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Identifying Severity Standards on the Cognitive Test Anxiety Scale: Cut Score Determination Using Latent Class and Cluster Analysis

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Abstract

The purpose of the current examination was to preliminarily suggest severity standards for the recently revised Cognitive Test Anxiety Scale–Second Edition (CTAS-2). Participants responded to the CTAS-2, Motivated Strategies for Learning Questionnaire (MSLQ), and FRIEDBEN Test Anxiety Scale. Using both latent class and cluster analyses, we were able to classify participants as belonging to one of the three distinct cognitive test anxiety profiles—low, moderate, and high. Comparison of the identified test anxiety profiles allowed us to generate a set of severity standards for the CTAS-2 that can be used to differentiate between individuals with differing levels of cognitive test anxiety. The validity of the severity standards was established through group comparisons of test-anxious students on the MSLQ–Text Anxiety, FRIEDBEN–Cognitive Obstruction, FRIEDBEN–Social Derogation, and FRIEDBEN–Physiological Tenseness scales. Discussion concerns the practical implications of establishing CTAS-2 severity standards for educators, student support staff, and learners.

Keywords

cognitive test anxiety, severity standards, standard setting, latent class analysis, cluster analysis

Anxiety is an expansive construct often used to refer to the multitude of affective, cognitive, and physiological responses experienced within situations that are perceived as threatening (Kaplan & Sadock, 1981; Taylor & Arnow, 1988). Of particular relevance to educators—and their students—is the contextual anxiety experienced within evaluative situations commonly referred to as test anxiety, or evaluation anxiety. A substantial body of literature amassed over decades of research has identified test anxiety as a significant barrier to academic achievement. That is, test anxiety has been consistently linked to numerous negative outcomes among elementary, high school, and university students including (a) decreased academic performance, (b) impaired problem-solving ability, (c) decreased self-efficacy, and (d) decreased sense of self-worth (Cassady, 2004; Hembree, 1988; Putwain, 2007). The negative influence of test anxiety is

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concerning for educators given the high prevalence of debilitating levels of test anxiety among students within typical academic settings. Recent investigations have revealed that approximately 10% to 40% of students report experiencing some degree of test anxiety (Ergene, 2003; Segool, Carlson, Goforth, von der Embse, & Barterian, 2013), whereas approximately 15% of students report experiencing debilitating levels of test anxiety within assessment contexts (Putwain & Daly, 2014). Given the prevalence of test anxiety within traditional academic contexts, those responsible for overseeing the academic progress of students have called for the identification of methods that can be used to reliably identify learners with the greatest potential to experience debilitating test anxiety (von der Embse, Kilgus, Segool, & Putwain, 2013). Therefore, the purpose of the current investigation was to identify and provide preliminary validity evidence for the Cognitive Test Anxiety Scale (CTAS) severity standards for identifying test-anxious students in a university population.

Dimensions of the Test Anxiety Construct

Decades of research on the structure and dimensionality of test anxiety has provided converging evidence that test anxiety is a multidimensional construct consisting of at least two qualitatively distinct components, traditionally known as emotionality and worry (Liebert & Morris, 1967; Lowe et al., 2007; Morris, Davis, & Hutchings, 1981). *Emotionality* is a term used to describe the multitude of physiological responses commonly experienced by test-anxious learners during evaluative situations (Lowe et al., 2007). Explorations of the physiological manifestations of test anxiety have provided evidence suggesting that test-anxious learners often demonstrate bodily symptoms including dizziness, nausea, increased cortisol production, nervousness, and elevated heart rate within testing events (Daly, Chamberlain, & Spalding, 2011; Hembree, 1988).

The second dimension, traditionally labeled as *worry*—or more recently identified as cognitive test anxiety—refers to manifestations of test anxiety that engage cognitive learning and planning operations (see Cassady, 2010). These experiences range from interfering thoughts related to performance to merely possessing lower levels of skill in standard study, organization, and comprehension behaviors (e.g., Naveh-Benjamin, 1991; Sarason, 1986).

Although emotionality and worry are well-established core dimensions of test anxiety, some researchers have also begun to explore the viability of a "social" component of test anxiety, as represented in the biopsychosocial model of test anxiety (Friedman & Bendas-Jacob, 1997; Lowe & Lee, 2007; Lowe et al., 2007). The proposed social component is comprised largely of the perceived potential negative reactions from important others (e.g., parents, peers, teachers) that would follow from below average performance. The biopsychosocial model is a relatively new offering to the test anxiety field, perhaps providing a parsing of the cognitive aspect of test anxiety into cognitive and social components. Investigations with this model have provided preliminary evidence that social concerns are salient for test-anxious learners during evaluative events (Friedman & Bendas-Jacob, 1997; von der Embse, Mata, Segool, & Scott, 2014), but the impact on learning is very similar in nature to the pathway for impaired performance described as worry or cognitive test anxiety (i.e., interference of optimal performance through self-deprecating thoughts; for example, Sarason, 1986; Zeidner & Matthews, 2005).

Examinations of the impact of the distinct components of test anxiety on academic performance have traditionally demonstrated that the cognitive dimension of test anxiety (i.e., worry) is more directly associated with student outcomes—such as course grades, examination scores, and grade point average—than the physiological (or emotional) component (Cassady, 2004, 2010; Morris et al., 1981; Morris & Liebert, 1970; Zohar, 1998). Furthermore, investigations have provided evidence that the physiological manifestations of test anxiety exert little influence on learners' academic performance when they are experienced in isolation. That is, physiological manifestations of test anxiety typically only contribute to performance deficits when individuals are also experiencing the cognitive manifestations of test anxiety (Morris et al., 1981; Schwarzer, 1984; Schwarzer & Jerusalem, 1992).

Processes Contributing to Impaired Performance Among Test-Anxious Learners

One of the most enduring explanations for the performance deficits observed among test anxious is the cognitive-interference model—which initially proposed that test anxiety impairs optimal performance because students are focusing on task-irrelevant cognitions *during* testing situations (Cassady, 2004; Wine, 1971). That is, the cognitive-interference model proposes that test anxiety—and the associated task-irrelevant cognitions—prevent students from effectively retrieving and using information necessary for success in testing situations (Sarason, 1986; Wine, 1971). Updates to the standard cognitive-interference model suggest that the debilitative influence of test anxiety is not limited to information retrieval during evaluative situations, acknowledging that cognitive interference during the test preparation phase in the learning-testing cycle (Schwarzer & Jerusalem, 1992) can occur and significantly impair success during later testing episodes.

Contemporary investigations of patterns of underperformance observed among skilled and knowledgeable individuals during evaluative situations (i.e., "choking under pressure"; Ramirez & Beilock, 2011) provide additional insight into the mechanisms contributing to the difficulties test-anxious learners experience during the test preparation and performance phases of the learning-testing cycle. Specifically, the research demonstrates that when individuals with sufficient skills and knowledge experience test anxiety, they encounter disruptions in efficient working memory processing sparked by situation-related worries (Beilock & Carr, 2005; Ramirez & Beilock, 2011). These worry-related cognitions elicited by the evaluative situation compete for working memory resources, interfering with learners' abilities to store and manipulate task-relevant information (Beilock & Carr, 2001, 2005; Ramirez & Beilock, 2011). In this model, cognitive test anxiety disrupts optimal working memory performance such that learners are impaired in storing, organizing, and retrieving information imperative for success in testing situations.

Another model with strong support explaining the influence of cognitive test anxiety on performance—initially referred to as the information-processing model of test anxiety (e.g., Naveh-Benjamin, 1991; Naveh-Benjamin et al., 1987)—identified that test-anxious learners were not merely distracted or suffering from cognitive overload. This model of research demonstrated that students with high levels of test anxiety also demonstrate deficiencies in study behaviors, organizational tasks, and basic comprehension activities. This brief overview draws into stark contrast the variations that may exist within a single population of learners who are identified as "test anxious." Specifically, you have at least two broad groups of learners with differential manifestations and processes of test anxiety impacting performance. As demonstrated in Beilock and Carr (2001) and Beilock and Carr (2005), the cognitive-interference model is most rational for learners who have the cognitive and self-regulatory skills to enact effective learning strategies. However, for students with lower comprehension, organization, and study skills, the information-processing model proves viable (demonstrating that there is a cognitive failure to effectively encode and store content). In addition to these two foundational views, Zeidner and Matthews (2005) proposed up to six types of test anxiety, with a greater level of attention to motivational influences that may dictate slight differences in test anxiety manifestation.

Regardless of the model, the key underlying feature in explaining the deleterious impact of test anxiety on performance is the cognitive test anxiety component (either interference from distractions or irrelevant intrusions or simple cognitive processing failures). As such, considerable attention to effectively measuring the cognitive dimension of test anxiety, as well as exploring the construct for telling indicators for identifying the levels of cognitive test anxiety that warrant intervention and support, is vital to providing effective support to test-anxious learners.

Assessing Cognitive Test Anxiety

The CTAS is a self-report instrument designed to assess the cognitive manifestations of test anxiety experienced by learners within the preparation and performance phases of the learning-testing cycle (Bozkurt, Ekitli, Thomas, & Cassady, 2016; Cassady & Johnson, 2002). Since the development of the instrument, researchers have established the validity of the measure for use within a wide range of contexts including the United States (Ramirez & Beilock, 2011), Great Britain (Kapetanaki, 2010), and Greece (Tsianos, Lekkas, Germanakos, Mourlas, & Samaras, 2009). Cross-cultural examinations have also established the validity of the instrument for use among Chinese (Chen, 2007), Spanish (Furlan, Cassady, & Perez, 2009), Arabic (Cassady, Mohammed, & Mathieu, 2004), and Turkish (Bozkurt et al., 2016) speakers, demonstrating the utility of the CTAS in examining cross-cultural patterns of cognitive test anxiety.

The widespread use of various versions of the CTAS and repeated evidence in cultural adaptations, that the CTAS is a durable instrument for identifying differential levels of cognitive test anxiety, have led to repeated requests to identify a set of diagnostic criteria for identifying learners with elevated or debilitative levels of test anxiety. Furthermore, as a scale that is readily available and free for use, the CTAS was an optimal choice to explore the potential to identify students who struggle with test anxiety and may benefit from interventions designed to alleviate the debilitative effects of cognitive test anxiety. For instance, promising work by Tsianos and colleagues (2009) revealed that students demonstrated increased performance on experimental tasks when the presentation of task-relevant materials was personalized to account for characteristics of the learner (e.g., levels of test anxiety). If the field is to realize a meaningful step toward identification and treatment as proposed by leaders within the discipline (Segool et al., 2013; von der Embse et al., 2014), steps must be taken toward the identification of a simple and reliable method for identifying at-risk learners.

Approaches to Standard Setting

Conceptually, standard setting can be thought of as the process of establishing cut scores (i.e., performance standards) for an instrument for the purpose of differentiating categories of performance or groupings of examinees (Cizek & Bunch, 2007). Traditional standard-setting approaches assume performance on an instrument is primarily determined by an examinee's underlying knowledge, skill, or ability (Brown, 2007; Cizek & Bunch, 2007). Furthermore, traditional approaches propose that there exists a level of the underlying latent trait (e.g., test anxiety) where meaningful distinctions can be made between examinees and categories of performance (Brown, 2007). Early approaches to standard setting relied on independent content experts to determine response probabilities for test items among examinees falling within specified performance categories (e.g., passing/failing), which were then used to establish performance standard for an instrument (e.g., the Nedelsky method; Cizek & Bunch, 2007). Contemporary standard-setting approaches have shifted the focus from expert judgments regarding test items in isolation to impressions of instruments in their entirety in an attempt to improve the validity of obtained performance standards (i.e., the Bookmark method; Cizek & Bunch, 2007).

Although judgment-based methods are still at the core of many standard-setting efforts, some in the field of psychometrics have noted the potential benefits of the use of statistical techniques as a method for standard setting (Brown, 2007; Sireci, 2001). Statistical standard-setting methods differ from traditional approaches in several key aspects. First, statistical standard-setting methods rely on an analysis of examinee data to establish performance standards rather than the subjective judgments of instrument items provided by content experts (Sireci, 2001). Statistical standard-setting methods also differ in their assumptions regarding the proposed cause of examinee performance on an instrument. That is, traditional methods assume that performance on an instrument is determined by an unmeasured latent trait, whereas statistical techniques—such as latent class or cluster analysis—suggest variations in performance are the result of qualitative differences among "groups" or "classes" of respondents (Brown, 2007; Cizek & Bunch, 2007; Sireci, 2001). Using such clustering or grouping methods, researchers can classify each member of the sample into one of the (hopefully) small number of discrete groups that best accounts for their response pattern on the instrument of interest. Each group is then characterized based on a collective measure, such as the mean, median, or the quartiles of the scores. Given these group characteristics, cut scores can then be identified to successfully differentiate among members of the identified groups (Sireci, 2001). Comparisons of commonly used standard-setting approaches have determined statistical methods - based on latent class/cluster analysis – provide performance standards that are often comparable to those generated through consultation with content experts (Brown, 2007).

Method

The goal of the study was to identify the viability of establishing severity standards for the CTAS using statistical techniques in an undergraduate population as well as to provide preliminary validation information on those established severity standards. To accomplish this goal, a multiyear data collection effort was used with an undergraduate subject pool, consistent with the protocol approved by the local institutional review board. During the 3-year data collection effort, all participants completed the measure of cognitive test anxiety, but there were differences in the secondary measures participants completed. One subset of participants completed the Motivated Strategies for Learning Questionnaire (MSLQ), while another completed the FRIEDBEN Test Anxiety Scale (FTAS). It is important to note that standard-setting efforts using statistical methods should be conducted on a representative sample to generate severity standards that will generalize to the population of interest. Given the "limited" nature of the available research participants in the current examination, identification of learners with differing test anxiety severity levels within this population is intended to start a process of identifying university learners most at risk for experiencing incapacitating levels of cognitive test anxiety.

Participants

Data were collected from undergraduate students (N = 807, 81% female) attending a midsize public university in the Midwestern United States. Participants provided informed consent before participation and satisfied a course requirement by taking part in the data collection session. Mean age of the sample was 21.36 years (SD = 4.85), consistent with the population from which the study was drawn.

Measures

Cognitive Test Anxiety Scale–Revised (CTAR). Cognitive test anxiety was assessed using the CTAR—a 25-item revision to the original CTAS (Cassady & Johnson, 2002). Participants reported how well each of the presented statements described them using a 4-point Likert-type scale (1 = *not at all like me* to 4 = *very much like me*). Previous work has demonstrated that the CTAR is able to validly assess cognitive test anxiety within a variety of cultural contexts (Bozkurt et al., 2016; Cassady et al., 2004; Chen, 2007; Furlan et al., 2009; Kapetanaki, 2010; Ramirez

& Beilock, 2011; Tsianos et al., 2009). Within the current examination, the CTAR demonstrated excellent levels of internal consistency (Cronbach's α = .96)

MSLQ–Test Anxiety (MSLQ-TA) subscale. The MSLQ-TA subscale is a five-item subscale designed to assess the cognitive and physiological manifestations of test anxiety experienced by learners within evaluative situations (Pintrich, Smith, Garcia, & McKeachie, 1991). Participants reported how well each item describes them using a 7-point Likert-type scale (1 = *not at all true of me* to 7 = *very true of me*). Prior investigations have demonstrated reasonable reliability for the instrument when applied to adolescent populations (Cronbach's α = .80; Pintrich et al., 1991).

FTAS. The FTAS is a 23-item measure designed to assess the physical, cognitive, and social manifestations of test anxiety. Participants reported how well each statement describes them using a 6-point Likert-Type scale (1 = Does not characterize me at all to 6 = Characterizes me most perfectly). FTAS items can be used to create the Social Derogation (FTAS-SD), Cognitive Obstruction (FTAS-CO), and Psychological Tenseness (FTAS-PT) scales. The FTAS-SD is an eight-item scale designed to assess social concerns commonly experienced by test-anxious learners. The FTAS-CO is nine-item scale designed to assess the cognitive manifestations of text anxiety experienced by learners during evaluative events. Finally, the FTAS-PT is a six-item scale designed to assess patterns of physiological arousal experienced by test-anxious students within testing events. Previous examinations have demonstrated acceptable levels of internal consistency for each of the scales when applied to adolescent populations (FTAS-SD Cronbach's α = .86, FTAS-CO Cronbach's α = .85, and FTAS-PT Cronbach's α = .81; Friedman & Bendas-Jacob, 1997).

Procedure

Participants were recruited through the standard undergraduate research participation pool. Participation in this project was one option of several to satisfy a course requirement, and all participants provided informed consent prior to completing the study materials. All participants completed the study materials through an online survey distribution, collection, and management system. The participants completed the surveys and demographics information form in a single administration at their convenience through the online survey environment.

Analytic Strategy

Severity standards for the CTAS were identified through a series of related analyses. To allow for the cross validation of obtained results, the full sample (N = 807) was randomly divided into two equal halves.

Set 1: Establishing test anxiety profiles. We first conducted an exploratory latent class analysis (ELCA) on Sample 1 to identify learners with similar test anxiety profiles using R 3.3.1 (R Core Team, 2016) and the poLCA package (Linzer & Lewis, 2011). In the current examination, responses provided to CTAR items served as indicators of the underlying latent class variable (i.e., cognitive test anxiety). Prior investigations using the CTAR have identified an item that appears to be weakly related to the cognitive test anxiety construct (i.e., Item 24; Cassady & Finch, 2015; Bozkurt et al., 2016). Removal of the problematic item—which focuses on attributing exam success to external factors—has been shown to improve the measure's ability to account for observed data (Bozkurt et al., 2016). Therefore, ELCA models were generated which categorized participants into 2, 3, 4, or 5 distinct groups based on their endorsment of CTAR items – with the exception of the previously identified problematic item. The optimal model was selected through an evaluation of information-based model fit indices, model distinctiveness, and theoretical interpretability.

We next conducted a series of K-means cluster analyses to test the viability of the optimal latent class solution described in the ELCA described above. Specifically, we classified participants into 3, 4, or 5 distinct groups based on their endorsement of CTAR items using SPSS 21 software. The optimal cluster grouping was again selected through an evaluation of the distinctiveness of the generated cluster solutions. We reasoned that the optimal cluster solution would produce statistically significant differences between each of the identified clusters with respect to the means on other well-validated test anxiety measures.

After identifying the optimal latent class and cluster solutions, we explored the consistency of the categorizations generated by the two statistical methods using the Cramer's V statistic (Cramer, 1946). Cramer's V is a chi-square–based measure of association that generates an index—with values ranging from 0 to 1—indicating the strength of the relationship that exists between nominal level data (Cramer, 1946). The Cramer's V statistic is interpreted in a manner similar to the Pearson correlation coefficient such that larger values indicate a stronger relationship between the variables of interest (Agresti, 2013). We reasoned the use of Cramer's V in the current examination would provide an easily interpretable value providing an indication of the level of "agreement" between the classifications generated by the two statistical methods.

Set 2: Cross-validation of latent class solution. To evaluate the generalizability of our ELCA results, we conducted a confirmatory latent class analysis (CLCA) on Sample 2 using Mplus Version 7.11 to assess the classification quality of the optimal latent class solution. Classification quality was assessed using entropy values and average posterior class probabilities (APCP) for each of the latent classes. Entropy (E) is an index—ranging from 0 to 1—of classification precision with higher entropy values indicating greater classification accuracy (Klonsky & Olino, 2008). APCP simply refers to the mean probability that an individual will be assigned to each of the identified latent classes. Higher probabilities indicate greater confidence by the model in the class assignment that it has made. These values are commonly used to assess the reliability of latent class solutions. Guidelines regarding the interpretation of APCP suggest values above .70 signal a latent class solution possessing acceptable classification accuracy (Murphy, Shevlin, & Adamson, 2007).

Set 3: Establishing severity standards. Our methods for setting severity standards are an extension of those reported in Sireci (2001) and Brown (2007). To begin, we used the optimal cluster and latent class solutions to establish group identities (e.g., Low Anxiety, Moderate Anxiety, High Anxiety). Once those groupings were completed, we calculated the range for each cluster and latent class group. To determine the cut score between the adjacent groups, we identified the amount of overlap in Cognitive Test Anxiety Scale–Second Edition (CTAS-2) total score that existed between adjacent groups. As an example, the lower bound of the "overlap range" between Low and Moderate Anxiety was the lowest score by a member in the "Moderate" group and the upper bound was the highest score of the "Low" group (with the same process to identify the cut scores between other groupings). The median of the scores for participants falling within the overlap ranges were then calculated, which served as the cut score differentiating the adjacent groups (e.g., high from moderate, moderate from low). This operation was conducted for both grouping methods described above (i.e., cluster analysis and exploratory latent class analysis [ELCA]).

Set 4: Establishing the validity of the CTAS-2 severity standards. To establish the validity of the identified CTAS-2 severity standards, we compared mean levels of anxiety for participants grouped into the proposed test anxiety severity groups on the MSLQ-TA, FTAS-CO, FTAS-T, and

Table 1. AIC and BIC Values for Exploratory Latent Class Analysis Conducted for the CTAS-2.

Model	AIC	BIC
2-class solution	20,758.55	21,334.39
3-class solution	19,695.17	20,560.91
4-class solution	19,361.25	20,516.89
5-class solution	19,297.57	20,743.11

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; CTAS-2 = Cognitive Test Anxiety Scale–Second Edition.

FTAS-SD scales using a set of one-way ANOVAs followed by Scheffe post hoc comparisons. It was predicted that participants in the identified CTAS-2 severity standard groups would differ from one another on each measure.

Results

Set 1: Establishing Test Anxiety Profiles

ELCA. Examination of model fit indices for latent class solutions based on the 24-item version of the CTAR revealed evidence suggesting that a 4 or 5 - class solution may be optimal. For instance, observed Akaike information criterion (AIC) values suggested that a 5-class solution provided superior fit to the competing models whereas observed Bayesian information criterion (BIC) values suggested that the 4-class solution provided better model fit. Prior research (Nylund, Asparouhov, & Muthén, 2007) has shown that BIC provides for more accurate recovery of the latent class structure underlying a set of data than does AIC, or other relative fit indices. For this reason, BIC will serve as the primary method for identifying the correct number of latent classes to retain. Based on the BIC, it would appear that a 4-class solution based on the CTAS-2 provided the best overall fit for the observed data (see Table 1).

The existence of four unique profiles of cognitive test anxiety among university learners contradicts previous findings noting the existence of three distinct test anxiety profiles (e.g., Low Anxiety, Mid Anxiety, High Anxiety; von der Embse et al., 2014). Furthermore, review of the class members' data demonstrated that the class distinctions were essentially just progressively higher levels of test anxiety (not some distinct sub-classification of "types" of test anxiety).

Therefore, additional analyses were conducted to explore the distinctiveness of each of the latent class solutions derived from the CTAS-2. Specifically, participants were assigned to their most likely class membership, according to the 3, 4, and 5-class solutions. Means on the MSLQ-TA and FTAS-CO were then compared across the latent classes identified by the ELCA, using a series of one-way ANOVAs with Scheffe post hoc comparison tests as the follow-up to statistically significant F test results. It was predicted that the optimal latent class solution would sufficiently discriminate between students with differing levels of test anxiety. That is, we predicted that the optimal latent class solution would produce statistically significant differences between each of the classes identified in the latent class solution.

ANOVA results revealed statistically significant differences among participants assigned to their most likely class membership according to the 3, 4, and 5-class solutions on the MSLQ-TA and FTAS-CO. Post hoc comparisons conducted for the 3-class solution demonstrated that there were statistically significant differences in mean levels of anxiety between each of the three classes on the MSLQ-TA and FTAS-CO. However, post hoc comparisons for the 4- and 5-class solutions demonstrated that there were no statistically significant differences in mean levels of anxiety between each class on the MSLQ-TA and FTAS-CO. That is, follow-up analyses

Table 2. Comparative Analyses for 3-, 4-, and 5-Class Solutions Derived From the CTAS-2 on FTAS-CO and MSLQ-TA.

	Class 1	Class 2	Class 3	Class 4	Class 5		
Model	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*F*	η_p^2
FTAS-CO							
3-class	22.38[a] (4.29)	28.36[b] (5.10)	35.48[c] (5.06)	—	—	71.43*	.51
4-class	22.39[a] (4.24)	27.37[b] (5.36)	30.80[c] (4.65)	37.09[d] (5.25)	—	48.34*	.51
5-class	22.38[a] (4.29)	27.25[b] (5.19)	29.37[b] (6.25)	30.70[b] (4.66)	37.09[c] (5.25)	36.44*	.52
MSLQ-TA							
3-class	14.83[a] (5.53)	22.20[b] (5.52)	27.24[c] (6.00)	—	—	80.70*	.40
4-class	14.87[a] (5.79)	21.63[b] (5.53)	23.63[b] (5.34)	29.21[c] (5.56)	—	60.13*	.43
5-class	14.71[a] (5.50)	20.88[b] (6.69)	21.92[b] (5.24)	23.59[b] (5.44)	29.56[c] (5.44)	48.70*	.45

Note. Scheffe Post hoc comparison results within solution identify differences with superscripts (a, b, c, d).
CTAS-2 = Cognitive Test Anxiety Scale–Second Edition; FTAS-CO = FRIEDBEN Test Anxiety Scale–Cognitive Obstruction; MSLQ-TA = Motivated Strategies for Learning Questionnaire–Test Anxiety.
*p < .001.

indicated that there were no statically significant differences between learners demonstrating moderate levels of test anxiety for the 4 and 5-class solution (4-class solution: Class 2 and Class 3; 5-class solution: Class 2, Class 3, and Class 4). Examination of the class means and differences also revealed that the high group was a relatively consistent group across the 3 to 5-class solutions (see Table 2).

When considered in conjunction, results of the ELCA's and subsequent ANOVAs suggest that the 3-class solution provided the best representation of the data. In addition, given that the primary goal for identifying severity standards is to identify the high-test anxious group, there was no noted benefit to the additional classes generated in the 4 and 5-class solutions. Finally, a 3-class model is consistent with previous research on test anxiety profiles and conforms to the focus on serving the most at-risk learners (Segool et al., 2013; von der Embse et al., 2014). Class and item probabilities for the preferred 3-class solution are provided in Table 3.

At first glance, our finding suggesting that approximately 25% of participants in Sample 1 possess high levels of test anxiety may seem inflated. However, our results are consistent with recent investigations making use of classification techniques to identify unique groupings of test-anxious students. For instance, using latent profile analysis von der Embse and colleagues (2013) identified that approximately 30% of students in their investigation could be classified as possessing high levels of test anxiety. Furthermore, our results are consistent with past research suggesting that approximately 20% to 40% of students routinely experience elevated levels of test anxiety within evaluative situations (Carter, Williams, & Silverman, 2008; Ergene, 2003; McDonald, 2001; Putwain, 2007). As such, we believe these findings solidify the importance of developing severity standards that can be used to identify students who would most benefit from intervention efforts.

Cluster analysis. To determine the optimal cluster solution, we again evaluated the distinctiveness of the observed categorizations. Specifically, participants were assigned to their most likely cluster membership, according to the 3, 4, and 5-cluster solutions. Means on the MSLQ-TA and FTAS-CO were then compared across the cluster grouping identified by the K-means cluster analysis, using a series of one-way ANOVAs with Scheffe post hoc comparison tests.

Comparisons of the cluster solutions were consistent with the pattern of results observed within the ELCA reported above. That is, a one-way ANOVAs with Scheffe post

Table 3. Class and Conditional Item Probabilities for Preferred 3-Class Solution Derived From the CTAS-2.

	Class 1 (40%)				Class 2 (34%)				Class 3 (25%)			
Item	Pr (1)	Pr (2)	Pr (3)	Pr (4)	Pr (1)	Pr (2)	Pr (3)	Pr (4)	Pr (1)	Pr (2)	Pr (3)	Pr (4)
1	.16	.57	.18	.07	.48	.43	.06	.00	.07	.30	.27	.34
2	.04	.32	.39	.22	.22	.38	.28	.09	.01	.15	.32	.50
3	.26	.43	.22	.06	.70	.27	.02	.00	.02	.18	.33	.45
4	.12	.42	.34	.11	.58	.38	.02	.00	.02	.13	.29	.55
5	.23	.49	.24	.02	.77	.19	.02	.00	.02	.23	.32	.42
6	.09	.43	.29	.16	.63	.32	.04	.00	.01	.06	.26	.66
7	.47	.38	.08	.04	.85	.13	.01	.00	.04	.36	.23	.35
8	.45	.41	.08	.03	.90	.09	.00	.00	.07	.23	.38	.30
9	.25	.34	.32	.07	.71	.26	.02	.00	.00	.12	.36	.51
10	.23	.29	.35	.11	.53	.40	.05	.00	.10	.12	.38	.38
11	.15	.52	.25	.06	.72	.26	.01	.00	.03	.04	.43	.49
12	.18	.51	.25	.03	.64	.30	.04	.00	.02	.15	.35	.46
13	.13	.54	.28	.03	.63	.32	.02	.01	.00	.09	.31	.58
14	.08	.47	.37	.06	.49	.47	.03	.00	.01	.04	.35	.59
15	.50	.34	.12	.03	.93	.06	.00	.00	.11	.23	.34	.30
16	.14	.56	.26	.03	.79	.19	.01	.00	.01	.07	.44	.46
17	.20	.48	.21	.09	.81	.17	.00	.00	.01	.10	.33	.55
18	.07	.62	.25	.04	.52	.46	.01	.00	.00	.09	.44	.46
19	.13	.35	.36	.15	.59	.35	.04	.00	.00	.05	.24	.70
20	.04	.32	.46	.16	.26	.54	.17	.01	.01	.10	.35	.53
21	.37	.42	.13	.06	.84	.15	.00	.00	.06	.22	.35	.36
22	.04	.33	.43	.18	.31	.46	.19	.02	.00	.09	.37	.52
23	.07	.26	.40	.25	.38	.43	.17	.01	.02	.05	.11	.80
24	.46	.43	.08	.01	.92	.07	.00	.00	.07	.37	.36	.18
Average item probability	.20	.43	.26	.09	.63	.30	.05	.01	.03	.15	.33	.48

Note. Pr (1) = Probability of responding "Not at all typical of me"; Pr (2) = Probability of responding "Somewhat typical of me"; Pr (3) = Probability of responding "Quite typical of me"; Pr (4) = Probability of responding "Very typical of me." CTAS-2 = Cognitive Test Anxiety Scale–Second Edition.

hoc comparison tests conducted for the 3-cluster solution revealed statistically significant differences in mean levels of test anxiety among participants in Clusters 1, 2, and 3 on both the MSLQ-TA and FTAS-CO. As with the classes generated with the ELCA, when comparisons on these two measures were conducted for the 4 and 5-cluster solutions, the distinctive in-group identity was lost. That is, comparisons once again failed to reveal statistically significant differences between learners with moderate levels of test anxiety for the 4 and 5-cluster solution (4-cluster solution: Cluster 2 and Cluster 3; 5-cluster solution: Cluster 2, Cluster 3, and Cluster 4; see Table 4). Further examination revealed cluster probabilities for the preferred cluster solutions that were similar to the class probabilities observed for the preferred latent class solution, High Test Anxiety: 22%, Moderate Test Anxiety: 38%, Low Test Anxiety: 39%.

Cramer's V. With converging evidence from the two unique approaches suggesting the existence of three underlying "groups" of test-anxious students, it was decided to evaluate the consistency of the categorizations generated by the latent class and cluster analyses with Cramer's *V* statistic.

Table 4. Comparative Analyses for 3-, 4-, and 5-Cluster Solutions Derived From the CTAS-2 on FTAS-CO and MSLQ-TA.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5		
Model	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*F*	η_p^2
FTAS-CO							
3-cluster	22.63[a] (4.29)	28.64[b] (5.11)	35.58[c] (5.10)	—	—	71.98*	.51
4-cluster	22.39[a] (4.24)	27.63[b] (4.54)	31.61[c] (5.28)	37.31[d] (5.41)	—	50.43*	.52
5-cluster	22.38[a] (4.29)	26.58[b] (3.96)	30.92[b] (5.70)	31.48[b] (5.05)	37.23[c] (5.14)	41.46*	.55
MSLQ-TA							
3-cluster	15.83[a] (6.03)	22.24[b] (5.57)	27.30[c] (6.00)	—	—	67.60*	.36
4-cluster	15.02[a] (5.56)	21.49[b] (5.68)	24.07 [b] (5.60)	29.97[c] (4.48)	—	65.08*	.45
5-cluster	14.83[a] (5.53)	20.91[b] (5.64)	23.84 [b] (5.52)	24.17 [b] (5.57)	29.60 [c] (4.72)	49.96*	.46

Note. Scheffe Post hoc comparison results within each cluster solution identify differences with superscripts (a, b, c, d). CTAS-2 = Cognitive Test Anxiety Scale–Second Edition; FTAS-CO = FRIEDBEN Test Anxiety Scale–Cognitive Obstruction; MSLQ-TA = Motivated Strategies for Learning Questionnaire–Test Anxiety.
$^*p < .001$.

Our results revealed that there was a significant association between the classifications provided by the latent class and cluster solutions suggesting that the two statistical methods classified participants in a consistent manner, $V = .93$, $p < .001$.

Set 2: Cross-Validation of Latent Class Solution

CLCA. CLCA was utilized in the current examination to assess the classification quality of the preferred 3-class solution. Specifically, we utilized inequality constraints to model item response patterns (e.g., probability of item endorsement) that were observed among low, moderate, and highly test-anxious students in the ELCA. Examination of the observed Entropy value and APCPs revealed that the CLCA produced a precise latent class solution ($E = 0.96$) that demonstrated acceptable levels of classification accuracy (APCP Latent Class 1 = .985, APCP Latent Class 2 = .982, APCP Latent Class 3 = .984).

Set 3: Establishing Severity Standards for the CTAS-2

Our method of standard setting (described above) produced identical cut score values from the latent class and cluster group identities—generating confidence in the identified values to serve as cut scores to be used with the CTAS-2. Specifically, the range of scores for each of the identified groups was set at: Low Cognitive Test Anxiety (24-43), Moderate Cognitive Test Anxiety (44-66), and High Cognitive Test Anxiety (67 and above). To provide preliminary evidence for the validity of the identified cut scores, we examined 95% confidence intervals for the lower bound (i.e., minimum value) of each severity category. We reasoned that a lack of overlap in these values would indicate that there is a distinction among the identified test anxiety categories. Examination of the 95% confidence intervals revealed that there was no overlap in the confidence intervals which supports the validity of the identified severity standards.

Set 4: Validity of the CTAS-2 Severity Standards

To provide further evidence for the validity of the CTAS-2 severity standards, we compared mean levels of test anxiety for participants in the three groups on the MSLQ-TA, FTAS-CO,

Table 5. Summary Table for a Set of One-Way ANOVAs Exploring CTAS-2 Severity Standard Group Differences on Measures of Test Anxiety.

	Low anxiety	Moderate anxiety	High anxiety		
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*F*	η_p^2
FTAS-CO	21.95[a] (3.66)	27.96[b] (5.01)	35.60[c] (5.46)	166.23*	.53
FTAS-SD	18.83[a] (10.87)	26.85[b] (10.87)	35.09[c] (9.78)	46.83*	.24
FTAS-PT	15.04[a] (6.93)	21.04[b] (7.24)	28.72[c] (5.32)	84.82*	.36
MSLQ-TA	15.36[a] (5.95)	22.22[b] (5.60)	27.94[c] (5.29)	184.63*	.42

Note. Scheffe post hoc analyses comparing group differences summarized with superscripts (a, b, c, d). CTAS-2 = Cognitive Test Anxiety Scale–Second Edition; FTAS-CO = FRIEDBEN Test Anxiety Scale–Cognitive Obstruction; FTAS-SD = FRIEDBEN Test Anxiety Scale–Social Derogation; FTAS-PT = FRIEDBEN Test Anxiety Scale–Psychological Tenseness; MSLQ-TA = Motivated Strategies for Learning Questionnaire–Test Anxiety.
*p < .001.

FTAS-PT, and FTAS-SD scales using a set of one-way ANOVAs followed by Scheffe post hoc comparisons. We predicted that participants in the identified CTAS-2 severity standard groups would differ from one another on all measures. Results confirmed this expectation, with significant differences observed between the three levels of cognitive test anxiety for both externally validated measures of test anxiety (see Table 5).

Discussion

Investigations of the determinants of academic achievement have consistently identified cognitive test anxiety as a barrier that impedes optimal performance within academic settings (Cassady, 2004; Morris et al., 1981; Morris & Liebert, 1970; Zohar, 1998). Given the common interest in identifying students most at-risk for suffering the negative effects of cognitive test anxiety with a simplified classification process (von der Embse et al., 2014), the primary purpose of the current investigation was to preliminarily suggest severity standards for the CTAS. Using two approaches to identifying stable groups regarding cognitive test anxiety, we generated indicators for low, moderate, and high cognitive test anxiety that should have simple, practical utility in helping educators, academic support staff, and researchers identify individuals who meet the criterion for "high test anxiety" who would presumably be targeted for interventions to support the barriers to performance imposed by that anxiety level.

Severity Standards for Cognitive Test Anxiety

Prior studies have provided evidence illustrating that one of the items in the CTAR (25-item scale) is only weakly related to the cognitive test anxiety construct (Bozkurt et al., 2016; Cassady & Finch, 2015). Based on the converging evidence from multiple samples and cultures on that point, we have determined the removal of the item is warranted. Consequently, we identify the 24-item finalized measure as the CTAS-2 (see the Appendix for final version). Although not the primary purpose of this investigation, we believe exploring the rationale for—and establishing—the finalized measure was a necessary first step to ensure that the most durable version of the scale was used in determining the cut scores required to generate the severity standards.

Using both latent class and cluster analyses, we were able to classify participants as belonging to one of the three distinct cognitive test anxiety profiles—low, moderate, and high. Comparisons of the identified test anxiety profiles resulted in the creation of a set of severity standards that can be used to differentiate among students with low (CTAS-2 scores: 24-43), moderate (CTAS-2 scores: 44-66), and high levels (CTAS-2 scores: 67 and above) of cognitive test anxiety. Preliminary evidence for the validity of the proposed severity standards was demonstrated through group comparisons indicating that the low, moderate, and high anxiety groups significantly differed from one another in mean levels of test anxiety on two well-validated measures of the test anxiety construct.

The clear differentiation among levels of test anxiety severity in the current examination provides a simple alternative to the traditional “continuum” view of test anxiety. Although we believe that in general it is most appropriate to consider test anxiety as a continuous variable (particularly in research studies), there is practical value to providing practitioners with a simple “diagnostic indicator” for identifying individuals with elevated test anxiety. When attempting to identify students most at-risk for experiencing the debilitative effects of cognitive test anxiety within evaluative contexts—or when attempting to determine if a single learner is in need of support—a clear label of “high cognitive test anxiety” helps categorize individuals who can then be referred for support. The use of cut scores in establishing indications of severity for psychological constructs is standard practice (Cacciola, Pecoraro, & Alterman, 2007; Matthey, Henshaw, Elliott, & Barnett, 2006; Sprinkle et al., 2002) and we believe this model provides guidelines that allow educators to effectively target individuals with elevated (or suppressed) levels of test anxiety, with an eye toward intervention.

Limitations and Future Directions

A primary limitation of the current examination was our reliance on statistical methods to validate the suggested severity standards. Our results provided convincing evidence suggesting that our cut scores can be used to differentiate among students reporting differing levels of test anxiety. However, we have no direct evidence related to the practical usefulness of the identified severity standards. That is, it is not clear whether the cut scores that were generated for the CTAS-2 provide educators and academic support staff with a practical and meaningful method for identifying students that are at-risk for experiencing negative academic outcomes due to the experience of test anxiety within traditional educational settings. Future research could address this potential limitation by exploring the practical utility of the generated cut scores in predicting indicators of student achievement.

Obviously, the current study has a limitation based on the nature of the participant population. That is, data available in the current examination were based on questionnaire responses provided by volunteers taking part in an undergraduate research pool. As a result, data collected during the examination is rather limited in terms of age, gender, and ethnicity, and we are sensitive that the established cut scores must be examined with the awareness of the population in review. Although cross-cultural studies and investigations with earlier versions of the CTAS from other ages and locations have demonstrated reasonable durability and validity in response patterns across populations (Cassady, 2004; Chen, 2007; Ramirez & Beilock, 2011; Tsianos et al., 2009), continued efforts focused on determining if there are differential norms to be established based on demographic breakdowns should be encouraged in the field. It is possible that future norming studies will identify gender-based norms, age-based norms, or cultural standards. For example, empirical investigations have demonstrated that students from Islamic and Eastern cultures often report significantly higher levels of test anxiety than their Western counterparts (Bodas, Ollendick, & Sovani, 2008; Sharma & Sud, 1990). Previous examinations have noted socialization practices, parental expectations, and the sociocultural framework of the educational settings may contribute to the disparate pattern of test anxiety observed during cross-cultural examinations (Bodas & Ollendick, 2005; Bodas et al., 2008; Furlan et al., 2009).

Regarding future steps with this work, in addition to the examination of severity standards in differing populations (i.e., varied age ranges, diverse settings), we see viable avenues of research building from these severity standards. First, prior research has demonstrated that those with high levels of test anxiety have a greater sensitivity to dimensions of cognitive test anxiety (Cassady & Finch, 2015). It is possible that only when levels of test anxiety are elevated that learners can identify differences among manifestations of test anxiety that are driven by cognitive interference or information-processing barriers to performance. Once learners are identified as "high test anxiety," greater attention to differences among the high anxiety group may provide more empirical support for the theoretical propositions for multiple "types" of test anxiety (Zeidner, 1998; Zeidner & Matthews, 2005). Once those types or profiles are identified, the next natural step is to test whether specific interventions can be developed to be delivered to these diverging types of test anxiety, rather than treating all test-anxious learners universally (Segool et al., 2013).

Appendix

Please complete the following items using the 4-point scale below.

1	I lose sleep over worrying about examinations.	1	2	3	4
2	I worry more about doing well on tests than I should.	1	2	3	4
3	I get distracted from studying for tests by thoughts of failing.	1	2	3	4
4	I have difficulty remembering what I studied for tests.	1	2	3	4
5	While preparing for a test, I often think that I am likely to fail.	1	2	3	4
6	I am not good at taking tests.	1	2	3	4
7	When I first get my copy of a test, it takes me a while to calm down to the point where I can begin to think straight.	1	2	3	4
8	At the beginning of a test, I am so nervous that I often can't think straight.	1	2	3	4
9	When I take a test that is difficult, I feel defeated before I even start.	1	2	3	4
10	While taking an important examination, I find myself wondering whether the other students are doing better than I am.	1	2	3	4
11	I tend to freeze up on things like intelligence tests and final exams.	1	2	3	4
12	During tests, I find myself thinking of the consequences of failing.	1	2	3	4
13	When I take a test, my nervousness causes me to make careless errors.	1	2	3	4
14	My mind goes blank when I am pressured for an answer on a test.	1	2	3	4
15	During tests, the thought frequently occurs to me that I may not be too bright.	1	2	3	4
16	During a course examination, I get so nervous that I forget facts I really know.	1	2	3	4
17	I do not perform well on tests.	1	2	3	4
18	During tests, I have the feeling that I am not doing well.	1	2	3	4
19	I am a poor test taker in the sense that my performance on a test does not show how much I really know about a topic.	1	2	3	4
20	After taking a test, I feel I should have done better than I actually did.	1	2	3	4
21	My test performances make me believe that I am not a good student.	1	2	3	4
22	I often realize mistakes I made right after turning in a test.	1	2	3	4
23	When I finish a hard test, I am afraid to see the score.	1	2	3	4
24	I don't seem to have much control over my test scores.	1	2	3	4

Note. 1 = *Not at all typical of me*; 2 = *Somewhat typical of me*; 3 = *Quite typical of me*; 4 = *Very typical of me*.

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