



# Using factor mixture modeling to identify dimensions of cognitive test anxiety



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## ABSTRACT

The research on test anxiety has repeatedly attempted to provide a more refined measurement of multiple dimensions of the construct. Divergence in the field has repeatedly arisen in the specific dimensions, but there is a broad acceptance that there are various manifestations of test anxiety. The current study attempts to specifically explore the potential for identifying subcomponents of the construct referred to as cognitive test anxiety. The analyses did not support the initial prediction that a temporal determination of factors (i.e., related to the Learning-Testing Cycle) would arise. Alternatively, exploratory factor mixture modeling (EFMM) demonstrated that there were two latent classes of students (based on levels of reported test anxiety). Furthermore, the EFMM demonstrated that the factorial structure of cognitive test anxiety differed between these two latent classes. Specifically, undergraduate students with low levels of cognitive test anxiety represented cognitive test anxiety as a unidimensional construct. However, for those students with high levels of test anxiety, there were two distinct factors. The results suggest that those learners with high-test anxiety are able to differentiate among more different “types” of test anxiety as compared to their non-anxious peers.

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## 1. Introduction

Research in test anxiety has become progressively refined over the past 50 years, with greater precision in identifying subcomponent aspects of anxious responses to evaluative events since Liebert and Morris (1967) identified emotionality and worry as primary factors for test anxiety. Research over this time frame has consistently identified behavioral and attitudinal tendencies for individuals with high levels of test anxiety in these two broad domains. Indicators of high levels of emotionality generally include specific physiological indicators such as perspiration, headaches, elevated heart rate, tension, and cortisol production (Daly, Chamberlain, & Spalding, 2010; Mattarella-Micke, Mateo, Kozak, Foster, & Beilock, 2011; Sarason, 1984). Alternatively, high levels of the classic worry factor – which is also referred to as cognitive test anxiety (e.g., Cassady, 2010; Lowe et al., 2008) – is associated with a broader range of behaviors and beliefs that impact the learning and testing experiences for students. Commonly identified characteristics associated with this dimension of test anxiety include (a) heightened perceived threat for tests; (b) inferior cognitive processing, organization skills, and study strategies; (c) susceptibility to cognitive interference (i.e., distractibility) during both study sessions and the exam period; and (d) motivational perspectives that promote task avoidance, failure acceptance, and disengaged coping strategies (e.g., Cassady, 2004a, 2010; Cassady & Johnson, 2002; Davis, Distefano,

& Schutz, 2008; Sarason, 1984; Schwarzer & Jerusalem, 1992; Zeidner, & Matthews, 2005).

Dominant models of test anxiety assert that both domains are relevant in explaining the learning and testing experiences for individuals with high-test anxiety, with the emotionality factor serving largely as a cue to the learner regarding the level of threat imposed by an evaluative condition (Hembree, 1988; Mattarella-Micke et al., 2011; Spielberger & Vagg, 1995; Zeidner & Matthews, 2005). When this threat appraisal is identified, the cognitive test anxiety beliefs and behaviors become prevalent and influence learning and performance (e.g., Cassady, 2004a; Hembree, 1988). Given the widespread acceptance of the physiological indicators of emotionality and the research identifying that cognitive test anxiety is more directly linked to test performance levels, the cognitive component has received more attention in the literature focused on the structure and measurement of test anxiety (e.g., Cassady & Finch, 2014; Lowe et al., 2008; von der Embse, Kilgus, Segool, & Putwain, 2013). As such, our investigation focuses on the cognitive dimension of test anxiety, specifically exploring the potential for multiple dimensions of cognitive test anxiety as measured through a widely used self-report measure.

### 1.1. Theoretical multidimensionality of cognitive test anxiety

As early as the 1980's, there was attention given to further differentiating test anxiety beyond the initial worry and emotionality factors. The most popular measure in this line was Sarason's (1984) Reactions

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to Tests scale that identified worry and test-irrelevant thinking as distinct elements representing the cognitive dimensions of test anxiety. While there is no universal acceptance of specific factors within the cognitive domain of test anxiety, the research started at that time sparked a series of engaging studies into the diverse experiences test anxious learners encounter in evaluative settings. The results demonstrated that there were a wide range of beliefs and behaviors that are commonly reported by individuals with test anxiety.

One approach to attempting to differentiate among these various beliefs and behaviors has been to examine “types” or “profiles” of test anxiety. Zeidner and Matthews (2005); see also Zeidner, 1998) summarized the dominant types that had been proposed in the literature, proposing six types of test anxiety: (a) study skills deficits, (b) anxiety blockage and retrieval failure, (c) failure acceptance, (d) failure-avoidance, (e) self-handicapping, and (f) perfectionism. Zeidner’s summarization of these types of anxiety can be largely seen as an integration of Covington’s (1992) self-worth theory with two classic explanations for the influence of cognitive test anxiety on performance–anxiety blockage and skills deficits.

An additional approach to examining differences in cognitive test anxiety recognizes variations in the manifestation of test anxiety across three phases of the “learning–testing cycle”. This model proposes that test anxious learners demonstrate different beliefs and behaviors related to evaluative pressure during the test preparation, test performance, and test reflection phases (Raffety, Smith & Ptacek, 1997; Schwarzer & Jerusalem, 1992). Both of these procedures for distinguishing among test anxiety experiences (as well as others) have merit and critical evaluation of these dimensional approaches lies beyond the current focus of this study. However, the viability of all these models center on the recognition that there are variations among test anxious learners’ experiences in evaluative settings. That is, learners who are identified as high-test anxious are not a homogenous group – and the beliefs and behaviors an individual with test anxiety exhibits may change as situational factors (e.g., perceived difficulty, proximity to testing) are modified.

The “anxiety blockage” view of test anxiety is perhaps the most prototypical and classic view. This classic explanation proposes that test anxiety negatively impacts performance due to cognitive interference and distraction experienced during the testing session (e.g., self-deprecating ruminations, test-irrelevant thinking, cue overload during retrieval; Deffenbacher, 1980; Geen, 1980; Sarason, 1984). More recent explanations for this effect highlight the importance of recognizing cognitive interference also occurs during the test preparation phase, when learners attempt to encode content to be recalled during the test performance phase (Cassady, 2010). Empirical research on this effect – which includes work on “choking under pressure” – has confirmed high-anxiety learners are more susceptible to performing at a lower level of proficiency when they perceive evaluative stress (Beilock, 2010; DeCaro, Thomas, Albert, & Beilock, 2011; Covington & Omelich, 1987; Mattarella-Micke et al., 2011). Chen and Chang (2009) reframed this classic representation of test anxiety using cognitive load theory, reporting that students with high-test anxiety experience a greater cognitive load in evaluative settings (including test preparation), with extraneous load demands drawing necessary cognitive resources from the task at hand.

However, this view of test anxiety has been contested, driven in part by research that demonstrates high overlaps in state anxiety and cognitive abilities (e.g., Sommer & Arendasy, 2014). This approach to viewing test anxiety through a skills deficit model is supported by research demonstrating that test performance decrements for test anxious learners are generally not relieved in non-evaluative stress contexts (e.g., Cassady, 2004b), and verbal working memory capacity for high test-anxious learners does not vary between high and low evaluation threat settings (Putwain, Shah, & Lewis, 2014). In line with these findings, the second broad explanation for cognitive test anxiety builds from research demonstrating that learners with test anxiety display

deficiencies in cognitive operations and activities (i.e., self-regulated learning strategies) – regardless of evaluative stress (e.g., Naveh-Benjamin, 1991). This view of test anxiety holds that students with test anxiety experience poor test performance due to the inability to effectively encode, organize, or comprehend content to be used during the test session. This view has been validated by work with subjects who attempt to organize to-be-learned content in a non-evaluative setting (Naveh-Benjamin) as well as those who take practice tests that have no evaluative pressure (i.e., in a lab setting, Cassady, 2004b; Putwain et al., 2014). The overarching view in this view of test anxiety is that the evaluative event itself does not impose a stressor that “blocks” retrieval of established knowledge for test anxious learners – rather the deficit comes from limitations in working memory, executive functioning, or self-regulation that preclude effective encoding (Owens, Stevenson, Norgate, & Hadwin, 2008).

### 1.2. Applied multidimensional model of cognitive test anxiety

While there has been clear evidence validating the presence of both skills deficit and anxiety blockage (or cognitive interference) “forms” of cognitive test anxiety, the standard strategies of assessment of cognitive test anxiety generally do not provide information regarding learner differences on the various dimensions of cognitive test anxiety that may influence student experiences. While some measures identify the different broad themes of test anxiety captured by these perspectives, in general the measurement models for test anxiety scales result in a single scale score for cognitive test anxiety (or worry). However, as Serrano-Pintado and Escolar-Llamazares (2014) recently argued, identifying differential profiles of test anxiety are essential to support effective treatment strategies. In their study, contrasting students with “rational anxiety” (students with poor coping and study skills who worry about tests) and “irrational anxiety” (students with good coping and study skills who *still* worry about tests) revealed that information about the “type” of anxiety can help isolate the most effective intervention strategies to support success (i.e., study skills interventions were only effective for those with “rational” anxiety).

The advancement we believe that was provided in Serrano Pintado and Escolar Llamazares’ (2014) approach to the treatment of test anxiety was afforded by using more individually-specific information when determining optimal test anxiety interventions. In early work focused on primarily unidimensional treatment strategies (i.e., skills training vs relaxation), results were generally underwhelming and showed limited success overall as applied to a general student population (Hembree, 1988). However, reviews of more contemporary intervention efforts have demonstrated promising results for test anxiety intervention strategies, particularly when the interventions employed combinatory intervention techniques (e.g., cognitive–behavioral approaches, skills training plus relaxation). Research attempting to organize and summarize the findings across the literature has suggesting five general categories of test anxiety interventions (behavioral, cognitive, cognitive–behavioral, study skills, and test-taking skills; e.g., Ergene, 2003; von der Embse, Barterian, & Segool, 2013). We believe that work in the measurement of test anxiety can support this positive trend toward intervention utility by helping practitioners more effectively parse the population of test anxious learners to identify the underlying “form” or “type” of test anxiety and subsequently provide more targeted prescribed interventions. Identification of the specific needs learners have related to test anxiety, test preparation, and test performance can help isolate the intervention or interventions that are most likely to support each individual’s success, and ideally lead to more efficient treatment implementation (Serrano-Pintado & Escolar-Llamazares, 2014).

### 1.3. Present investigation

The purpose of this study was to explore the potential of detecting differential representations of cognitive test anxiety among learners

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