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Confidence in Academic Testing: The Effect of Induced Checking and Anxiety on University Students' Emotional Responses to, and Performance in, Academic Challenge

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CONFIDENCE IN ACADEMIC TESTING: THE EFFECT OF INDUCED CHECKING
AND ANXIETY ON UNIVERSITY STUDENTS’ EMOTIONAL RESPONSES TO,
AND PERFORMANCE IN, ACADEMIC CHALLENGE

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In Partial Fulfillment
of the Requirements for the Degree
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Experimental Psychology

by
Elijah Bruner
May, 2018
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Dean of Graduate Studies
ABSTRACT

CONFIDENCE IN ACADEMIC TESTING: THE EFFECT OF INDUCED CHECKING AND ANXIETY ON UNIVERSITY STUDENTS’ EMOTIONAL RESPONSES TO, AND PERFORMANCE IN, ACADEMIC CHALLENGE

by

Elijah Bruner

May, 2018

Academic tests such as the American College Testing (ACT), Scholastic Aptitude Test (SAT), and National Assessment for Educational Progress (NAEP) have been used to assess academic aptitude. Research suggests that both test anxiety and test emotions (positive and negative) influence academic performance. The purpose of this study was to investigate the effects of test anxiety and uncertainty (i.e., re-checking items) on performance and test emotions. It was hypothesized that induced checking and participant anxiety would negatively predict performance and positive testing emotions, and positively predict negative testing emotions. It was also hypothesized that induced checking and anxiety would interact, with anxiety levels affecting performance and emotion more strongly when induced checking occurs (compared to a control condition).

A sample of \( N = 332 \) participants completed the Test Anxiety Inventory (TAI) (Spielberger, 1980), the Academic Emotions Questionnaire (AEQ) (Pekrun, Goetz, & Frensel, 2005), and completed a 10-item reading comprehension assessment taken from the National Assessment for Educational Progress (NAEP) (National Center for
Educational Statistics, 2017). Participants were randomly assigned to a check or no check condition, in which they were or were not given prompts to check answers periodically throughout the academic assessment. Results of multiple regression analyses suggest that test anxiety acted as a predictor for academic test performance, and positive and negative test emotions as hypothesized. The interaction was marginally significant, suggesting that anxiety predicted increased negative test emotions, and this effect may be exacerbated for participants assigned to the checking condition.
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CHAPTER 1
INTRODUCTION

Confidence and competence are intricately linked, particularly within the world of high-stakes academic standardized testing (Stankov, Lee, Luo, & Hogan, 2012). Specifically, anxiety is associated with fluctuations in the dominant response for confidence as well as increases in negative affect (Goette, Benadahan, Thoseson, Hollis, & Sandi, 2015; Morali, Onursal, & Tok, 2007). Given the anxiety that arises from the testing situation, performance can also be indirectly affected due to lost confidence (Segool, Carlson, Goforth, von der Embse, & Barterian, 2013). In this context, confidence is defined as the sense of sureness about a mental, physical, or emotional construct (Merriam-Webster, 2017).

Repeated checking of stimuli has been demonstrated to impact confidence in responding, wherein the repeated checking decreases sureness of recollection and in some cases leads directly to poorer performance through lack of conceptualization (i.e., movement from conscious action to unconscious processing; Harkin & Kessler, 2009). This occurs to detriment primarily in obsessive-compulsive populations; but occurs in non-clinical populations on a regular basis (van den Hout & Kindt, 2003).

The purpose of the current study is to investigate the interactive effects of anxiety and the undermining of confidence (via repeated checking) on university students’ performance and emotional response on a NAEP-derived critical thinking-oriented exam.
CHAPTER II
LITERATURE REVIEW

Confidence and Performance

The link between competence and confidence in performance is demonstrated in academic studies in which confidence is correlated with performance (e.g., Stankov et al., 2012). Although the literature mostly corroborates this link, the results of empirical investigation on the relationship between confidence and performance is somewhat mixed.

Recently, a sample of 1940 Singaporean students was surveyed and given an academic test in order to examine the relationship between confidence in performance and corresponding academic accuracy scores (Stankov et al., 2012). Specifically, the researchers attempted to predict accuracy in mathematics testing from confidence in mathematics, comparing confidence against concepts such as self-efficacy and test anxiety in predicting said accuracy. In the same study, a separate sample of 1786 students filled out English-related course surveys to investigate the same variables but for English coursework instead of math. The researchers found that math accuracy and confidence in performance were positively correlated; and there was a similar but smaller relationship present for English accuracy and confidence. The investigators found evidence for confidence as an integral construct in effective academic performance, with self-efficacy and anxiety being weaker predictors (Stankov et al., 2012).

While the previous research suggests a positive correlation between confidence and academic performance, the relationship between confidence and physical performance appears to be more tenuous (Woodman, Akehurst, Hardy, Lew, & Beattie,
In one study, rope-skippers were put through a skipping task, with the experimental group being misled about the nature of their practice rope in comparison to the competition rope (i.e., they were told that the ropes differed). Confidence was measured using the State Sport Confidence Inventory (Vealey, 1986). A decrease in confidence from pre-task was found for the experimental group during skipping. However, performance as measured by number of successful skips increased for this group during competition, as compared to during practice (Woodman et al., 2010). In sum, although confidence decreased for the experimental group, performance actually increased.

**Test Anxiety**

Test anxiety is another well-documented construct linked to performance. Anxiety has typically been viewed according to the Yerkes-Dodson law, wherein there is an optimum level of arousal for performance (Yerkes & Dodson, 1908). This is often seen particularly with physical activity. However, more recent theory has postulated that physical and cognitive arousal affect performance differently. Specifically, physical arousal maintains the Yerkes-Dodson curve; but cognitive anxiety has a linear negative impact on performance (Martens, Burton, Vealey, Bump, & Smith, 1990). Further, the impact of test anxiety on performance is affected by both the situation and experienced emotions (Segool et al., 2013).

**Performance anxiety and academic testing.** Investigators have explored how test anxiety affects academic performance, specifically for students at different points in their academic careers. Chappell et al.’s (2005) hypothesis was that test anxiety would be negatively correlated with performance, regardless of where students were in their
education. A sample of undergraduate and graduate students completed the Test Anxiety Inventory (Spielberger, 1980), and provided their grade point averages (GPAs) as a performance measure. The participants were classified into naturally low, medium, and high anxiety groups. Findings of the study suggest that for both undergraduate and graduate students, there was a direct inverse relationship between anxiety level and GPA (Chappell et al., 2005).

In a study on adolescents designed to explore the indirect effects of anxiety on performance, Owens, Stevenson, Hadwin, and Norgate (2012) tested the relationship between anxiety, depression, and academic test performance. The authors hypothesized that anxiety and depression would be related to increased worry and disrupted working memory, leading to lower scores on academic tests. Across two studies, researchers measured children’s anxiety and depression in addition to performance on the Wide Range Achievement Test (Wilkinson & Robertson, 2006). Results showed higher levels of anxiety and depression were related to decreases in academic performance. Worry, a functional aspect of the concept of anxiety, was positively related to both depression and the overall concept of anxiety, and further exhibited a negative relationship with academic performance (Owens et al., 2012).

More recently, anxiety was investigated with regard to high-stakes testing and standardized test scores (von der Embse & Witmer, 2014). After assessing anxiety and retrieving scores from a standardized exam as a performance measure, researchers found that students with lower anxiety scored significantly higher on the exam than students who experienced higher levels of anxiety. Increases in cognitive disruption, a facet of test anxiety involving the inability to finish a thought because of divided attention, was a
particularly strong factor in predicting lower test scores (von der Embse & Witmer, 2014).

Test anxiety has been linked to the ability to engage in specific types of thinking, including the critical thinking that comes from textual reading comprehension. In a 2016 study, Wood, Hart, Little, and Phillips assessed reading comprehension and anxiety, by administering the Children’s Test Anxiety Scale (Wren & Benson, 2004), and the Florida Comprehensive Achievement Test to a sample of children between grades 3-7. Results suggested that reading comprehension was negatively correlated with total anxiety.

Prior knowledge and reading comprehension have also been investigated in the context of anxiety’s negative impact on performance. Specifically, researchers have found that individuals with high anxiety and low knowledge typically perform the worst; and low anxiety and high prior knowledge perform the best (Minnaert, 1999).

Researchers have also explored the effects of anxiety on rate of performance, a variable that could ultimately impact performance on timed exams as well. Calvo and Carreiras (1993) examined this issue by having high and low anxiety students read a passage, word by word; and found that high anxiety students took a significantly longer period of time to complete the task. These results point to mental processes being undermined by anxiety (Calvo & Carreiras, 1993).

**Performance anxiety outside academics.** In related research looking beyond academic performance outcomes, researchers have investigated the relationship between anxiety and performance in musicians (Yoshie, Shigemasu, Kudo, & Ohtsuko, 2009). The researchers’ hypothesis was that cognitive anxiety (involving mental and emotional processes), and somatic anxiety (involving physical symptoms) would be predictive of
performance in a sample of piano players. Performance was measured by self-report of perception of performance level as compared to perception of a standard performance. The results indicated that state cognitive anxiety, but not somatic anxiety, negatively correlated with performance (Yoshie et al., 2009).

Similar results have been demonstrated in the athletic performance realm. An initial inquiry by Abenza, Alarcon, Pinar, and Urena (2009) was conducted to explore the connection between state and trait anxiety and performance of basketball players. Spanish Amateur Basketball League players were given the State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Luscher, 1970) directly prior to competition and during training sessions. Athletic statistics were compiled to assess performance. Although trait anxiety was not a significant factor, results indicated that state pre-competition and training anxiety were negatively correlated with field goal percentage, and positively correlated with turnovers (Abenza et al., 2009).

These results were corroborated through a study on attentional control theory as affected by perceived anxiety (Wilson, Vine, & Wood, 2009). Basketball players completed the Mental Readiness Form – Likert (Krane, 1994) to measure mental readiness and both cognitive anxiety (i.e., anxious mental processes such as panicky, racing thoughts) and somatic anxiety (i.e., physical anxiety responses such as getting sweaty palms) before competition and then participated in sets of free throws. The stress condition was given anxiety-provoking interventions in between sessions. Players exhibited higher cognitive and somatic anxiety in the stress condition compared to a no stress control condition. Higher cognitive and somatic anxiety was, in turn, linked with
decreased accuracy, as participants in the stress condition performed more poorly than those in the control condition (Wilson et al., 2009).

Given the link between anxiety and performance, research has begun to explore effective ways of reducing such anxiety in hopes of increasing performance. For example, Hazell, Cotterill, and Hill (2014) studied the efficacy of pre-performance routines on anxiety and performance in athletes. English semi-professional soccer players in the control condition underwent a penalty-kicking exercise, and those in the experimental condition did the same but also underwent pre-performance routine training before the post-test penalty kicks. There was a significant difference between intensity of anxiety scores for pre- and post-test kicking exercises for the experimental condition, with post-test anxiety scores being significantly lower than pre-test. In addition, the authors found a significant difference between penalty kick performance between the groups, with higher post-test kicking scores for the experimental group than for the control. The authors inferred that performance increased because of a lessening of anxiety in the pre-performance routine condition, allowing procedural memory to function unimpeded (Hazell et al., 2014).

**Challenging literature.** Some very recent literature has, to a certain extent, challenged the current psychological literature described above. Sung, Chao, and Tseng (2016) explored the relationship between test anxiety and learning achievement in a sample of Taiwanese students. A weak but significant relationship between anxiety and standardized testing scores was found. Specifically, high achievers reported less anxiety than middle or low achievers across 10 groups of increasing participant anxiety. Surprisingly though, it was found that medium achievers experienced the most anxiety.
Both low and high achievers were shown to exhibit less anxiety when their scores trended toward the extremes (Sung et al., 2016).

The results contradict previous literature to some degree, but given the idea of a division of achievement around the median, the results are not necessarily surprising. Those in the middle do not know how well they will do and are thus anxious and lacking in confidence (Koocher, 1985; Sung et al., 2015). They also may not have adequate coping skills for anxiety, affecting performance (Yerkes & Dodson, 1908).

**High-stakes testing.** Research has repeatedly shown that the stakes of testing can affect test anxiety. In one study, researchers investigated differences in test anxiety for school children based on low-stakes versus high-stakes testing contexts (Segool et al., 2013). The researchers hypothesized that test anxiety would be greater for participants during higher-stakes testing than during low-stakes testing conditions. A sample of children completed the No Child Left Behind standardized achievement test, the Children’s Test Anxiety Scale (Wren & Benson, 2004) to classify students into high- and low-anxiety groups, and the Behavior Assessment Scale for Children (Reynolds & Kamphaus, 2004). Teachers additionally reported on their perceptions of children’s anxiety. In line with their hypotheses, investigators found significantly higher anxiety (as measured by self-report and teacher observation) during high-stakes testing among all pre-existing anxiety groups (Segool et al., 2013).

The results from the preceding articles provide conflicting evidence related to anxiety. There is strong support for the presence of low anxiety in high achievers, and high-stakes testing effects on both performance and anxiety. Also, as shown by the
literature, there is often a significant relationship between anxiety and performance, such that individuals perform better as they are lower in anxiety.

**Positive Emotions**

Just like anxiety, positive emotions are linked to, and can be predictors of, performance. For example, in a study examining positive emotions and achievement, Villavicencio and Bernardo (2013) collected data from a sample of university trigonometry students who completed the Academic Emotions Questionnaire-Math (Pekrun et al., 2004), and their GPAs were recorded as a performance measure. The investigators found that enjoyment and pride were positive predictors of higher GPAs. As such, it was inferred that those who felt best about learning did the best in school (Villavicencio & Bernardo, 2013).

Corroborating the results that positive emotions positively predict academic performance, Putwain, Sander, and Larkin (2012) examined positive learning-related emotions and academic self-efficacy as predictors of academic achievement and emotions in undergraduate students. Results indicated that independent study self-efficacy predicted better academic performance (i.e., GPA) and more positive learning-related emotions. It was also found that pleasant learning-related emotions (e.g., enjoyment, hope, pride), were also positive predictors of performance (Putwain et al., 2012). The results support the idea that emotion and performance may have a reciprocal relationship – positive emotions toward school beget better grades, which beget more positive feelings about education. Since positive emotions are linked with performance in school more generally, it is plausible that positive emotions toward a test may have similar effects.
Research has also investigated the impact of emotions on athletic performance rather than academic performance (Uphill, Groom, & Jones, 2014). In one study, researchers sampled female basketball players and had them recall their positive and negative emotions from a videotaped game, where success or lack thereof was based on team outcomes. Happiness was a significant predictor of successful game involvement. Unsuccessful game involvement was predicted by anger and by embarrassment. Specifically, happiness positively predicted performance, and anger and embarrassment negatively predicted performance (Uphill et al., 2014).

Having positive emotions towards learning is potentially useful in improving performance over time. The research suggests that learning-positive people already likely have stronger performance and typically perform better in a high-stakes environment, but also enjoy it more compared to less learning-positive people (Putwain, 2008).

Checking

Checking behavior is associated with memory confidence, and at times memory accuracy. The majority of research is this area is based on obsessive-compulsive habits, centering on the impact of mental and physical checking on memory mistrust (Radomsky, Gilchrist, & Dussault, 2006). However, in academia, confidence includes knowing answers are correct and, therefore, the need to check answers repeatedly could, like other repeated checking, affect memory trust and actually result in more mistakes. Investigations into physical and mental checking both on clinical and non-clinical populations examine how checking and subsequent misleading interference causes memory mistrust (Radomsky & Alcolado, 2010).
Checking is a common practice for many people, although extensively seen in obsessive-compulsive behavior. The question of why checkers – people who repeatedly check items such as locks or stovetops – experience memory distrust despite their checking has been the subject of investigation. van den Hout and Kindt (2003) hypothesized that repeated checking increases familiarity, which increases conceptual reasoning and inhibits perceptual processes. The ability to have vivid and detailed recollections is thereby limited, causing memory mistrust. Researchers conducted a series of experiments that supported their reasoning. In an initial study, a sample of sub-clinical undergraduate participants were trained in how to turn a stove on and off via a computer. Participants were then given a pre-test of checking a stove’s burners to make sure they were off, and then split into groups where they engaged in either relevant or irrelevant checking (i.e., practicing checking the stove or practicing checking a light bulb) for 20 trials. All participants then completed questionnaires to assess their memory experience. Results indicated no significant change in memory accuracy as a result of the checking condition. However, meta-memory processes (i.e., vividness, detail, memory confidence) were significantly lower for the relevant checking group as compared to the irrelevant checking group. These results support the authors’ hypothesis and underscore the separation of mistrust from ability. Specifically, it is likely that deeper conceptual reasoning occurs after repeated relevant checking, but that it clouds meta-memory functions (e.g., confidence) while they are happening (van den Hout & Kindt, 2003). As such, mistrust appears to be detached from performance ability.

As a follow up, investigators undertook an ecologically valid study into checking and memory distrust to investigate if memory mistrust would occur when given relevant
checking cues before a final exercise to demonstrate the checking procedure (Radomsky et al., 2006). A sample of sub-clinical undergraduate students completed a relevant checking exercise (i.e., turned a stove on and off in a standardized manner) with a final stove check. Irrelevant checkers checked a light bulb instead of the stove. Results indicated that relevant checkers showed significantly lower memory accuracy than did irrelevant checkers. Meta-memory, specifically confidence, also differed by group in that relevant checkers had significantly lower confidence compared to irrelevant checkers. The investigators suggest that confidence in memory is fleeting, and that memory accuracy diminishes slightly with each check (Radomsky et al., 2006).

In a subsequent study, Cuttler and Graf (2007) explored whether sub-clinical checkers perform worse at prospective memory tasks than non-checkers. Undergraduate students were categorized by the checking portion of an obsessive-compulsive behavior inventory (Sanavio, 1988) into low-, medium-, or high-checking groups and completed several memory questionnaires. The participants also completed a personal belonging task during which they recalled personal belongings and a phone-call reminder task wherein they had to remember to remind someone about a phone call. Although there were no differences for the phone call reminder task, results showed that on the personal belonging task, low checkers performed significantly better than medium checkers and high checkers. Medium and high checkers performed similarly. As such, there is some evidence that lower checkers may have fewer problems with memory (Cutter & Graf, 2007).

Confidence, specifically, and checking was investigated as well (Coles, Radomsky, & Horng, 2005) in a pair of studies examining thresholds necessary for non-
clinical memory mistrust to set in. Participants were placed into a checking (i.e., 15 checks) or control (i.e., 2 checks) group and had their memory and confidence for a task tracked over time. There were main effects for time (i.e., pre-test and post-test) and for memory confidence based on checking condition. High checkers had lower memory confidence than did the control group. There was also an interaction, wherein those who were in the checking condition had significantly lower confidence in their performance after treatment than did those in the control condition, whose confidence increased slightly across tests (Coles et al., 2005).

Radomsky and Alcolado (2010) also investigated memory accuracy and repeated checking in regards to meta-memory processes, this time comparing physical to mental checking behaviors. As a manipulation, participants were taught to physically or mentally check a laboratory stove, and then participants either physically checked or mentally checked a stove and recalled the order of turning off burners. Researchers found that the recollections of physical checkers were affected by the manipulation of how many checks were undergone more strongly than mental checkers. Those who physically checked had lower meta-memory processing than mental checkers during testing – especially for memory confidence. Memory accuracy was lessened from pre- to post-test for both types of checkers. Investigators claimed that repeated attempts at memory retrieval engender distrust with each repetition, and poor performance develops as a result (Radomsky & Alcolado, 2010).

Checking is connected to lack of procedural memory clarity and trust in memory. While mostly disconnected from performance due to practice effects, high checkers have been shown to perform more poorly at memory tasks when there were no pre-test trials
(van den Hout & Kindt, 2003). The stunted confidence stemming from checking could also have an effect on emotions, decreasing the prevalence of positive affect and increasing the prevalence of negative affect.

Although checking behavior is a common practice in the academic performance realm, the effects of checking in this context are relatively unknown. Checking behavior is seen more commonly when an answer is not known, or vacillated upon; wherein the process of doing the work is often restarted to check if done correctly the first time. As such, the purpose of the current study is to investigate checking behavior and anxiety levels in university students, and how these factors affect performance and emotions during testing. It is hypothesized that: (a) both induced checking and participant anxiety will negatively predict performance; (b) induced checking and anxiety will negatively predict positive test emotions, and positively predict negative emotions; (c) there will be an interaction between anxiety and checking on performance and emotion, with anxiety levels affecting performance and emotion more strongly when induced checking occurs via a manipulation (vs. a control condition).
CHAPTER III

METHODS

Participants

The participants for this study consisted of a convenience sample of 332 (238 females, 64% Caucasian, $M_{age} = 20.67$, $SD_{age} = 5.35$) undergraduate university students from Central Washington University. Recruitment was extended to as many students as possible through the Department of Psychology’s Sona system.

Research Design

The experiment utilized a quantitative quasi-experimental design. The independent variables of this study were the continuous variable of test anxiety and the dichotomous variable of induced checking of answers. Participants were randomly assigned to experience one of two experimental checking conditions meant to manipulate confidence: absence or presence of a suggestive manipulation at the beginning, at the midpoint of, and at the end of an appropriately difficult critical-thinking academic test. The manipulation was designed to encourage and reinforce checking behaviors based on confidence in test answers. Anxiety levels, assessed pre-test, also served as an independent variable. The dependent variables were academic performance and both positive and negative emotional responses to the academic testing situation.

Materials

The surveys included in the study were the Test Anxiety Inventory (Spielberger, 1980) and the relevant items (i.e., assessing emotions that occur specifically during testing) selected from the Achievement Emotions Questionnaire (Pekrun et al., 2005). A
test was taken in between and included items sampled from previous official National Assessment of Educational Progress (NAEP) administrations.

**Test Anxiety Inventory (TAI).** The Test Anxiety Inventory (Spielberger, 1980) included 20 statements rated on a 4-point Likert-scale from 1 (almost never) to 4 (almost always) asking how participants feel at the moment in regards to the worry (e.g., “I seem to defeat myself while working on important tests”) and emotionality (e.g., “I feel panicky before taking a test”) subscales of test anxiety (see Appendix A). Scores were calculated to reflect the sum of all responses, with higher scores indicating higher test anxiety. Previous research suggests that all questions have item-total $r$ values greater than .5, with most greater than .65; and strong test-retest reliability ($r = .80$), retesting at one month (Spielberger, 1980). Internal consistency was also calculated for the study sample, demonstrating a Cronbach’s alpha coefficient of .94.

**Achievement Emotions Questionnaire (AEQ).** Items, having had singular item-total score reliability established, were selected from Pekrun et al.’s (2005) Achievement Emotions Questionnaire (see Appendix B). The items comprised the During Testing subscale, embedded within the Test Emotions subscale. The During Testing subscale had a total of 27 5-point Likert items ranging from 1 (strongly agree) to 5 (strongly disagree). The items asked how participants feel now in terms of seven subscales of emotion covering positive (e.g., “For me the test is a challenge that is enjoyable”) and negative (e.g., “I am fairly annoyed”) emotions felt during academic testing: joy, hope, pride, anger, anxiety, shame, and hopelessness. Scores were summed for positive and negative emotions groupings separately, with higher scores indicating stronger positive or negative test emotion.
The scale demonstrated strong internal consistency in the literature describing the test’s development, with alpha values at .75 or greater for item subscales, and the internal consistency for the current study sample was good at .80 for the set of selected items from the “during test” portion of the portion of the AEQ.

**Performance Measure.** The critical-thinking test was taken from the open-source NAEP, via the National Center for Education Statistics (NCES) website (National Center for Educational Statistics, 2017). The NAEP items included 10 multiple-choice items across three problem sets retrieved from the reading comprehension portion of the 12th-grade assessment, with no time limit so as to encourage checking. Items were selected based on difficulty for a 12th grade population as described by NCES. An item difficulty cutoff of .7 was utilized, indicating that a minimum of 70% of students from the literature were able to correctly answer the items. Accuracy scores were computed by summing the number of correct responses, with higher scores indicating better performance. Internal consistency for the study sample was acceptable at alpha = .64.

**Procedures**

Students completed the study online from their own computers at locations of their choosing. Participants were given a link that randomly dispersed them to one of two Qualtrics questionnaires – one coded with checking prompts and one control without checking prompts. All participants first completed the Test Anxiety Inventory (Spielberger, 1980). They then encountered a message that the test they were about to take was compiling a distribution of scores and that doing one’s best would be highly appreciated. This message’s purpose was to indicate the importance (stakes) of the exam.
Next, participants were tested with NCES-provided reading comprehension questions with specific manipulations per condition, as randomly assigned during sign-up.

Reading comprehension questions served as the performance measure of the experiment. Unlike math and science questions, which involve knowledge of facts or formulae, reading comprehension requires locating, evaluating, synthesizing, and communicating back information – all parts of the critical thinking process.

In the control condition, the participants completed the test uninterrupted. Those in the checking manipulation condition were given an initial reminder about the availability of checking (i.e., “Remember: during the test if you are not sure about your answers you can always go back and check”); a firm reminder about checking after completion of six items – two problem sets (i.e., “Now is a good time to go back over your answers if you are unsure of them”); and a reminder at completion of all 10 items (i.e., “This is your final chance to go back and check if you are not sure of your answers”).

Following the test, a pair of final questions was posed. Specifically, participants were asked whether or not they had looked back over their answers at any point, and how confident they felt about their answers on a 5-point Likert scale from “not at all” to “completely” (see Appendix C). The participants then completed the portion of the Achievement Emotions Questionnaire regarding during-test emotions. Following completion of the questionnaire, participants completed a demographics survey for age, identified gender, ethnicity, and year in school. A short debriefing message concluded the experiment.
Data Analysis

Data was analyzed using multiple linear regression analyses to predict test performance and positive and negative emotions from anxiety, induced checking, and their interaction. We expected main effects of anxiety and checking condition on each of the dependent variables. Specifically, we hypothesized that as participants reported higher anxiety, they would perform more poorly on the test and would report experiencing weaker positive emotion and stronger negative emotion during testing. We also predicted that the induced checking condition would predict poorer performance and weaker positive emotion and stronger negative emotion during testing relative to the no checking control condition. We also expected an interaction between checking condition and anxiety, with induced checking exacerbating anxiety’s effects on performance, and positive and negative emotions.
CHAPTER IV

RESULTS

Before analysis of the data, assumptions for use of parametric regressions were tested. Linearity was determined through the use of Q-Q plotting, and normality was assumed given the large sample size. Multicollinearity was assessed through Pearson correlation matrices of all predictor variables, with no correlations of .5 or greater between variables. Finally, homoscedasticity was assessed through investigation of residuals plots. All assumptions were met, and principal data analysis was completed using multiple linear regressions.

Descriptive statistics and zero-order correlations.

Tables 1-6 present descriptive statistics and zero-order correlations among the variables.

Table 1

Test Score Descriptive Statistics (Out of 10)

<table>
<thead>
<tr>
<th>Gender</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>6.03</td>
<td>2.71</td>
</tr>
<tr>
<td>Female</td>
<td>6.35</td>
<td>2.46</td>
</tr>
<tr>
<td>Overall</td>
<td>6.35</td>
<td>2.54</td>
</tr>
</tbody>
</table>
Table 2

**TAI Descriptive Statistics (Out of 4)**

<table>
<thead>
<tr>
<th>Gender</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2.15</td>
<td>0.62</td>
</tr>
<tr>
<td>Female</td>
<td>2.52</td>
<td>0.65</td>
</tr>
<tr>
<td>Overall</td>
<td>2.42</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Table 3

**Positive Test Emotions Descriptive Statistics (Out of 5)**

<table>
<thead>
<tr>
<th>Gender</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>3</td>
<td>0.84</td>
</tr>
<tr>
<td>Female</td>
<td>2.87</td>
<td>0.67</td>
</tr>
<tr>
<td>Overall</td>
<td>2.87</td>
<td>0.73</td>
</tr>
</tbody>
</table>
Table 4  

_Negative Test Emotions Descriptive Statistics (Out of 5)_

<table>
<thead>
<tr>
<th>Gender</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2.41</td>
<td>0.95</td>
</tr>
<tr>
<td>Female</td>
<td>2.62</td>
<td>0.97</td>
</tr>
<tr>
<td>Overall</td>
<td>2.62</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Table 5  

_Confidence Descriptive Statistics (Out of 100)_

<table>
<thead>
<tr>
<th>Gender</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>60.55</td>
<td>27.46</td>
</tr>
<tr>
<td>Female</td>
<td>51.58</td>
<td>25.39</td>
</tr>
<tr>
<td>Overall</td>
<td>54.1</td>
<td>26.26</td>
</tr>
</tbody>
</table>
Table 6

Zero-Sum Correlations Amongst Dependent and Secondary Variables

<table>
<thead>
<tr>
<th></th>
<th>TAI</th>
<th>NAEP</th>
<th>Confidence</th>
<th>POS</th>
<th>NEG</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAI</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAEP</td>
<td>-0.17**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>0.29**</td>
<td>0.46**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POS</td>
<td>-0.30**</td>
<td>0.21**</td>
<td>0.50**</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEG</td>
<td>0.69**</td>
<td>0.29**</td>
<td>-0.33**</td>
<td>-0.24**</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.09*</td>
<td>0.22**</td>
<td>0.18**</td>
<td>0.20**</td>
<td>-0.19**</td>
<td>-</td>
</tr>
</tbody>
</table>

Note. ** p < .001, * p < .01

Test anxiety was weakly correlated with the dependent variables of test score, \( r (330) = -0.17 \), and positive test emotions, \( r (330) = -0.30 \); and moderately correlated with the dependent variable of negative test emotion, \( r (330) = 0.69 \). As anxiety increased, test scores and positive test emotions decreased, but negative test emotions increased.

All correlations between dependent variables were small and in the expected direction. As positive test emotions increased, test scores increased, \( r (330) = 0.21 \), and negative test emotions decreased, \( r (330) = -0.24 \). As negative test emotions increased, scores also tended to decrease, \( r (330) = -0.29 \).

**Manipulation check.**

A manipulation check indicated differences in self-reported checking behavior between the checking and non-checking conditions, \( \chi^2(1) = 13.91, p < .001 \). Specifically,
there was a larger percentage of checkers to non-checkers (55% checkers) in the checking condition compared to the non-checking condition (34% checkers).

**The effects of anxiety and checking on exam performance and emotions.**

The primary focus of the current study was to assess the influence of anxiety and checking behavior on exam performance and emotion. Thus, multiple regression analyses were conducted in which each dependent variable (i.e., participants’ performance, positive test emotions, negative test emotions) was simultaneously regressed on participants’ anxiety scores, checking condition, and their interaction (product term).

**Prediction of performance.** Anxiety, checking condition, and their interaction were used to predict performance on the NAEP, $R^2 = .02$, $F(3, 327) = 3.70$, $p = .01$. Although there were no significant effects of checking condition or the interaction term ($p s > .6$), the relationship between score and anxiety was strong. Consistent with hypotheses, a unique effect of anxiety on score was found, $\beta = -.61$, $t = -2.09$, $p = .04$. Specifically, participants experiencing greater anxiety tended to score lower on the reading comprehension test.

**Prediction of positive test emotions.** Anxiety, checking condition, and their interaction were used to predict positive checking condition, nor the interaction emerged as significant predictors ($p s > .55$), an effect of anxiety on positive test emotions was found, $\beta = -.37$, $t = -4.51$, $p < .001$. Consistent with hypotheses, as participants experienced greater anxiety, they reported experiencing weaker positive test emotions.
Prediction of negative test emotions. Anxiety, checking condition, and their interaction were used to predict negative test emotions, \( R^2 = .48, F(3, 327) = 100.90, p < .01 \). Although there was again, no significant effect of checking condition, consistent with our hypotheses we did find an effect of anxiety on negative test emotions, \( \beta = .91, t = 11.13, p < .001 \). Specifically, as participants experienced greater anxiety, they also reported experiencing stronger negative test emotions. More important, this effect was qualified by a marginally significant predicted interaction with checking condition, \( \beta = .19, t = 1.67, p = .10 \). As illustrated in Figure 1, although anxiety was associated with increased negative test emotions, this was especially pronounced for those participants assigned to the checking condition. In other words, the checking condition exacerbated test anxiety’s effects on negative test emotions.

Test Anxiety

Figure 1. Effects of checking condition and test anxiety (+/- 1 SD) on negative test emotions.
Exploratory analyses.

Additional analysis was undertaken to explore the role of self-reported confidence in academic testing. Anxiety, checking condition, and their interaction were used to predict confidence in testing, $R^2 = .08$, $F(3, 327) = 10.52$, $p < .01$. Neither the effect of checking condition nor the interaction ($ps > .44$) emerged as significant predictors. However, test anxiety was a strong negative predictor of confidence, $\beta = -10.30$, $t = -3.51$, $p < .001$ such that those participants who reported being more anxious tended to report being less confident.

Additionally, we explored the extent to which demographic variables might predict our dependent variables. Age was significantly correlated with performance ($r(330) = .22$), positive test emotions ($r(330) = .20$), and negative test emotions ($r(330) = -.19$).

Gender differences did not emerge for performance ($p > .15$), but they did for testing emotions and confidence. Specifically, females reported stronger negative test emotions ($M = 2.62$, $SD = .97$) than males ($M = 2.41$, $SD = .95$), $t(171) = 2.52$, $p = .01$. Given a violation of Levene’s test for homogeneity of variances, $F(331, 1) = 5.83$, $p = .02$, a $t$ test not assuming homogeneous variances was calculated. The results of this test indicated that males reported feeling marginally stronger positive test emotions ($M = 3.00$, $SD = .84$) than females ($M = 2.87$, $SD = .67$), $t(140.42) = -1.93$, $p = .06$. Finally, males also reported higher levels of confidence ($M = 60.55$, $SD = 27.46$) than females ($M = 51.58$, $SD = 25.39$), $t(157) = 2.73$, $p = .01$. 

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CHAPTER V
DISCUSSION

Test anxiety and checking have been supported through literature to be significant variables to consider when investigating performance. The literature on academic performance, anxiety, and checking has principally considered effects between anxiety and performance (e.g., Sung et al., 2016), positive emotions and performance (e.g., Villavicencio & Bernardo, 2013), and checking and performance (e.g., van den Hout & Kindt, 2003). However, the focus has never been on the impact of checking on test-related emotions nor on the simultaneous impact of checking and anxiety on test related outcomes. The current study was conducted to examine the interactive effects of item checking and anxiety on performance and both positive and negative test-related emotions. The results illuminate salient predictors of performance, positive test emotions, and negative test emotions. In addition, the effects of predictor variables on confidence are illustrated, and the link between key dependent variables and demographic variables (i.e., age, gender) are disclosed.

Prediction of Performance

It was hypothesized that checking condition and test anxiety level, as well as their interaction wherein test anxiety’s effects are exacerbated by presence of the checking condition, would negatively predict academic performance. Our hypotheses were supported only for test anxiety, wherein increased reported test anxiety was indicative of decreased academic performance. This significant negative test anxiety effect supports previous literature (Wood et al., 2016). The predicted effects of the checking condition and the interaction may not have been observed because re-checking something after
going through a complete mental process (e.g., taking a standardized academic test) is a
different set of mental actions than remembering a set of instructions to carry out (e.g.,
checking a stove mentally or physically before going through the motions on a real
stove).

**Prediction of Positive Test Emotions**

It was hypothesized that checking condition and test anxiety, as well as their
interaction, would negatively predict positive test emotions. Supporting our hypotheses,
we did find that test anxiety negatively predicts positive test emotions such that as test
anxiety increases, the strength of positive test-related emotions decreases. The predicted
effect of checking condition and the interaction effect were not found, possibly because
of a lack of impact of checking on positive test-taking emotions in particular. It could be
that negative emotions may sometimes be more accessible during testing, with positive
emotions being less applicable to and less wide-ranging in regards to testing than
negative emotions.

**Prediction of Negative Test Emotions**

It was hypothesized that checking condition and test anxiety, as well as their
interaction, would positively predict negative test emotions. Anxiety positively predicted
negative test emotions, corroborating Owens et al. (2012), but checking condition did not.
However, there was a marginally significant interaction between anxiety and condition,
indicating a possible indirect effect of condition on negative test emotions – one where
the checking condition amplifies anxiety’s effects on negative testing emotions. In
essence, test anxiety increases were associated with stronger negative test-taking
emotions – especially when participants were induced to check answers. These results
indicate that negative testing indicators may further deteriorate negative emotions that already exist.

**Prediction of Confidence**

There were no hypotheses for confidence, as it was deemed an important post hoc analysis to examine checking’s mental effect. Anxiety was a negative predictor of confidence – an increase in anxiety predicted decreased confidence. However, checking condition did not maintain an effect, starkly in contrast to the literature (Coles et al., 2005). However, one difference between current and previous studies was that in the case of Coles et al. (2005), the checking was a mental check for a later stove-checking memory exercise a la van den Hout and Kindt (2003). Recollection based on spending time memorizing information differs from reading comprehension analysis and may contribute to differential results between studies. The type and duration of remembering, as well as an active cognitive element, complicates the task and could possibly decrease the efficacy of participants in comparison to memory-based checkers.

**Limitations**

There were multiple limitations to the current study, specifically in terms of sampling, the efficacy of the manipulation, and the makeup of the academic test. In terms of sampling, there was an large differential in the frequency of female to male participants. This differential is a limitation because of the differences between males and females across confidence and two of the three dependent variables (i.e., positive test emotions and negative test emotions). The data may not be generalizable to the general public because of these differences and others, but the data are still very salient for the female population. Such gender differences may have influenced results related to the
strength of predictors and, as is the case for many studies in the field, the use of a convenience sample from a university setting should be noted when applying these results to other contexts.

The manipulation’s efficacy could not assure actual manipulation of confidence, and there were no data supporting its efficacy in doing so. Analysis of a manipulation check was enacted by recording whether answers were checked or not, and although there was a significantly larger ratio of checkers to non-checkers in the checking condition (vs. the no checking condition), many individuals still reported checking behaviors that were inconsistent with their randomly assigned condition (i.e., checking in the no checking condition, not checking in the checking condition). Analyses on our three primary dependent variables were repeated using self-reported checkers vs. non-checkers rather than checking condition, and results were parallel to those seen in the primary analyses.¹ The manipulation could possibly be more effective with more aggressive checking encouragements, as opposed to the gentle suggestion given out in the current study.

The effects of the manipulation may also be overstated. There is no guarantee that participants who checked answers checked all of the possible items – many may have gone back and only looked at one or two, if not only a few items. This particular fault could be allayed by a change in the wording of the manipulation messages to include a suggestion to check all items, regardless of how confident someone is in their answers.

¹ There was an observed test anxiety effect, but no significant observed relationship between self-reported checking and any of the dependent variables; and no interaction effects were noted.
Alternately, time spent on each individual item could be analyzed to examine differences in focus between individual items.

The makeup of the academic test may not have been ideal due the small (N = 10) sample of items utilized. This question set was selected in order to maintain an observed item difficulty of at least .7 – a minimum prescribed after consultation with knowledgeable experts in the field. In other words, we chose items for which 70% of previous test-takers answered correctly (National Assessment for Educational Progress, 2017). Unfortunately, many of the items that had an item difficulty of .7 or greater for the general 12th grade populous appeared to be more difficult for many in the study sample. Additional items of lower difficulty may have created a ceiling effect and skewed results. As some of the items included for the experiment had item difficulties for this study’s participants in the .5-.6 range, it was feasible to assume that using more difficult items would have been unsuccessful. Future research could alleviate this issue in multiple ways. First, difficult items from lower-level tests could be used. Second, more difficult items could be added and one incorrect answer could be removed from all items. The first method would make items difficulties for some of the items unknown for the target population, and the second method would make the item difficulties unknown, but undoubtedly higher.

**Future Research**

One possible research direction would be to more closely examine the possibly divergent effects of different manifestations of anxiety (e.g., physically, mental, emotional). Differences in manifestations might indicate different effects on performance and test emotions, and could lead to investigations into interventions for improving them.
Another direction for future research would be to study emotions and confidence related to memory tasks when cognitively interrupted during the test. This would follow more traditional work involving memory and performance, and expand on interruptions to confidence, such as attempted in this study – but examining memory rather than performance.

Another possible area of future research would be to explore checking as a natural part of the intellectual process. Researchers could investigate unconscious checking actions as an indicator for checking (e.g., repeated turns of the head between a passage and an item, measured through a combination of video recording and recording times taken for each individual item) vs. conscious ones, as well as the amount of within-person checking that occurs. Unconscious checks would be anything from very short, quick turns of the head to a more extensive time attending to the material before returning to the question.

**Conclusion**

Mental processes and confidence have been studied extensively, albeit in the context of recollected memory and not of functional memory. Separately, test emotions have also been associated with different levels of performance. The confluence of test emotions and the need to check answers warranted investigation. It was found that anxiety uniquely predicted test scores and test emotions. Specifically, anxiety was associated with lower performance, weaker positive emotions, and stronger negative emotions (especially in conjunction with repeated checking). These results mostly corroborate existing literature, but they also indicate anxiety’s wide-ranging debilitating
effects – not just exacerbating negative test emotions, but degrading positive ones in addition to performance.
REFERENCES


APPENDIX A

Test Anxiety Inventory (Spielberger, 1980) Items

Instruction: “Read each statement and then select the appropriate numbered response to indicate how you generally feel. Please answer each statement.”

Scoring: 4-point Likert – 1 = almost never; 2 = sometimes; 3 = often; 4 = almost always

1. I feel confident and relaxed while taking tests
2. While taking examinations I have an uneasy, upset feeling
3. Thinking about my grade in a course interferes with my work on tests
4. I freeze up on important exams
5. During exams I find myself thinking about whether I'll ever get through school
6. The harder I work at taking a test, the more confused I get
7. Thoughts of doing poorly interfere with my concentration on tests
8. I feel very jittery when taking an important test
9. Even when I'm well prepared for a test, I feel very nervous about it
10. I start feeling very uneasy just before getting a test paper back
11. During tests I feel very tense
12. I wish examinations did not bother me so much
13. During important tests I am so tense that my stomach gets upset
14. I seem to defeat myself while working on important tests
15. I feel very panicky when I take an important test
16. I worry a great deal before taking an important examination
17. During tests I find myself thinking about the consequences of failing
18. I feel my heart beating very fast during important tests
19. After an exam is over I try to stop worrying about it, but I can't
20. During examinations I get so nervous that I forget facts I really know
APPENDIX B

Achievement Emotions Questionnaire (Pekrun, Goetz, & Frensel, 2005)

Instruction: "The following questions pertain to feelings you may have experienced DURING taking the test. Please indicate how you felt, typically, during taking the test."

Scoring: 5-point Likert – “strongly disagree” (1) to “strongly agree” (5)

Items:

<table>
<thead>
<tr>
<th></th>
<th>Item</th>
<th>mean</th>
<th>sd</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I enjoy taking the exam.</td>
<td>2.37</td>
<td>1.07</td>
<td>.54</td>
</tr>
<tr>
<td>2</td>
<td>I worry whether I will pass the exam.</td>
<td>3.42</td>
<td>1.24</td>
<td>.52</td>
</tr>
<tr>
<td>3</td>
<td>Hoping for success, I’m motivated to invest a lot of effort.</td>
<td>3.77</td>
<td>.91</td>
<td>.30</td>
</tr>
<tr>
<td>4</td>
<td>At the beginning of the test, my heart starts pounding.</td>
<td>3.45</td>
<td>1.23</td>
<td>.59</td>
</tr>
<tr>
<td>5</td>
<td>I start to think that no matter how hard I try I won’t succeed on the test.</td>
<td>2.05</td>
<td>1.07</td>
<td>.72</td>
</tr>
<tr>
<td>6</td>
<td>I get angry.</td>
<td>1.88</td>
<td>1.08</td>
<td>.60</td>
</tr>
<tr>
<td>7</td>
<td>I think that I can be proud of my knowledge.</td>
<td>3.46</td>
<td>.91</td>
<td>.55</td>
</tr>
<tr>
<td>8</td>
<td>I am very nervous.</td>
<td>3.04</td>
<td>1.32</td>
<td>.73</td>
</tr>
<tr>
<td>9</td>
<td>I feel like giving up.</td>
<td>1.99</td>
<td>1.12</td>
<td>.70</td>
</tr>
<tr>
<td>10</td>
<td>My hands get shaky.</td>
<td>2.29</td>
<td>1.25</td>
<td>.49</td>
</tr>
<tr>
<td>11</td>
<td>I am ashamed of my poor preparation.</td>
<td>2.47</td>
<td>1.16</td>
<td>.58</td>
</tr>
<tr>
<td>12</td>
<td>I get so nervous I can’t wait for the exam to be over.</td>
<td>2.59</td>
<td>1.28</td>
<td>.63</td>
</tr>
<tr>
<td>13</td>
<td>I am very confident.</td>
<td>3.00</td>
<td>.96</td>
<td>.59</td>
</tr>
<tr>
<td>14</td>
<td>I think the questions are unfair.</td>
<td>2.45</td>
<td>.99</td>
<td>.59</td>
</tr>
<tr>
<td>15</td>
<td>I start to realize that the questions are much too difficult for me.</td>
<td>2.35</td>
<td>1.00</td>
<td>.65</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Score 1</td>
<td>Score 2</td>
<td>Score 3</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>16</td>
<td>Pride in my knowledge fuels my efforts in doing the test.</td>
<td>3.27</td>
<td>.91</td>
<td>.55</td>
</tr>
<tr>
<td>17</td>
<td>I feel panicky when writing the exam.</td>
<td>2.84</td>
<td>1.21</td>
<td>.74</td>
</tr>
<tr>
<td>18</td>
<td>I feel so resigned that I have no energy.</td>
<td>1.93</td>
<td>.93</td>
<td>.75</td>
</tr>
<tr>
<td>19</td>
<td>I feel humiliated.</td>
<td>1.79</td>
<td>1.01</td>
<td>.68</td>
</tr>
<tr>
<td>20</td>
<td>I am happy that I can cope with the test.</td>
<td>3.48</td>
<td>.90</td>
<td>.40</td>
</tr>
<tr>
<td>21</td>
<td>I am so anxious that I’d rather be anywhere else.</td>
<td>2.55</td>
<td>1.21</td>
<td>.69</td>
</tr>
<tr>
<td>22</td>
<td>I have given up believing that I can answer the questions correctly.</td>
<td>1.92</td>
<td>1.02</td>
<td>.69</td>
</tr>
<tr>
<td>23</td>
<td>I get so embarrassed I want to run and hide.</td>
<td>1.52</td>
<td>.85</td>
<td>.62</td>
</tr>
<tr>
<td>24</td>
<td>For me the test is a challenge that is enjoyable.</td>
<td>2.70</td>
<td>1.09</td>
<td>.60</td>
</tr>
<tr>
<td>25</td>
<td>I feel hopeless.</td>
<td>1.79</td>
<td>1.00</td>
<td>.74</td>
</tr>
<tr>
<td>26</td>
<td>Because I am ashamed my pulse races.</td>
<td>1.79</td>
<td>.95</td>
<td>.66</td>
</tr>
<tr>
<td>27</td>
<td>I get embarrassed because I can’t answer the questions correctly.</td>
<td>2.00</td>
<td>1.04</td>
<td>.68</td>
</tr>
</tbody>
</table>
APPENDIX C

Addendum Questions

Instruction: “Please respond to the following questions and continue.”

• When taking your quiz, did you at any point go back and check over completed answers?
  o Response options: Yes / No

• How confident are you in your quiz answers? (Visual Analog Scale scale from “not at all” to “completely”)

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