Archives of Assessment Psychology, Vol. 13, No. 1, (49-67)

The Bulgarian and Greek Versions of the Cognitive Test Anxiety Scale in University Students: In Search of a Factor Structure

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Abstract

University students face test anxiety regardless of their country of origin. Therefore, it is necessary to use psychometric measures with identified factor structures. The Cognitive Test Anxiety Scale (CTAS) has been used in different countries to measure the cognitive aspect of test anxiety. Although the CTAS has been used widely, its factor structure is a topic of debate. In this study, we focused on concurrent data collection in two adjacent countries (Bulgaria and Greece), with two aims: a) to establish for the first time the factor structure for the Bulgarian and Greek versions of the CTAS, and b) to investigate any cross-cultural differences in two large samples of university student populations. Results from an exploratory factor analysis (EFA; n = 824) for the Greek adaptation of the CTAS support a two-factor model, consisting of cognitive test anxiety and test confidence, with all 27 items included. For the Bulgarian sample (n = 735), the EFA showed the same internal structure of two factors, but for 14 items, differing from the Greek version. In addition, no gender-based or cross-cultural differences in the CTAS total score were found for the two countries. Future research should consider that university students' test anxiety should be examined with caution, and particular emphasis should be given to cultural settings and educational systems.

Introduction

The present study aims to adapt the CTAS to Bulgarian and Greek cultural settings, to establish its psychometric properties for Bulgarian and Greek learners, and to compare its psychometric properties with other cultural adaptations of the questionnaires. Establishing the factor structure of the CTAS in two neighboring countries (Bulgaria and Greece) could help to find cultural and educational influences on test anxiety. If the structure is similar in both countries, then it could be proposed that test anxiety is independent of cultural specifics and educational organization.

The CTAS with 27 items has been used in Greece in the past (Tsianos et al., 2009), but its psychometric properties were not reported. The CTAS was applied in Bulgaria and found to have a Cronbach’s alpha of .64 and a Guttman split-half reliability of .80, but its factor structure was not examined (Relojo-Howell & Stoyanova, 2019). The current study aims to establish the CTAS’s psychometric properties by focusing on Bulgarian and Greek samples of university students.

In Bulgaria, there is a shortage of psychological tools for examining exam anxiety among students. Establishing the psychometric properties of the Bulgarian adaptation of the CTAS will allow its application for the diagnosis of exam anxiety in Bulgarian students, and, in the future, to clarify the effectiveness of interventions and techniques to reduce the anxiety of students in an assessment situation. Examining test anxiety could explain how it affects student academic performance.

Forms and Components of Test Anxiety

Anxiety is the subjective feeling of tension, apprehension, nervousness, and worry associated with acute arousal of the autonomous nervous system in various and specific situations (Tzoannopoulou, 2016) before, during, and after exams (Baghaei & Cassady, 2014, p.1).

Test anxiety may be an individual's trait test anxiety characterized by high levels of concern about performance across all conditions and stages of a task (Cassady & Johnson, 2002). Test anxiety may be situation-specific state test anxiety characterized by low self-confidence for the specific task, perception of the exam as a threat, and self-awareness for being underprepared for the exam during evaluation (Cassady & Johnson, 2002).

Test anxiety is a multidimensional complex construct with several components - cognitive, affective, physiological, behavioral, and social components (Papantoniou et al., 2017; Thomas et al., 2018). Traditionally, the forms and components of test anxiety are defined as worry/cognitive test anxiety and emotionality (Baghaei & Cassady, 2014; Thomas et al., 2018; Tzoannopoulou, 2016).

Emotionality as a component of test anxiety is the individual's subjective awareness of heightened autonomic arousal (Cassady & Gridley, 2005; Cassady & Johnson, 2002) and nervousness (Thomas et al., 2018) during examinations. The emotionality component of test anxiety includes heightened physiological activity and bodily symptoms provoked by evaluation (Baghaei & Cassady, 2014; Cassady & Johnson, 2002; Thomas et al., 2018) such as elevated heart rate, dizziness (Baghaei & Cassady, 2014; Cassady & Johnson, 2002; Thomas et al., 2018), headaches (Baghaei & Cassady, 2014), feelings of panic (Baghaei & Cassady, 2014; Cassady & Johnson, 2002), trembling, perspiring (Tzoannopoulou, 2016), increased galvanic skin response (Cassady & Johnson, 2002), nausea (Cassady & Johnson, 2002; Thomas et al., 2018), and increased cortisol production (Thomas et al., 2018). Emotionality is also related to behavioral responses, such as stammering and general uneasiness (Tzoannopoulou, 2016).

The second dimension of test anxiety, traditionally labeled as *worry* — or more recently identified as cognitive test anxiety — refers to cognitive manifestations of test anxiety that concern learning and planning operations (Thomas et al., 2018), impaired study skills (Baghaei & Cassady, 2014; Thomas et al., 2018), inappropriate testing strategies, and poor working memory and cognitive processing (Baghaei & Cassady, 2014). For example, comprehension (Thomas et al., 2018) and poor organization skills (Baghaei & Cassady, 2014; Thomas et al., 2018) act as self-handicappers, leading to not having time to study, or to losing study books. These are subject to external attributions as the cause for the failure, thereby preserving self-esteem (Baghaei & Cassady, 2014). Problems with coping during exams (Cassady & Johnson, 2002), and setting high-performance standards, then criticizing one's own performance, and subsequently perceiving a high threat during testing events (Baghaei & Cassady, 2014) are further examples.

The term "cognitive test anxiety" refers to:

- thoughts comparing self-performance to this one of peers and evaluating it as worse (Baghaei & Cassady, 2014; Cassady & Gridley, 2005; Cassady & Johnson, 2002),
- worry about the impact of the results from testing on self-esteem and peer status (Baghaei & Cassady, 2014),
- failure anticipation and fear of failure (Cassady & Johnson, 2002),

- thoughts expressing low levels of self-confidence in one's performance (Cassady & Gridley, 2005; Cassady & Johnson, 2002),
- feeling/considering oneself as unprepared for a test (Cassady & Gridley, 2005; Cassady & Johnson, 2002),
- limitations in retrieval cues utilization (Cassady & Gridley, 2005),
- interfering thoughts related to performance (Thomas et al., 2018), cognitive interference means the unwanted, undesirable, and disturbing intrusive thoughts in academic situations during exams that do not have any functional value in solving the cognitive task at hand, i.e., they are task-irrelevant, they consume working memory, and in this way, they reduce the quality or efficiency of exam performance (Papantoniou et al., 2017),
- self-deprecating thoughts/ruminations (Baghaei & Cassady, 2014; Cassady & Johnson, 2002; Tzoannopoulou, 2016),
- self-concern (Cassady & Johnson, 2002),
- escape cognitions and irrelevant thinking at the time of the exam (test-irrelevant thinking) (Cassady & Johnson, 2002), task-irrelevant ideas (Tzoannopoulou, 2016),
- distractibility during study and evaluation (Baghaei & Cassady, 2014),
- loss of self-worth (Cassady & Johnson, 2002; Thomas et al., 2018),
- concerns about subsequent examinations (Cassady & Johnson, 2002),
- internal dialogue (self-talk) related to evaluative situations in times before, during, and after an activity that is due to be evaluated (Cassady & Johnson, 2002),
- anxiety blockage and failure to successfully retrieve the acquired information during evaluation (Baghaei & Cassady, 2014),
- failure-accepting - a learned-helplessness orientation is adopted to exams, and the learners give up trying to prepare (Baghaei & Cassady, 2014) adequately,
- avoidance of test preparation and evaluative situations, procrastination, performance-avoidance goals, and avoiding complex tasks to limit threats (Baghaei & Cassady, 2014).

A social component of test anxiety is comprised of the perceived potential adverse reactions from essential others (e.g., parents, peers, teachers) that would follow from below-average performance (Thomas et al., 2018), considering the consequences of failure, including some thoughts about the possible negative parents and other relatives reactions to an exam failure (Cassady & Gridley, 2005; Cassady & Johnson, 2002), that impair, interfere optimal performance through self-deprecating thoughts (Thomas et al., 2018).

Besides, foreign language classroom anxiety comprises communication apprehension, test anxiety, and fear of negative evaluation (Tzoannopoulou, 2016). Communication apprehension refers to cases where learners are afraid to communicate authentically with peers or teachers because of self-perceived poor communication skills. Test anxiety is performance anxiety triggered by the fear of failure and involves worry over frequent tests and examinations in language classrooms (Tzoannopoulou, 2016). Fear of negative evaluation is apprehension about others' evaluations because one expects the teacher or student's peers to evaluate themselves negatively. Hence, the person strives to avoid evaluative situations (Tzoannopoulou, 2016). Although fear of negative evaluation is similar to test anxiety, it is not limited to test-taking environments. Still, it is present in a wider variety of situations that require evaluation, such as being interviewed for a position or speaking out in a foreign language class (Tzoannopoulou, 2016). The major sources provoking language anxiety and fear of negative evaluation are communication apprehension toward teachers, peers, and native speakers, fear of tests and speaking in class, and fear of teachers' questions and corrections (Tzoannopoulou, 2016).

Effects of Test Anxiety on Performance

The existing studies emphasize the importance of test anxiety for students' academic performance:

- Test anxiety may decrease cognitive ability test scores (Papantoniou et al., 2017),
- Test anxiety is related to reduced intelligence test scores (Cassady & Johnson, 2002; Papantoniou et al., 2017),
- Test anxiety may decrease students' grades/ academic achievement (Cassady & Johnson, 2002; Papantoniou et al., 2017; Thomas et al., 2018; Tzoannopoulou, 2016),
- High levels of test anxiety negatively correlate with aptitude (Cassady & Johnson, 2002).
- High levels of test anxiety are related to impaired problem-solving ability (Cassady & Johnson, 2002; Thomas et al., 2018).
- High levels of test anxiety are related to memory impairment (Cassady & Johnson, 2002).
- Test anxiety has been linked to decreased self-efficacy (Thomas et al., 2018).

The cognitive dimension of test anxiety (worry) has the greatest negative impact on performance (Baghaei & Cassady, 2014) since it involves cognitive capacity, which would otherwise be allocated to more relevant tasks (Tzoannopoulou, 2016). Students with high levels of cognitive test anxiety have impaired performance in all phases of the learning-testing cycle, namely test preparation (forethought), test performance, and test reflection (Cassady & Gridley, 2005).

The CTAS scores predict course examination performance (Cassady & Johnson, 2002). Cognitive test anxiety can account for a 7 to 8% drop in test grades (Moore, 2013). Higher levels of cognitive test anxiety are associated with lower test scores during test examinations, so cognitive test anxiety exerts a stable and negative impact on academic performance for secondary and postsecondary students due to their inability to suppress competing negative thoughts during the exam that distract attention to more irrelevant cues for the task in the exam situation, hinder the ability to effectively process and retrieve necessary information, as well as increase awareness of a lack of preparation or ability to cope with the exam situation (Cassady & Johnson, 2002). High emotionality worsens test performance only when combined with high worry but not with a high level of self-confidence regarding own performance (Cassady & Johnson, 2002).

Gender Differences in Test Anxiety

Between 25% and 40% of learners experience some form of test anxiety, higher among females and ethnic minorities, when making critical decisions in academic institutions (Baghaei & Cassady, 2014, p.2). There are some significant gender differences in language anxiety and fear of negative evaluation (Tzoannopoulou, 2016). There are some gender differences in test anxiety such that females are more anxious than males because of higher levels of females' emotionality, higher levels of cognitive test anxiety among females, females' perception of evaluative situations as threatening instead of challenging, and females' tend to underestimate their abilities, to perceive themselves as less self-efficient, to be less selfconfident than males in the case of an evident evaluative situation (Cassady & Johnson, 2002, pp.274-275, p.290). Nursing students have a high occurrence of moderately high cognitive test anxiety (Moore, 2013). Because nursing students are mainly females, this is evidence of a higher frequency of cognitive test anxiety among women than men. However, a study in Turkey indicated gender equivalence in cognitive test anxiety (Bozkurt et al., 2017), which means cognitive test anxiety could be a culturally specific phenomenon.

The current study aimed to establish the construct validity of the CTAS through factor analysis of Bulgarian and Greek samples.

Method

Procedure

The study was conducted both paper-and-pencil and online in Bulgarian and Greece among some volunteering university students. The questionnaire CTAS was translated from English to Bulgarian and then backward from Bulgarian to English by several psychologists and philologists. The research received appropriate ethics approval. As mentioned earlier, the CTAS was previously applied in Greece (Tsianos et al., 2009) and Bulgaria (Relojo-Howell & Stoyanova, 2019), but its psychometric properties were not reported. Some participants completed CTAS twice within two weeks to establish its test-retest reliability.

Sample

Participation was voluntary and anonymous. Purposeful sampling was applied, and the criterion for selection was to be a university student. The criteria for including individuals in the study were a Bulgarian/Greek university student, an adult Bulgarian/Greek, and a citizen of Bulgaria/Greece.

Because some scientists recommend at least 20 items (Costello & Osborne, 2005; MacCallum et al., 2001) to conduct a factor analysis, the minimum required sample size was 27 items by 20 subjects, giving 540 participants per country, something that was achieved in the present study.

In Bulgaria, 735 university students from 19 to 29 years old (M = 22.9, SD = 2.9) were studied using the CTAS. The female students (n = 480; 65.3%) exceeded the number of male students (n = 255; 34.7%).

In Greece, 824 university students from 19 to 22 years old (M = 19.6, SD = 0.9) were studied using the CTAS. The female students (n = 428; 51.9%) exceeded the number of male students (n = 396; 48.1%).

Instruments

The CTAS questionnaire (Cassady & Johnson, 2002) was used. It focuses on the cognitive dimension of test anxiety, not on emotionality or test procrastination (Cassady & Johnson, 2002). The CTAS comprises items concerning task-irrelevant thinking during test-taking and exam preparation, comparing oneself to others during the test-taking and preparation period, intruding thoughts during exams, and distractions from relevant cues during testing (Cassady & Johnson, 2002, p.277). The authors have developed the CTAS over two years using data from more than 400 participants to generate its final version of 27 items. This was completed by 168 undergraduate psychology students (with a mean age of 21) within 48 hours of taking the exam (Cassady & Johnson, 2002, p.276). The CTAS was developed to measure only the cognitive component of test anxiety. The responses are on a 4-point scale (Cassady & Johnson, 2002). Cronbach's alpha was .86, .92, and .91 in several studies in the USA (Cassady & Johnson, 2002, p.277). Cronbach's alpha of the CTAS varied between .77 (Orakwue & Okigbo, 2023) and .82 (Amalu, 2017) in two studies in Nigeria. Test-retest reliability coefficients ranged from .88 to .93, being higher at the end than when administered at the beginning of the academic year (Cassady & Gridley, 2005).

According to its authors, the 27-item version of the CTAS represents a single-factor cognitive test anxiety model (Cassady & Johnson, 2002, p.276). The repeated factor analyses of the CTAS revealed a consistent unidimensional construct (Cassady & Finch, 2014).

The CTAS contains some reverse-scored items (Cassady & Johnson, 2002). The use of reverse-coding on some items of the original scale (items 3, 5, 8, 9, 10, 17, 18, and 21, according to Cassady & Finch, 2014) produced a secondary factor that had been previously undetected in the scale validation efforts for both Argentinian and U.S. samples (Baghaei & Cassady, 2014, p.2). This second factor did not add to the model fit for the CTAS (Cassady & Finch, 2014).

The two-factor model of the original 27-item CTAS included the factors *cognitive test anxiety* and *test confidence* (Cassady & Finch, 2015), with the latter factor containing all the reverse-coded items (Baghaei & Cassady, 2014, p.2). The original intention of the reverse-coded items in the CTAS was to avoid response-set bias (Baghaei & Cassady, 2014, p.2).

A reduced length version of the CTAS with 17 items (a short form of the revised CTAS, i.e., CTAR-17) that was created by the removal of reverse-coded items is a conceptually preferable and more parsimonious measure of cognitive test anxiety than either the original single factor full-length version or the two-factor solution using all the original items (Cassady & Finch, 2014). The CTAS–Revised (CTAR) is a single-factor scale composed of 17 items using a four-point response scale: 1 = *not at all typical of me*, 2 = *somewhat typical of me*, 3 = *quite typical of me*, and 4 = *very typical of me* (Baghaei & Cassady, 2014, pp. 2-3; Cassady & Finch, 2015).

The 17-item version of CTAS (CTAR-17) has been adapted into Persian for Iranian university students, and it has been reduced to a 13-item brief version of CTAS (the Persian CTAS—Revised; PCTAS-R, Baghaei & Cassady, 2014). No items required reverse scoring, and higher scores indicated higher levels of cognitive test anxiety (Baghaei & Cassady, 2014, p.3).

In one study, eight additional items focused on test anxiety experiences in all three phases of the learning–Testing cycle were added to the CTAR-17. Still, the CTAS does not include any temporal components related to the learning-testing cycle (Cassady & Finch, 2015). The CTAS–Revised (CTAR) is a 25-item revision to the original CTAS whose answers are given on a four-point Likert-type scale (1 = *not at all like me* to 4 = *very much like me*), and its Cronbach's alpha was .96 (Thomas et al., 2018). The students were divided into two latent classes based on their levels of reported test anxiety on the CTAS-25 (Cassady & Finch, 2015). For undergraduate students with low levels of cognitive test anxiety, cognitive test anxiety is a unidimensional construct. Still, for students with high levels of cognitive test anxiety, there are two distinct factors of cognitive test anxiety: factor one concerns some aspects of cognitive interference during both test preparation and test performance period, and factor two addresses some appraisals of test-taking ability and the test performance potential (Cassady & Finch, 2015). The items identifying some exam performance failures due to specific cognitive failures are cross loaded between the two factors on CTAS -25, applying geomin rotation of factor axes (Cassady & Finch, 2015). One item, which focuses on attributing exam success to luck, does not load onto either factor for CTAS–25 (Cassady & Finch, 2015).

CTAS-Revised (CTAS-R) adopted in Turkey is a four-point Likert-type self-report scale comprising 25 items, with a mean of 47.5 and a standard deviation of 10.8 (Burhan et al., 2020). The Turkish version of the CTAS–Revised (CTAR) has a unidimensional structure, but a 23-item version of the measure provided a better fit to the data and higher internal consistency ($\alpha = .93$) than the 25-item Turkish version of CTAR (Bozkurt et al., 2017). The 23-item one-dimensional CTAS adapted to Turkish university students had Cronbach's alpha of .95, Spearman-Brown split-half reliability coefficient of .82, and test-retest reliability r = .95 (Dogan & Ekitli, 2021).

A Spanish version of the CTAS was used with some Argentinean university students (Furlan, Cassady, & Pérez, 2009). EFA of all normally distributed answers on 26 items (except for item 21, "Finding unexpected questions on a test causes me to feel challenged rather than panicky”) showed an internal structure of two factors. Still, confirmatory factor analyses demonstrated that a 16-item single-factor solution was the preferable factor model with enough reliability (Furlan, Cassady, & Pérez, 2009, p.10).

The German version of the CTAS (G-CTAS) contained 26 items (without item 25, "I feel under a lot of pressure to get good grades on tests"), and Cronbach's alpha was .92 (Stefan et al., 2020).

A revised CTAS—Second Edition (CTAS—2) has been created with 24 items, and 17 of them are the same as in the CTAS: items 1, 2, 4, 6, 7, 11, 12, 14, 15, 16, 19, 20, 22, 23, 24, 26 and 27 (Thomas et al., 2018).

The initially proposed single-factor solution, the updated two-factor solution, and a shortened version of the scale (dropping the reverse-coded items) are all viable solutions for interpreting the data from that scale (Baghaei & Cassady, 2014, p.2).

According to the results on CTAS (with 27 items), the participants are divided into three groups: high, middle, and low test anxiety, each consisting of one-third of the participants (Cassady & Johnson, 2002, p.279). According to the results on CTAS-2 (with 24 items), the participants could be 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 (Thomas et al., 2018).

Analysis

Data were processed statistically using the software JASP 0.17.2.0 (JASP Team, 2023). Exploratory and confirmatory factor analyses were applied, and some reliability indexes were computed. Exploratory parallel factor analysis was used with ordinary least squares appropriate for ordinary variables (Lee et al., 2012), applying geomin oblique rotation of factor axes as per Cassady & Finch (2015). Parallel analysis supposes that the eigenvalues of the actual data should be higher than the eigenvalues of some occasional data with the same sample size and number of variables (Hayton, Allen, & Scarpello, 2004). Then, confirmatory factor analysis was applied with the diagonally weighted least squares (DWLS) method. DWLS is appropriate for data on the ordinal level of measurement, precise for estimating factor loadings in two-factor models, and not supposing any concrete distribution of the observed variables but extracting some normally distributed latent variables (e.g., factors; Li, 2016). Finally, Cronbach’s alpha was computed for the extracted factors. Independent sample t-tests were applied to establish gender and country differences in test anxiety.

Results

The Greek version of the CTAS

The coefficient skewness of all items from the CTAS was within -1 and +1, except for item 21 (skewness was 9.7). The coefficient kurtosis of all items from CTAS varied between -0.6 and -1.2, except for item 21 (kurtosis was 119.7), which suggested that item 21 should be omitted from the scale.

Table 1

CTAS Item Factor Loadings (Greece)

Items	Factor loadings	
	Factor 1	Factor 2
CTAS1	0.97	-0.78
CTAS2	0.95	-0.78
CTAS3	-0.82	0.99
CTAS4	0.95	-0.79
CTAS5	-0.75	0.92
CTAS6	0.95	-0.76
CTAS7	0.93	-0.78
CTAS8	-0.70	0.86
CTAS9	-0.65	0.80
CTAS10	-0.68	0.83
CTAS11	0.97	-0.80
CTAS12	0.95	-0.79
CTAS13	-0.63	0.75
CTAS14	0.96	-0.79
CTAS15	0.92	-0.75
CTAS16	0.92	-0.79
CTAS17	-0.74	0.88
CTAS18	-0.69	0.86
CTAS19	0.95	-0.77
CTAS20	0.92	-0.76
CTAS21	-0.33	0.39
CTAS22	0.96	-0.79
CTAS23	0.92	-0.73
CTAS24	0.94	-0.78
CTAS25	0.93	-0.76
CTAS26	0.93	-0.74
CTAS27	0.92	-0.76

The results from the EFA (of all 27 items) indicated that the Kaiser-Meyer-Olkin overall MSA was 0.98, i.e., marvelous factorial simplicity, and the significance level of Bartlett's test was < .001, which means the results from factor analysis deserve being interpreted (Kaiser, 1974). Extraction communalities were above 0.5, which was higher than the recommended value of 0.4 (Costello & Osborne, 2005; Hampel et al., 2018) or 0.2 (Yong & Pearce, 2013) for all the items except for item 21, but the measures of sampling adequacy for all items were above 0.9 that means high enough (Kaiser, 1974).

Two factors were extracted that explained 81.6% of the variance of the variables in the CTAS (the first factor explained 58.7%, and the second factor explained 22.9% of the variance of the answers on the items in these factors). The second extracted factor included all reverse–coded items from the CTAS (see Table 1), as found in some other countries (Baghaei & Cassady, 2014; Cassady & Finch, 2014; Cassady & Finch, 2015). The two-factor model of the factors cognitive test anxiety and test confidence (Cassady & Finch, 2015) was reproduced in the Greek adaptation of the CTAS.

Cronbach's alpha of the first extracted factor, cognitive test anxiety, was .99. Cronbach's alpha of the second extracted factor, test confidence, was .93 (without item 21, Cronbach's alpha would be .96). Cronbach’s alpha of the total score on CTAS was .99 (without item 21, Cronbach's alpha would be .99).

The average inter-item correlation for the first extracted factor was 0.89. The average inter-item correlation for the second extracted factor was 0.65. The average inter-item correlation for the whole CTAS (27 items) was 0.74. Test–retest reliability of the total score on CTAS was $r = .96$ ($p < .001$, $n = 62$). The mean value of the scores on the first extracted factor was 38.0, and the standard deviation was 17.6. The mean value of the scores on the second extracted factor was 24.7, and the standard deviation was 7.6. The mean value of the total scores on CTAS was 76.3, and the standard deviation was 24.2.

All reverse-coded items of the CTAS (3, 5, 8, 9, 10, 13, 17, 18, and 21) had higher factor loadings on the second extracted factor (see Table 1). Both extracted factors correlated negatively ($r = -.82$).

Some indices indicated mediocre fitting for this two-factor model to the original data:

- Comparative Fit Index (CFI) = 0.94, i.e., acceptable factor model (Hooper et al., 2008; Kula, 2011; McIntosh, 2001; Mohamed, 2019; Vittersø et al., 2002);
- Tucker-Lewis Index (TLI) = 0.93, i.e., acceptable factor model (Bentler, & Bonett, 1980; Brown, 2014; Kula, 2011; Kulkarni, 2017; Mohamed, 2019);
- RMSEA with 90% confidence interval = 0.09 [0.09; 0.10], i.e., mediocre fit of the factor model (Bentler & Bonett, 1980; Brown, 2014; Browne & Cudeck, 1992; Hooper et al., 2008; Hu & Bentler, 1999; McIntosh, 2001; Schermelleh-Engel et al., 2003; Salama-Younes, 2011);
- Standardized root mean square residual (SRMR) = 0.01, i.e., well-fitting factor model (Hooper et al., 2008; Hu & Bentler, 1999; Kula, 2011; Lages et al., 2018).

However, confirmatory factor analysis supported only one–factor model for the Greek sample of university students (Cronbach’s alpha = .993), without all the reverse–coded items, i.e., CTAR-17 (see Figure 1).

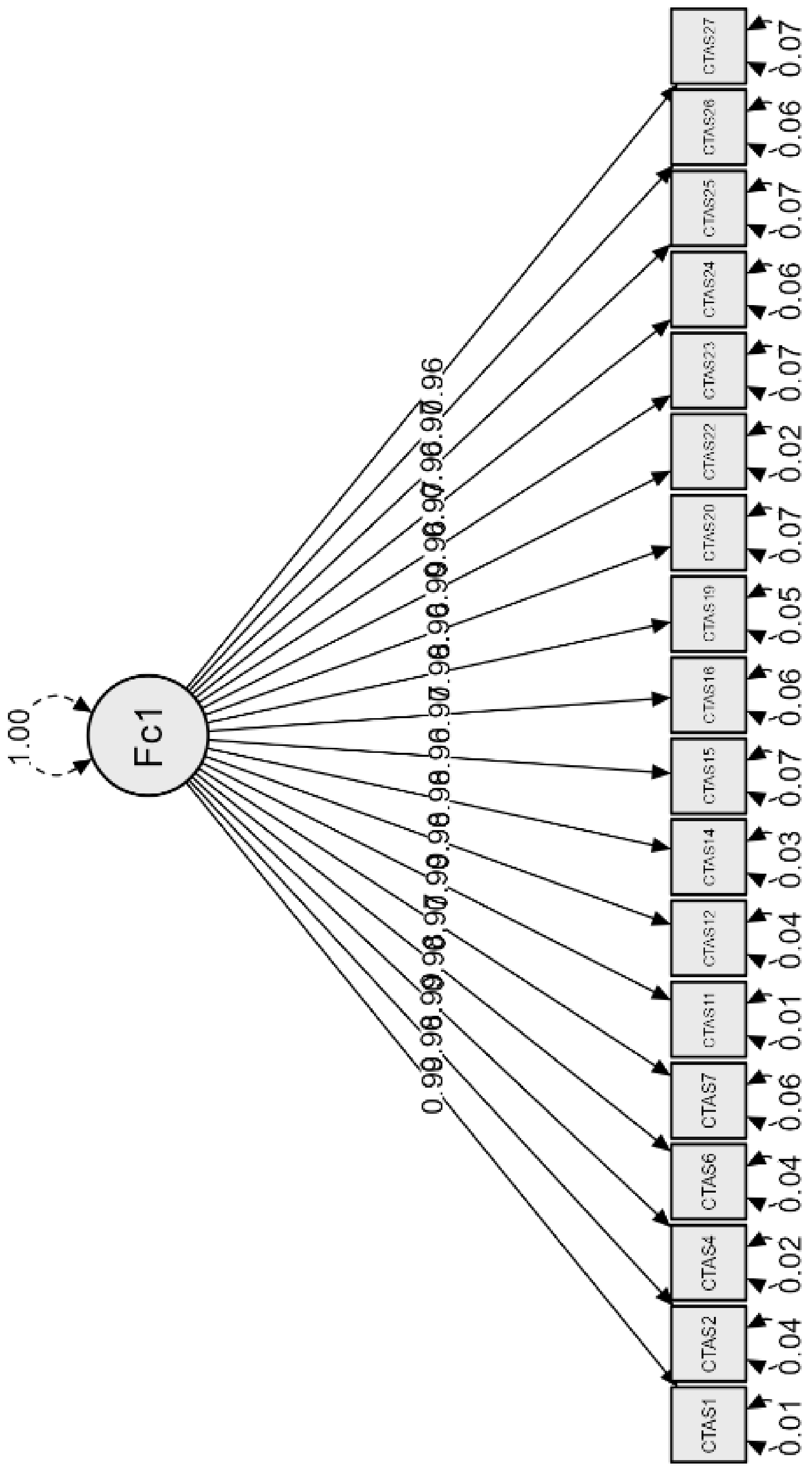
The indices that indicated good fitting of this one-factor model to the original data are:

- Comparative Fit Index (CFI) = 1.000, i.e., well-fitting factor model (Hooper et al., 2008; Kula, 2011; McIntosh, 2001; Mohamed, 2019; Vittersø et al., 2002);
- Tucker-Lewis Index (TLI) = 1.000, i.e., well-fitting factor model (Bentler & Bonett, 1980; Brown, 2014; Kula, 2011; Kulkarni, 2017; Mohamed, 2019);

- RMSEA with 90% confidence interval = 0.060 [0.055; 0.065], i.e., the acceptable fit of the factor model (Bentler & Bonett, 1980; Brown, 2014; Browne & Cudeck, 1992; Hooper et al., 2008; Hu & Bentler, 1999; McIntosh, 2001; Schermelleh-Engel et al., 2003; Salama-Younes, 2011);
- Standardized root mean square residual (SRMR) = 0.010, i.e., well-fitting factor model (Hooper et al., 2008; Hu & Bentler, 1999; Kula, 2011; Lages et al., 2018);
- Bentler-Bonett Non-normed Fit Index (NNFI) = 1.000, i.e., well-fitting factor model (Bollen, 1987; Hooper et al., 2008);
- Bentler-Bonett Normed Fit Index (NFI) = 1.000, i.e., perfect fitting factor model (Hooper et al., 2008; Kulkarni, 2017; Mohamed, 2019);
- Parsimony Normed Fit Index (PNFI) = 0.882, i.e., adequate factor model (Hooper et al., 2008);
- Bollen's Relative Fit Index (RFI) = 1.000, i.e., very good adequacy of the factor model (Kulkarni, 2017; Mohamed, 2019);
- Bollen's Incremental Fit Index (IFI) = 1.000, i.e., very good adequacy of the factor model (Kulkarni, 2017);
- Relative Noncentrality Index (RNI) = 1.000, i.e., appropriate factor model (Hu & Bentler, 1999);
- The goodness of fit index (GFI) = 1.000, i.e., adequate factor model (Hooper et al., 2008; Lages et al., 2018; Mohamed, 2019; Salama-Younes, 2011);
- Hoelter's critical N = 253.191, i.e., enough sample size for estimating the adequacy of the factor model (Kula, 2011).

Figure 1

Confirmatory Factor Model Plot of the Greek CTAR-17



Note: Factor loading estimates are indicated on the lines linking the item to the factor; Residual variance estimates are displayed below the numbers of the items.

Bulgarian Version of CTAS

The coefficient of skewness of all items from the CTAS was within -1 and +1. The coefficient kurtosis of all items from CTAS varied between -2 and +2. The results from exploratory factor analysis indicated some low extraction communalities below the recommended value of 0.2 (Yong & Pearce, 2013) for some items and measure of sampling adequacy for the same items below 0.8 (Kaiser, 1974), which is why the items 1, 2, 4, 6, 7, 11, 12, 14, 15, 16, 19, 20 and 22 were removed from the analysis and another exploratory factor analysis was performed with the remaining items.

The results from the exploratory factor analysis (of the remaining 14 items) indicated that Kaiser-Meyer-Olkin overall MSA = 0.89, i.e., meritorious factorial simplicity, and the significance level of Bartlett's test was < .001, which means the results from factor analysis deserve being interpreted (Kaiser, 1974). Two factors were extracted from 14 items that explained 55.1% of the variance of the variables in the CTAS. Extraction commonalities were above the recommended value of 0.2 for all the items (Yong & Pearce, 2013).

The first extracted factor included all reverse–coded items from the CTAS (see Table 2), but this was the second factor in some other countries (Baghaei & Cassady, 2014; Cassady & Finch, 2014; Cassady & Finch, 2015). The two-factor model of the factors cognitive test anxiety and test confidence (Cassady & Finch, 2015) was reproduced in the Bulgarian adaptation of CTAS with a shortened version of the factor cognitive test anxiety, including only the items 23, 24, 25, 26 and 27.

Cronbach's alpha of the first extracted factor, test confidence, was .90. Cronbach's alpha of the second extracted factor, cognitive test anxiety, was .90. Cronbach's alpha of the total score on CTAS was .88.

The average inter-item correlation for the first extracted factor, test confidence, was 0.49. The average inter-item correlation for the second extracted factor, cognitive test anxiety, was 0.64. The average inter-item correlation for the whole CTAS (27 items) was 0.21. Test–retest reliability of the total score on CTAS was $r = .76$ ($p < .001$, $n = 42$). The mean value of the scores on the first extracted factor, test confidence, was 24.0, and the standard deviation was 6.8. The mean value of the scores on the second extracted factor, cognitive test anxiety, was 11.5, and the standard deviation was 4.6. The mean value of the total scores on CTAS was 59.0, and the standard deviation was 13.0.

All reverse-coded items of CTAS (3, 5, 8, 9, 10, 13, 17, 18, 21) had higher factor loadings on the first extracted factor (see Table 2). Both extracted factors correlated negatively ($r = -.27$).

Some indices indicated mediocre fitting of this two-factor model to the original data:

- Comparative Fit Index (CFI) = 0.92, i.e., acceptable factor model (Hooper et al., 2008; Mohamed, 2019; Vittersø et al., 2002);
- RMSEA with 90% confidence interval = 0.10 [0.09; 0.11], i.e., the minimal fit of the factor model (Brown, 2014; Browne & Cudeck, 1992; Hooper et al., 2008; Hu & Bentler, 1999; Schermelleh-Engel et al., 2003);
- Standardized root mean square residual (SRMR) = 0.04, i.e., well-fitting factor model (Hooper et al., 2008; Hu & Bentler, 1999; Kula, 2011).

However, confirmatory factor analysis supported only one–factor model for the Bulgarian sample of university students (Cronbach's alpha = .90), with all the reverse–coded items (see Figure 2).

Table 2

CTAS Item Factor Loadings (Bulgaria)

Items	Factor loadings	
	Factor 1	Factor 2
CTAS3	0.60	-0.17
CTAS5	0.64	-0.20
CTAS8	0.60	-0.23
CTAS9	0.76	-0.16
CTAS10	0.66	-0.18
CTAS13	0.71	-0.14
CTAS17	0.81	-0.25
CTAS18	0.83	-0.27
CTAS21	0.71	-0.16
CTAS23	-0.23	0.85
CTAS24	-0.20	0.75
CTAS25	-0.25	0.74
CTAS26	-0.22	0.87
CTAS27	-0.22	0.79

The indices that indicated good fitting of this one-factor model to the original data are:

- Comparative Fit Index (CFI) = 0.994, i.e., well-fitting factor model (Hooper et al., 2008; Kula, 2011; McIntosh, 2001; Mohamed, 2019; Vittersø et al., 2002);
- Tucker-Lewis Index (TLI) = 0.992, i.e., well-fitting factor model (Bentler & Bonett, 1980; Brown, 2014; Kula, 2011; Kulkarni, 2017; Mohamed, 2019);
- RMSEA with 90% confidence interval = 0.079 [0.067; 0.091], i.e., acceptable fit of the factor model (McIntosh, 2001; Schermelleh-Engel et al., 2003);
- Standardized root mean square residual (SRMR) = 0.047, i.e., well-fitting factor model (Hooper et al., 2008; Hu & Bentler, 1999);
- Bentler-Bonett Non-normed Fit Index (NNFI) = 0.992, i.e., well-fitting factor model (Bollen, 1987; Hooper et al., 2008);
- Bentler-Bonett Normed Fit Index (NFI) = 0.993, i.e., perfect fitting factor model (Hooper et al., 2008; Kulkarni, 2017; Mohamed, 2019);
- Parsimony Normed Fit Index (PNFI) = 0.745, i.e., adequate factor model (Hooper et al., 2008);
- Bollen's Relative Fit Index (RFI) = 0.990, i.e., very good adequacy of the factor model (Kulkarni, 2017; Mohamed, 2019);

- Bollen's Incremental Fit Index (IFI) = 0.994, i.e., very good adequacy of the factor model (Kulkarni, 2017);
- Relative Noncentrality Index (RNI) = 0.994, i.e., appropriate factor model (Hu & Bentler, 1999);
- Goodness of fit index (GFI) = 0.994, i.e., adequate factor model (Hooper et al., 2008; Lages et al., 2018; Mohamed, 2019; Salama-Younes, 2011).

Country and Gender Comparisons in Cognitive Test Anxiety

There were no gender differences in the CTAS scores (27 items) in Greece, $t(822) = 1.79$, $p = .08$, nor in Bulgaria, $t(733) = 1.84$, $p = .07$, which was also supported by the findings in Turkey (Bozkurt et al., 2017).

There were no differences in the CTAS scores (27 items) between Bulgarian and Greek university students, $t(1541.3) = 1.53$, $p = .13$, with Levene's test for equality of variances = 63.63, $p < .001$).

Discussion

The CTAS comprising all 27 items had high internal consistency coefficients both in Bulgaria (.88) and Greece (.99), and high enough test-retest reliability in Bulgaria (.76) and Greece (.96). This is why only the total scores on CTAS (27 items) were compared for country and gender differences in cognitive test anxiety. Because of the different factor structures of the CTAS in other countries, a comparison of total scores on CTAS between Bulgarian and Greek university students was performed. The different factor structure of cognitive test anxiety in different countries means its components and manifestations may be culturally specific. The current study revealed the importance of test confidence for the studied Bulgarian university students extracted as the first factor in the structure of cognitive test anxiety in support of the finding that reducing test anxiety was related to low self-criticism in Bulgarian university students (Relojo-Howell & Stoyanova, 2019).

Cognitive test anxiety predicts academic achievement (Amalu, 2017; Orakwue & Okigbo, 2023), so students should thoroughly study to increase their confidence level and leave no room for self-doubt or self-defeating behavior (Amalu, 2017). The teachers should ensure that test conditions are favorable to reduce cognitive test anxiety (Orakwue & Okigbo, 2023). Matching the instructional style to the students 'characteristics optimized performance, including anxiety-related performance (Tsianos et al., 2009).

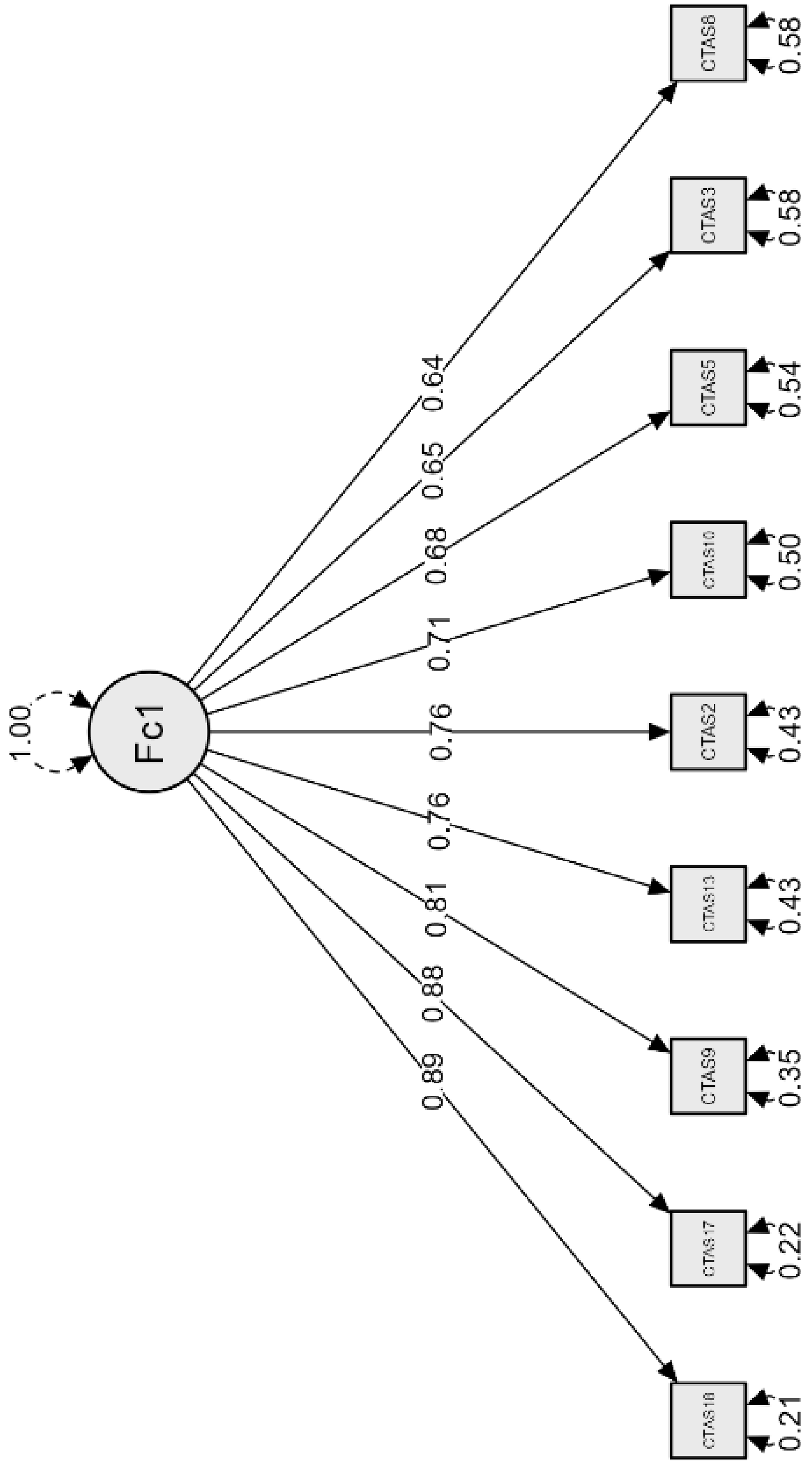
Letting the students with high test anxiety write down their worries, or write about some attributes of successful problem-solvers, for 10 minutes before the exam substantially diminished the link between cognitive test anxiety and test performance, however, the students with low test anxiety performed worse after expressive writing (Lang & Lang, 2011) which is why it is vital to establish the level of test anxiety before trying to reduce it.

Students who have high cognitive test anxiety underestimate their probability of success and consequently do not fully engage in solving the problems at hand (Lang & Lang, 2011). It has been established that cognitive test anxiety correlates significantly and positively with test-irrelevant thinking and procrastination (Cassady & Johnson, 2002).

Some behavioral modification techniques reduce test anxiety only when emotionality is targeted (Cassady & Johnson, 2002), which expresses the close connection between the components of test anxiety, meaning that emotionality is closely related to behavior. It has been established that cognitive test anxiety correlates significantly and positively with bodily symptoms of test anxiety and tension (Cassady & Johnson, 2002). Cognitive test anxiety was predicted by trait anxiety level and depressive symptom intensity (Burhan et al., 2020).

Figure 2

Confirmatory Factor Model Plot of the Bulgarian CTAS



Note: Factor loading estimates are indicated on the lines linking the item to the factor; Residual variance estimates are displayed below the numbers of the items.

Worry as a cognitive manifestation of test anxiety follows perceived high emotionality and own high levels of physiological arousal (Cassady & Johnson, 2002), which means that after reducing high emotionality, worry may also be decreased, which may explain why emotionally focused behavioral interventions diminish test anxiety.

Limitations

This cross-cultural study has some limitations related to a smaller sample size in Bulgaria than in Greece. A measurement bias due to imperfections in the translated instrument could also have influenced the results. In addition, the participants were informed that they could withdraw at any time during the testing procedure, which should reduce the risk of potential repeated negative experiences related to a testing situation. Another limitation could be related to the way of collecting data. It has been found that the scores on cognitive test anxiety are higher for paper–based testing than for online testing (Cassady & Gridley, 2005), so the conditions of testing are important for reducing test anxiety. Some of the data was collected online, and a portion was collected with paper-and-pencil testing in both Bulgaria and Greece to reduce testing effects on results.

Conclusion

Adapting the questionnaire to study exam anxiety in students would allow its future application for diagnosing exam anxiety and the success of techniques and interventions to reduce anxiety. The application of questionnaires in cross-cultural comparisons of university students' test anxiety reveals its specificity related to culture and country-specific educational systems even within the wider European education framework.

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