiety measure. The path from state anxiety to math performance was significant ($\beta = -.33, t = 3.0, p < .01$). The direct path from the humor manipulation to math performance, however, was not significant when state anxiety was included in the model ($\beta = -.15, t = 1.34, p = .19$). A Sobel test revealed that the decrease in the direct path from the humor manipulation to math performance when state anxiety was included in the model (from $-.28$ to $-.15$) was significant, $Z = -2.31, p < .05$. Exposure to humorous material enhanced performance on the math test, at least in part, by mitigating state anxiety.

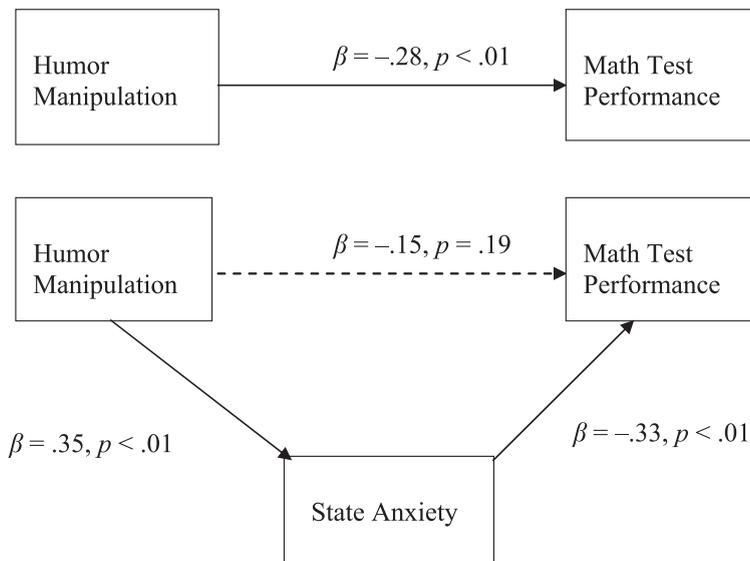


Figure 3. *The relation between the humor manipulation, state anxiety and math performance.*

6. Discussion

The results of our experiment support our hypothesis. Exposure to humorous cartoons prior to taking a difficult math test enhanced performance on the test, in part, by alleviating the amount of state anxiety participants felt while taking the math test. It is possible that the humorous cartoons created a positive affective state that is incompatible with anxiety and thus inhibited anxiety enough to prevent it from interfering with task-relevant processing (e.g., developing problem-solving strategies). This interpretation is consistent with research showing that exposure to humorous stimuli serves as a protective function against the negative effects of anxiety associated with a stressful event (Cann et al. 2000).

Although our analyses suggest that state anxiety mediated the relationship between the humor manipulation and math performance, it is possible that exposure to humorous cartoons enhanced math performance through other psychological processes as well. Ziv (1976), for instance, suggested that when solving problems that require cognitive-intellectual skill, one's efforts are

sometimes undermined by a tendency to be “practical, logical, and economical, so that judgment comes into play too quickly” (p. 320). In contrast, performance on such tasks can be enhanced by “creative problem solving” — thinking that accepts “crazy” ideas and is not bound to rational, logical and conventional answers (p. 320; See also Isen et al. 1987).

Ziv (1976) further argued that exposure to humorous material prior performing a cognitive task can facilitate creative problem solving. Humor activates a conversational rule of levity — to switch from the usual serious mindset to a playful or non-serious humor mindset (e.g., Attardo 1993; Berlyne 1972; Ford and Ferguson 2004; Kane et al. 1977; Mulkay 1988). Mulkay (1988), for instance, suggested that when in the humor mindset people loosen the rules of logic and expectations of common sense. Consequently, when presented with a joke, people do not apply the information-processing strategies typically required by serious communication. They abandon the constraints of practical, rational, logical ways of thinking.

By adopting a humor mindset prior to completing a task of cognitive-intellectual skill, one might temporarily feel greater freedom to generate and consider more divergent and creative problem solving strategies. It is possible, then, that participants in the present study performed better on the math test upon exposure to cartoons, in part, because they had adopted a humor mindset that facilitated creative thinking and problem solving.

6.1. *Exposure to humor and stereotype threat*

It is well-known that women tend to under-perform on math tests taken under conditions that foster stereotype threat — when they feel a risk of confirming the negative stereotype about women’s math ability (e.g., Quinn and Spencer 2001). Ford et al. (2004), however, found that the personality trait, coping sense of humor — the use of humor as a strategy for coping with stressful experiences (Martin and Lefcourt 1983) — buffered women against the performance-impairing effects of stereotype threat on math test performance by predisposing them to experience less anxiety while taking the test. Women who were high in coping sense of humor felt less state anxiety associated with taking a difficult math test and consequently performed better on the test in comparison to women who were low in coping sense of humor.

Based on the results of the present research, one may hypothesize that exposure to humorous material also could help members of stereotyped groups cope with the stress imposed by stereotype threat situations. For instance, like

coping sense of humor, exposure to humorous material prior to taking a math test might buffer women against the performance impairment that occurs under conditions that heighten the experience of stereotype threat.

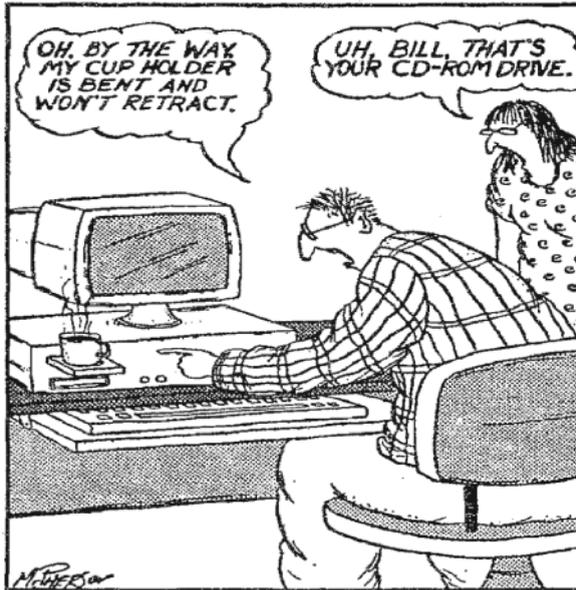
6.2. *Summary and conclusion*

The present experiment supported the hypothesis that exposure to humorous material prior to taking a difficult math test can inhibit the amount of state anxiety associated with the anticipated test, and thus enhance performance. Participants performed better on a difficult math test after first being exposed to funny cartoons versus non-humorous poems or nothing at all because they experienced less state anxiety while taking the test. Further research is necessary to delineate other psychological mechanisms besides anxiety that might mediate the effect of exposure to humor on test performance. We hope the present research will generate further interest in the relationship between humor, anxiety and task performance and the relationship between humor and coping stressful events more generally.

*Western Carolina University
Western Carolina University
University of Iowa
Western Michigan University*

Appendix A — Sample Cartoon and Poem

Sample Cartoon



Bill's co-workers slowly began to suspect that he had lied about having a master's degree in computer science.

Sample Poem: God and the Soldier

God and the soldier
All men adore
In time of trouble,
And no more;
For when war is over
And all things righted,
God is neglected—
The old soldier slighted.

References

- Arkin, Robert, Candace S. Detchon, & Geoffrey M. Maruyama. 1982. Roles of attribution, affect, and cognitive interference in test anxiety. *Journal of Personality and Social Psychology*, 43, 1111–1124.
- Ashcraft, Mark H. 2002. Math anxiety: Personal, educational and cognitive consequences. *Current Directions in Psychological Science*, 11, 181.
- Ashcraft, Mark H. & Elizabeth P. Kirk. 2001. The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General*, 130, 224–237.
- Attardo, Salvatore. 1993. Violation of conversational maxims and cooperation: The case of jokes. *Journal of Pragmatics*, 19, 537–558.
- Baron, Reuben M. & David A. Kenny. 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51, 1173–1182.
- Berk, Ronald A. 1998. *Professors Are from Mars and Students Are from Snickers*. Madison, WI: Mendota Press.
- Berk, Ronald A. 2000. Does humor in course tests reduce anxiety and improve performance? *College Teaching*, 48, 151–159.
- Berk, Ronald A. & Joy Nanda. 2006. A randomized trial of humor effects on test anxiety and test performance. *Humor: International Journal of Humor Research*, 19(4), 425–454.
- Berlyne, Daniel E. 1972. Humor and its kin. In J. H. Goldstein and P. E. McGhee (Eds.), *The psychology of humor*, 43–60. New York, NY: Academic Press.
- Cann, Arnie, Lawrence G. Calhoun, & J. T. Nance. 2000. Exposure to humor before and after an unpleasant stimulus: Humor as a preventative or a cure. *Humor: International Journal of Humor Research*, 13, 177–191.
- Carrier, Neil A., & Donald O. Jewell. 1966. Efficiency in measuring the effect of anxiety upon academic performance. *Journal of Educational Psychology*, 57, 23–26.
- Daniels, Bob & Jay Hewitt. 1978. Anxiety and classroom examination performance. *Journal of Clinical Psychology*, 34, 340–345.
- Eysenck, Michael W. & Manuel G. Calvo. 1992. Anxiety and performance: The processing efficiency theory. *Cognition and Emotion*, 6, 409–434.
- Ford, Thomas E. & Mark A. Ferguson. 2004. Social consequences of disparagement humor: A prejudiced norm theory. *Personality and Social Psychology Review*, 8, 79–94.
- Ford, Thomas E. Mark A. Ferguson, Jenna L. Brooks & Kate M. Hagadone. 2004. Coping sense of humor reduces effects of stereotype threat on women's math performance. *Personality and Social Psychology Bulletin*, 30, 643–653.
- Friedman, Hershey, Linda W. Friedman & Taiwo Amoo. 2002. Using humor in the introductory statistics course. *Journal of Statistics Education*, 10, 1–11.
- Isen, Alice M., Kimberly A. Daubman & Gary P. Nowicki. 1987. Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology*, 52, 1122–1131.
- Kane, Thomas, R. Jerry Suls, & James T. Tedeschi. 1977. Humour as a tool of social interaction. In A. J. Chapman and Foot, H. C. (Eds.), *It's a funny thing, humor*, 13–16. Elmsford, NY: Pergamon Press.
- Martin, Rod A. & Herbert M. Lefcourt. 1983. Sense of humor as a moderator of the relation between stressors and moods. *Journal of Personality and Social Psychology*, 45, 1313–1324.
- Marso, Ronald, N. 1970. Test item arrangement, testing time and performance. *Journal of Educational Measurement*, 7, 113–118.
- Mazzone, Luigi, Francesca Ducci, Maria C. Scoto, Eleonora Passaniti, Valentina G. D'Arrigo, & Bnedetto Vittello. 2007. The role of anxiety symptoms in school performance in a community sample of children and adolescents. *BMC Public Health*, 7, 347–447.

- McIntyre, Rusty B., Rene M. Paulson, & Charles G. Lord. 2002. Alleviating women's mathematics stereotype threat through salience of group achievements. *Journal of Experimental Social Psychology*, 39, 83–90.
- McMorris, Robert F., Sandra L. Urbach, & Michael C. Connor. 1985. Effects of incorporating humor in test items. *Journal of Educational Measurement*, 22, 147–155.
- Mulkay, Michael. 1988. *On Humor: Its Nature and Its Place in Modern Society*. Basil New York, NY: Blackwell Inc.
- Newman, Michelle G. & Arthur A. Stone. 1996. Does humor moderate the effects of experimentally-induced stress? *Annals of Behavioral Medicine*, 18, 101–109.
- Perlini, Arthur H., Roger G. Nenonen & David L. Lind. 1999. Effects of humor on test anxiety and performance. *Psychological Reports*, 84, 1203–1213.
- Sarason, Seymour B. & E. M. Gordon. 1953. The test anxiety questionnaire: Scoring norms. *Journal of Abnormal and Social Psychology*, 48, 447–448.
- Smith, Ronald E., James C. Ascough, Ronald F. Ettinger & Don A. Nelson. 1971. Humor, anxiety, and task performance. *Journal of Personality and Social Psychology*, 19, 243–246.
- Spielberger, Charles D., R. L. Gorsuch, & R. E. Lushene. 1970. *The State-Trait Anxiety Inventory (STAI) test manual*. Palo Alto, CA: Consulting Psychologists Press.
- Quinn, Diane M. & Steven J. Spencer. 2001. The interference of stereotype threat with women's generation of mathematical problem-solving strategies. *Journal of Social Issues*, 57, 55–71.
- Yovetich, Nancy A., J. Alexander Dale, & Mary A. Hudak. 1990. Benefits of humor in reduction of threat-induced anxiety. *Psychological Reports*, 66(1), 51–58.
- Ziv, Avner. 1976. Facilitating effects of humor on creativity. *Journal of Educational Psychology*, 68, 318–322.