Priming Competence Diminishes the Link Between Cognitive Test Anxiety and Test Performance: Implications for the Interpretation of Test Scores

Jonas W.B. Lang and Jessica Lang

*Psychological Science* 2010 21: 811 originally published online 30 April 2010
DOI: 10.1177/0956797610369492

The online version of this article can be found at:
http://pss.sagepub.com/content/21/6/811

Published by:
SAGE
http://www.sagepublications.com

On behalf of:
Association for Psychological Science

Additional services and information for *Psychological Science* can be found at:

Email Alerts: http://pss.sagepub.com/cgi/alerts
Subscriptions: http://pss.sagepub.com/subscriptions
Reprints: http://www.sagepub.com/journalsReprints.nav
Permissions: http://www.sagepub.com/journalsPermissions.nav

>> Version of Record - Jun 16, 2010
OnlineFirst Version of Record - Apr 30, 2010

What is This?
Test anxiety is a relatively stable trait and associated with test performance in a wide variety of testing situations, such as school examinations, scholastic-achievement tests, and intelligence tests (Ackerman & Heggestad, 1997; Hembree, 1988; Zeidner, 1998). The relation between test anxiety and test performance primarily results from one test-anxiety factor—cognitive test anxiety, or test worry—which refers to differences in “individuals’ cognitive reactions to evaluative situations, or internal dialogue regarding evaluative situations” (Cassady & Johnson, 2002, p. 272). The relation between the other major test-anxiety factor—emotional test anxiety, or test emotionality—and test performance is less pronounced and disappears after controlling for cognitive test anxiety (Cassady & Johnson, 2002; Hembree, 1988; Zeidner, 1998).

There is some disagreement regarding the source of the association between test anxiety and test performance, which has led to disagreement over educational testing policy. Assuming that test anxiety has a causal effect on test performance, some scholars have suggested giving test anxiety the status of a psychiatric disorder (Zuriff, 1997) and have called for special arrangements for test-anxious persons. For example, some researchers have recommended that test-anxious people be allowed to take tests without a time limit (Hill & Wigfield, 1984; Zuriff, 1997). Other scholars have contested these ideas (e.g., Kirkland & Hollandsworth, 1980). These authors have argued that test anxiety has no causal effect on test performance and that it is consequently not reasonable to make special arrangements for test-anxious persons or design interventions to treat test anxiety directly.

A preferred way to test a causal theory explaining the relation between a personality trait (such as cognitive test anxiety) and an outcome (such as test performance) is to experimentally manipulate the causal mechanism the theory proposes (Revelle, 2007; Revelle & Oehlberg, 2008). When altering the mechanism changes the relation between the two variables, this can provide convincing evidence that the mechanism is actually the source of the relation.

In the present research, we used this approach to provide new insights into the psychological mechanisms underlying test anxiety. Researchers disagree whether the correlation between cognitive test anxiety and test performance is causal or explainable by skill deficits, which lead to both cognitive test anxiety and lower test performance. Most causal theories of test anxiety assume that individual differences in cognitive test anxiety originate from differences in self-perceived competence. Accordingly, in the present research, we sought to temporarily heighten perceptions of competence using a priming intervention. Two studies with secondary- and vocational-school students (Ns = 219 and 232, respectively) contrasted this intervention with a no-priming control condition. Priming competence diminished the association between cognitive test anxiety and test performance by heightening the performance of cognitively test-anxious students and by lowering the performance of students with low levels of cognitive test anxiety. The findings suggest that cognitively test-anxious persons have greater abilities than they commonly show. Competency priming may offer a way to improve the situation of people with cognitive test anxiety.
the relation between cognitive test anxiety and test performance. We built on the fact that modern causal theories of test anxiety assume that individual differences in cognitive test anxiety fundamentally stem from individual differences in self-perceived competence. Manipulating self-perceived competence should consequently alter the link between cognitive test anxiety and test performance. To test this idea directly, we sought to temporarily heighten self-perceived competence. We therefore developed a priming procedure that allowed us to directly and specifically prime competence-related cognitions.

**Theoretical Explanations for the Relation Between Cognitive Test Anxiety and Test Performance**

Researchers who question a causal relation between test anxiety and test performance base their reasoning on skill-deficit theories (Benjamin, McKeachie, Lin, & Holinger, 1981; Kirkland & Hollansworth, 1980; Musch & Bröder, 1999). According to these theories, the correlation between test anxiety and test performance results from the causal effects of a third variable—skill—on both variables. Low skill levels lead to both test anxiety and low test performance, and therefore a correlation between the two variables emerges.

Researchers who question skill-deficit theories and suggest that a causal link between test anxiety and test performance exists have developed several causal test-anxiety theories. For the purpose of developing specific hypotheses for the present research, we focused on two particularly popular causal explanations: test-interference theory (e.g., Sarason, 1972) and disjunctive motivational models (e.g., Carver & Scheier, 1998). Like other causal test-anxiety theories (see Zeidner, 1998, for an overview), these theories predict that heightening competence-related cognitions should alter the relation between cognitive test anxiety and test performance.

Test-interference theory (e.g., Sarason, 1972, 1984) proposes that test-anxious persons have difficulties performing in testing situations because a considerable amount of their cognitive processing capacity is constantly occupied by worry-related thoughts regarding their competence. As a result, this cognitive processing capacity is not available for working on the test. From the perspective of test-interference theory, heightening self-perceived competence should reduce worry-related thoughts and free cognitive processing capacity. Consequently, test-anxious persons should be able to improve their performance.

Disjunctive motivational models (Carver & Scheier, 1998; Kukla, 1972; Vancouver, More, & Yoder, 2008; Wright, 2008) explain the relation between test anxiety and test performance using the idea that people can perform intellectual tasks in one of two disjunctive states: Either they spend effort or they give up. Before people perform a task, and occasionally during their work on a task, people interrupt their activity, assess the situation, and choose between these two states. When people believe that their competence is too low to yield success, they give up—they do not even try to succeed, and consequently effort and performance are low. As self-perceived competence increases, this low-effort response remains fairly constant up to a point (the break-even point) at which success suddenly seems achievable. At this point, effort jumps from its minimum—in a situation in which success seems impossible—to a maximum. The sudden jump occurs because success now appears difficult but possible to achieve, and people consequently spend maximum effort. Disjunctive motivational models assume that the point of the shift from giving up to spending effort varies as a function of test anxiety. Test-anxious persons have chronic doubts and pessimistic attitudes about their ability to perform and overestimate the effort they need to succeed. Therefore, temporarily heightening self-perceived competence should increase the probability that test-anxious persons’ self-perceived competence exceeds the break-even point for spending effort.

An interesting question concerning disjunctive motivational models is what happens when self-perceived competence increases beyond the point at which maximum effort is first reached. Most disjunctive models suggest that effort decreases when self-perceived competence increases further. The idea is that people start to believe that success is almost secure and consequently lower their effort. This idea is relevant for the present research because it suggests that the effects of heightening self-perceived competence may not only affect test-anxious persons but also alter the performance of people with low test anxiety. In testing situations, the self-perceived competence of individuals with low test anxiety is likely to exceed the break-even point for spending effort. Heightening competence past this point may therefore make them believe that success is increasingly secure and lead them to reduce their effort, so that heightening competence would be expected to have a twofold effect: heightening performance in test-anxious persons and lowering performance in individuals with low test anxiety.

Although disjunctive models share many characteristics, there are also some differences among them. One controversial issue concerns the process that links self-perceived competence with performance. The initial disjunctive model proposed by Kukla (1972) conceptualizes the choice between spending effort and giving up as a cognitive choice process. At the end of this process, people decide whether to spend effort, and this decision directly affects behavior. In contrast, Carver and Scheier’s (1998) self-regulation theory suggests that a more affect-driven and less direct process is operational. According to this theory, people first set goals. Using self-perceived competence and past experience, they then decide to engage in a goal or disengage from it. In Carver and Scheier’s theory, engagement is an affect-driven mediating mechanism. Engaged people feel confident and deeply absorbed by their work on the task, and extreme levels of engagement ultimately lead to the experience of flow. Disengagement, in contrast, constitutes a strong tendency to end working on the task.
Social constraints like the presence of a teacher may force people to continue their work on a task. In such situations, however, the disengagement impulse can be expressed mentally by daydreaming and off-task thinking—typical behaviors of test-anxious persons.

### Priming Competence

Priming manipulations are experimental procedures that typically are intended to passively and unobtrusively activate a behavior representation, such as a trait construct or a stereotype, by having the participant use it in an early phase of an experiment (e.g., a “language test” or a “pilot study”) that is ostensibly unrelated to what follows. Research suggests that trait-priming techniques are effective in altering behavior (Bargh & Williams, 2006). Initially, researchers explained effects on behavior with ideomotor activation (Bargh, Chen, & Burrows, 1996). According to this explanation, primes can affect behavior by increasing the accessibility of behavioral representations. This activation carries over for a time to exert an unintended, passive influence.

In recent years, researchers have complemented the ideomotor account with the idea that priming can activate self-perceptions, and that this activation can subsequently cause people to act and interpret their environment in accordance with the activated self-perceptions. This active-self model (DeMarree, Wheeler, & Petty, 2005) proposes that the self-concept includes a currently active self-concept and a chronic self-concept. The active self-concept is influenced by the chronic self-concept but also is susceptible to environmental and situational influence. Consequently, primes can activate self-perceptions that are not part of the chronic self or that are included in the chronic self-concept but are rarely active.

An implication of the active-self account is that dominant chronic self-perceptions can be modified by primed self-perceptions. A study by Wheeler, DeMarree, and Petty (2008) supported this idea. Wheeler and his colleagues primed people with the trait concepts of either extraversion or introversion, and the primed individuals responded to persuasion in the same ways that actually extraverted and introverted individuals tend to. Building on the active-self model and the findings by Wheeler and his colleagues, in the present research, we assumed that priming competence-related cognitions could temporarily activate the concept of competence, and that this activation would increase self-perceived competence beyond the chronic level determined by individuals’ (chronic) level of cognitive test anxiety.

### The Present Studies

We conducted two studies to investigate the idea that the relation between test anxiety and test performance can be altered by priming competence. Considering test-interference theory (e.g., Sarason, 1972) and disjunctive motivational models (e.g., Carver & Scheier, 1998), we expected that priming competence would improve performance among individuals with high levels of cognitive test anxiety. Taking into account disjunctive motivational models assuming that effort decreases at high levels of self-perceived competence, we also expected that competency priming would reduce performance at low levels of cognitive test anxiety.

In Study 2, we additionally investigated potential mediating mechanisms for the expected moderating effect of priming. Specifically, we examined whether the Priming × Cognitive Test Anxiety interaction is mediated by task engagement (cf. Carver & Scheier, 1998) and worry-related thoughts (cf. Sarason, 1972).

### Study 1

#### Method

Participants in Study 1 were 219 German secondary- and vocational-school students (122 female and 97 male) with an average age of 16.54 years ($SD = 1.57$). We collected data from three different sites. Two of the sites were local high schools. The third site was a convention center where a career day for high-school and vocational-school students was held. Students participated in conveniently assigned testing groups of 24 to 40 students. To avoid contamination of treatment effects, we randomized by testing group and not by individual so that all students who participated in the same testing group received the same treatment (there were three testing groups in the priming condition and four testing groups in the control condition). Following recommendations in the literature (Campbell, Donner, & Klar, 2007), we conducted the randomization within the sites so that the design was a typical stratified-cluster randomized design (Donner & Klar, 2004) with clusters (testing groups) nested in strata (sites).

Students were asked to take part in a series of studies conducted by the local university and lasting about 2 hr total. They were informed that as part of this series of studies, they would have the opportunity to work on selection tests that are routinely used to select high-school and vocational-school students after they graduate. Students were further informed that the series of studies would contain additional selection measures that were in development, as well as related studies. All students participated voluntarily and received no monetary reward. Participants were, however, provided with feedback regarding their performance on several of the standardized ability tests they completed. Feedback regarding the ability measures used to investigate the effects of the priming manipulations was not provided, as it was not clear how priming would affect performance on these tests.

Students first worked on a booklet of several questionnaires. One of the questionnaires was the German adaptation of the Test Anxiety Inventory (TAI-G; Hodapp, Laux, & Spielberger, 1982). The TAI-G consists of two scales: one that measures cognitive test anxiety and one that measures emotional test anxiety.
After finishing the questionnaire booklet, students in the priming condition worked on the priming task. Specifically, they were asked to imagine a person who is very successful in solving technical and scientific problems. Then they were instructed to write down (a) five to nine abilities this person possessed, (b) five to nine adjectives describing the personality and values of this person, and (c) three sentences or brief notes describing how this person felt immediately before he or she started to solve very complex problems. Students had up to 10 min to work on this task. The task was masked as an unrelated pilot study for a research project on competence. The control condition of Study 1 was a nonpriming condition. Consequently, students in the control condition did not work on the priming task.

After completing the priming task (or the questionnaire booklet, in the case of the control group), students were given a 5-min break before they worked on the test-performance measure. This measure was the computerized version of the verbal-analogies subtest of the Wilde Intelligenz Test-2 battery (WIT-2; Kersting, Althoff, & Jäger, 2008). The WIT-2 contains 20 verbal analogies (working time: 4 min and 30 s). Students worked on this test using laptop computers (International Business Machines R32, T40, and T43) and mouse input devices. We used a verbal-analogies test for this initial study because skill in solving verbal analogies is prototypical of the abilities assessed in most educational and vocational tests (Kuncel, Hezlett, & Ones, 2004).

Analyses were conducted using random-coefficient modeling (Pinheiro & Bates, 2000; Raudenbush & Bryk, 2002) to account for the stratified-cluster randomized design. Stratification and cluster randomization can bias standard error estimates either upward or downward even when group membership is not the focus of the analysis (Bliese & Hanges, 2004; Campbell et al., 2007; Donner & Klar, 2004), as was the case in the current research. Random-coefficient models can control for the influence of stratification and cluster randomization by treating nested structures as either fixed or random effects. Following recommendations in the literature (Donner & Klar, 2004; Raudenbush, 1997), we treated clusters as random effects. Strata such as sites may be treated either as random or as fixed effects in stratified-cluster randomized designs (Donner & Klar, 2004). We opted for a conservative approach and treated the sites as fixed effects because the number of strata was small, and the sites were a small, selected group.

To test the moderating effect of the priming manipulation, we followed recommendations by West, Aiken, and Krull (1996) and centered all continuous variables at the sample mean. The categorical moderator variables coding the experimental condition (priming vs. control) were dummy-coded. We coded the control condition as 0 and the priming condition as 1 so that the main effects for cognitive test anxiety referred to the control condition.

In addition to controlling for stratification and cluster randomization, we controlled for emotional test anxiety in all analyses because emotional test anxiety can also relate to test performance (Chapell et al., 2005; Hembree, 1988; Zeidner, 1998). Although we did not hypothesize that an interaction between emotional test anxiety and our priming intervention would emerge, we nevertheless included this interaction term for the sake of completeness and to ensure that any interaction between cognitive test anxiety and the priming intervention indeed originated from this type of interaction effect (and not from a possible noncontrolled interaction with emotional test anxiety).

Results and discussion
Table 1 provides means and standard deviations for cognitive test anxiety, emotional test anxiety, and test performance, as well as correlations among these measures. The correlation between cognitive test anxiety and test performance was lower in the priming condition than in the control condition. This result is in line with the idea that our priming intervention would reduce the impact of cognitive test anxiety on test performance.

To determine the exact impact of the priming intervention on the relation between cognitive test anxiety and test performance, we investigated the moderating effect of the experimental condition using random-coefficient modeling. Results revealed that the interaction between experimental condition (priming vs. control) and cognitive test anxiety was significant (see Table 2) and not susceptible to outliers (see Fig. S1 and Supplemental Analyses in the Supplemental Material available online).

We therefore proceeded with a closer examination of the moderating effect of priming. We found that the relation between cognitive test anxiety and test performance was moderate and negative in the control condition (see Table 2). To exactly determine the relation in the experimental (priming) condition, we recoded the categorical moderator variable (control = 1, priming = 0) and estimated the model with standardized continuous variables so that the estimated coefficients ($b_{cs}$) provided effect size information. This random-coefficient analysis revealed that the relation between cognitive test anxiety and test performance was small and not significant in the priming condition, $b_{cs} = -0.09, t(208) = -0.98, p = .33$.

To further investigate the nature of the interaction between priming and cognitive test anxiety, we graphed the interaction of these two variables. As Figure 1a shows, individuals with high cognitive test anxiety performed better, and individuals with low cognitive test anxiety performed worse, in the priming condition relative to the control condition. Thus, priming competence improved the performance of people with high cognitive test anxiety, but reduced the performance of people with low levels of cognitive test anxiety. This pattern of results is in line with the predictions of disjunctive motivational models.
Study 2

The purpose of Study 2 was to attempt to replicate the findings of Study 1 with a more general ability test and to further investigate the nature of the moderating effect of competency priming by examining mediational mechanisms. As stated previously, Carver and Scheier’s (1998) self-regulation theory suggests that cognitive test anxiety relates to test performance via task engagement, and test-interference theories (e.g., Sarason, 1972) assume that worry-related thoughts in the testing situation are an important mediating mechanism. Consequently, we hypothesized that the priming manipulation is effective because it alters situational perceptions of engagement and worry.

Method

Two-hundred thirty-two students (132 female and 100 male) from two German secondary schools participated in Study 2. All participants were 10th-grade students, and their average age was 15.27 years ($SD = 0.52$). Like Study 1, Study 2 used a stratified-cluster randomized design. The strata were the two high schools, and the clusters were eight classes at these schools (four at each school, and four in each condition). Class size varied between 27 and 30 students.

The procedure of Study 2 was largely the same as the procedure used in Study 1. There were two differences. The first was that participants filled out two questionnaires asking about their level of task engagement (10 items; Rheinberg & Vollmeyer, 2003) and their worry-related thoughts during testing (3 items; Rheinberg & Vollmeyer, 2003). Students filled out these questionnaires immediately after they finished their work on the test-performance measure.

The second difference was that we used a different test-performance measure. The test used in Study 2 was the German version of the Wonderlic Personnel Test (WPT; Wonderlic, 1996). The WPT is a brief paper-and-pencil measure of general intelligence. The test consists of 50 verbal, numerical, and figurative tasks (working time: 12 min) and is frequently used in personnel selection (Schmidt & Hunter, 2004). Several studies (Dodrill & Warner, 1988) have found that this measure is highly correlated with the Wechsler Adult Intelligence Scale (Wechsler, 1955).

We used the same random-coefficient modeling approach as in Study 1. Mediation analyses were conducted using the

### Table 1. Means, Standard Deviations, Internal Consistencies, and Intercorrelations of the Variables in the Control and Priming Conditions of Studies 1 and 2

<table>
<thead>
<tr>
<th>Condition and variable</th>
<th>Study 1</th>
<th></th>
<th></th>
<th>Study 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$\alpha$</td>
<td>CTA</td>
<td>ETA</td>
<td>Test performance</td>
</tr>
<tr>
<td>Control condition ($n = 98$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTA</td>
<td>2.17</td>
<td>0.44</td>
<td>.85</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>ETA</td>
<td>1.62</td>
<td>0.52</td>
<td>.71</td>
<td>.32***</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Test performance (verbal analogies solved)</td>
<td>9.98</td>
<td>4.56</td>
<td>.85</td>
<td>-.35***</td>
<td>-.01</td>
<td>—</td>
</tr>
<tr>
<td>Priming condition ($n = 121$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTA</td>
<td>2.06</td>
<td>0.49</td>
<td>.80</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>ETA</td>
<td>1.55</td>
<td>0.44</td>
<td>.78</td>
<td>.39***</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Test performance (verbal analogies solved)</td>
<td>9.41</td>
<td>3.79</td>
<td>.81</td>
<td>-.15</td>
<td>-.17</td>
<td>—</td>
</tr>
<tr>
<td>Control condition ($n = 115$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTA</td>
<td>2.17</td>
<td>0.46</td>
<td>.84</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>ETA</td>
<td>1.55</td>
<td>0.46</td>
<td>.71</td>
<td>.40***</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Test performance (WPT score)</td>
<td>23.10</td>
<td>4.94</td>
<td>.74</td>
<td>-.28***</td>
<td>-.04</td>
<td>—</td>
</tr>
<tr>
<td>Task engagement</td>
<td>4.60</td>
<td>1.15</td>
<td>.83</td>
<td>-.34***</td>
<td>-.12</td>
<td>.39***</td>
</tr>
<tr>
<td>Worry-related thoughts</td>
<td>3.05</td>
<td>1.76</td>
<td>.83</td>
<td>.29***</td>
<td>.18*</td>
<td>.05</td>
</tr>
<tr>
<td>Priming condition ($n = 117$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTA</td>
<td>2.16</td>
<td>0.56</td>
<td>.82</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>ETA</td>
<td>1.51</td>
<td>0.44</td>
<td>.83</td>
<td>.56***</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Test performance (WPT score)</td>
<td>22.92</td>
<td>4.26</td>
<td>.68</td>
<td>-.06</td>
<td>-.12</td>
<td>—</td>
</tr>
<tr>
<td>Task engagement</td>
<td>4.37</td>
<td>1.28</td>
<td>.85</td>
<td>.07</td>
<td>.04</td>
<td>.21*</td>
</tr>
<tr>
<td>Worry-related thoughts</td>
<td>2.89</td>
<td>1.69</td>
<td>.81</td>
<td>.08</td>
<td>.01</td>
<td>.10</td>
</tr>
</tbody>
</table>

Note: The measures of cognitive test anxiety (CTA) and emotional test anxiety (ETA) used 4-point Likert scales ranging from 1 (almost never) to 4 (almost always). The task-engagement and worry measures relied on 7-point Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree). WPT = Wonderlic Personnel Test (Wonderlic, 1996).

*p < .05. **p < .01.
Table 2. Results of Random-Coefficient Analyses Testing the Moderating Effect of the Competence-Priming Manipulation on the Relation Between Cognitive Test Anxiety and Test Performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Study 1 (DV = number of verbal analogies solved)</th>
<th>Study 2 (DV = WPT score)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE</td>
</tr>
<tr>
<td>Fixed effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>9.64</td>
<td>0.64</td>
</tr>
<tr>
<td>Stratum 2</td>
<td>0.72</td>
<td>0.71</td>
</tr>
<tr>
<td>Stratum 3</td>
<td>0.74</td>
<td>0.75</td>
</tr>
<tr>
<td>CTA</td>
<td>-4.04</td>
<td>0.98</td>
</tr>
<tr>
<td>ETA</td>
<td>0.98</td>
<td>0.83</td>
</tr>
<tr>
<td>Priming</td>
<td>-0.88</td>
<td>0.56</td>
</tr>
<tr>
<td>CTA × Priming</td>
<td>3.25</td>
<td>1.27</td>
</tr>
<tr>
<td>ETA × Priming</td>
<td>-2.10</td>
<td>1.22</td>
</tr>
<tr>
<td>Random effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clusters</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Residuals</td>
<td>16.06</td>
<td>4.00</td>
</tr>
</tbody>
</table>

Note: N = 219 for Study 1 and 232 for Study 2. Stratum 2 and Stratum 3 were dummy-coded (yes = 1, no = 0) such that each stratum was compared with Stratum 1. Priming was dummy-coded such that the priming condition was compared with the control condition (priming = 1, control = 0). All continuous variables were centered at the sample mean. Coefficients with standardized continuous variables (b_{cs}) were derived by setting the standard deviation of all continuous variables to 1 without standardizing the dummy variables, such that coefficients for the independent continuous variables reflect the standardized effects in the control groups, and the interaction effects indicate the difference between the control and the priming groups. DV = dependent variable; WPT = Wonderlic Personnel Test (Wonderlic, 1996); CTA = cognitive test anxiety; ETA = emotional test anxiety.

*df = 208, **df = 220, ***df = 3, ****df = 5.
*p < 0.05, **p < 0.01.

Fig. 1. Relation between cognitive test anxiety and test performance in the priming and control conditions of (a) Study 1 and (b) Study 2. The graphs are based on the models in Table 2. For the purpose of producing the graphs, we centered the dummy variables that controlled for the influence of the strata at the sample means so that the graphs plot the average relations for each study. CI = confidence interval; WPT = Wonderlic Personnel Test (Wonderlic, 1996).
procedure suggested by Baron and Kenny (1986). We first tested whether the Cognitive Test Anxiety × Priming interaction had effects on the mediator variables and then examined whether adding the mediator variables to the model reduced the interaction’s effect on performance. Finally, we formally tested the mediator effects for significance using Baron and Kenny’s version of the Sobel test (originally proposed by Aroian, 1947).

**Results and discussion**

Table 1 shows the mean scores, internal consistencies, and correlations among cognitive test anxiety, emotional text anxiety, task performance, task engagement, and worry-related thoughts for participants in the control and priming conditions. Table 2 shows the results of the random-coefficient analysis for cognitive test anxiety, emotional text anxiety, priming, and the interaction between both anxiety measures and priming, with WPT score as the dependent variable. We found a significant and robust interaction effect between the priming dummy and cognitive test anxiety similar to the interaction effect in Study 1 (see Table 1, Table 2, and Fig. 1b; see also Fig. S2 and Supplemental Analyses in the Supplemental Material available online). Again, the priming manipulation considerably reduced the effect of cognitive test anxiety on test performance—control group: $b_{cs} = -0.28$, $t(220) = -2.67$, $p < .01$; priming group: $b_{cs} = 0.10$, $t(220) = 1.05$, $p = .29$.

Results of the mediation analyses are shown in Figure 2. As Figure 2 reveals, worry did not significantly mediate the effects of the Cognitive Test Anxiety × Priming interaction. Task engagement, in contrast, mediated the effect of the interaction, $z = 2.26$, $p = .02$. This mediation effect, however, was only partial, as the direct effect of the interaction remained significant after we added both mediator variables to the model. This leaves open the possibility that the Cognitive Test Anxiety × Priming interaction also directly affects behavior—as suggested by Kukla’s (1972) disjunctive motivational model—or that other meditational mechanisms exist.

**General Discussion**

These two studies provide evidence that a minimal and very specific intervention—letting people work with competence-related content—can diminish the relation between cognitive test anxiety and test performance. These findings are difficult to explain by skill-deficit theories (e.g., Kirkland & Hollandsworth, 1980). Given that the tests and the testing situations in the priming and control conditions were identical, a skill-deficit account of the findings would need to assume that the priming procedure altered innate abilities or skills. The intervention was very brief and therefore could not lead to significant amounts of learning, and both test-performance measures we used target a very broad class of behavior (general intelligence). Accordingly, a skill-deficit explanation is highly unlikely.

![Fig. 2. Mediation analysis for Study 2. The analysis tested whether task engagement and worry-related thoughts mediated the effect of the interaction between the priming dummy and cognitive test anxiety on test performance. The analysis was conducted by first running two random-coefficient modeling analyses, one with each of the two mediator variables as the dependent variable. The mediator variables were then added to the random-coefficient model for test performance (see Table 2) to determine the degree to which the mediators altered the interaction between the priming dummy and cognitive test anxiety. In all analyses, the control variables used were the same as those in the analysis shown in Table 2. Asterisks and solid lines indicate significant effects ($^* p < .05$, $^{**} p < .01$). $b_{cs}$ = coefficient estimated with standardized continuous variables but nonstandardized dummy variables; WPT = Wonderlic Personnel Test (Wonderlic, 1996).]
Theories assuming that cognitive test anxiety alters test performance, in contrast, can readily account for our finding that priming competence altered the relation between cognitive test anxiety and test performance. As predicted by causal test-anxiety theories, the priming procedure improved the performance of people with high cognitive test anxiety so that they were able to perform closer to their true abilities. The pattern of findings was particularly in line with disjunctive motivational models. As predicted by several disjunctive motivational models, heightening perceived competence not only improved the performance of people with high cognitive test anxiety, but also reduced the performance of people with low levels of cognitive test anxiety. Additionally, Study 2 found that the priming manipulation reduced the relation between cognitive test anxiety and test performance by heightening task engagement. This finding directly supports the idea that cognitive test anxiety alters the probability that people choose to engage in the testing task (Carver & Scheier, 1998). Worry-related thoughts, in contrast, did not mediate the effect of the Priming × Cognitive Test Anxiety interaction on test performance, and Study 2 consequently does not support the idea that worry-related thoughts block the cognitive capacity of cognitively test-anxious persons.

A limitation of the present research is that we focused on samples of secondary- and vocational-school students. Although there is evidence that findings regarding test anxiety tend to generalize across age groups (Hembree, 1988; Zeidner, 1998), it is possible that repeated failures in testing situations make the link between cognitive test anxiety and test performance less susceptible to manipulation as age increases.

The present findings have several implications. One implication is that people with high levels of cognitive test anxiety receive test scores that do not reflect their true abilities. Decisions on the basis of educational examinations, educational tests, and personnel-selection procedures can have dramatic impacts on individuals’ lives. The present research therefore suggests that testing procedures actually hamper the educational and career success of cognitively test-anxious persons.

A second implication of these studies is that competence priming may be used to improve the validity of test scores for people with high levels of cognitive test anxiety. Some authors have called for accommodations that lessen the influence of test anxiety for individuals affected by it (Zuriff, 1997). As Study 1 and Study 2 demonstrate, the priming effect we found is so strong and lasting that it is possible to administer a short test without bias at high levels of cognitive test anxiety. To adequately use this effect, however, one would need to measure cognitive test anxiety using a reliable measure, and then prime only people with high cognitive test anxiety. Because competence priming reduces the performance of people with low levels of cognitive test anxiety, one would otherwise diminish the performance of people without cognitive test anxiety. At this point, it is also unclear how effective competence priming is if it is used repeatedly so that cognitively test-anxious persons become accustomed to it. Accordingly, future research is needed to determine whether competence priming has the potential to substantially help cognitively test-anxious persons.

Acknowledgments
We thank Verena Buddrus, Anne Vieten, Ricarda Schmitz, Niklas Friedrich, and Kerstin Blankertz for their help in collecting and entering data.

Declaration of Conflicting Interests
The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Supplemental Material
Additional supporting information may be found at http://pss.sagepub.com/content/by/supplemental-data

References
Bliwise, P. D., & Hanges, P. J. (2004). Being both too liberal and too conservative: The perils of treating grouped data as though they were independent. Organizational Research Methods, 7, 400–417.


