ACADEMIC ANXIETIES: WHICH TYPE CONTRIBUTES THE MOST TO LOW ACHIEVEMENT IN METHODOLOGICAL COURSES?

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Abstract

Students' academic achievement in courses with a high mathematical content can be affected by their levels of trait, math and test anxiety. In this study, 180 university students were assessed on these types of anxiety and the relationships between them and students' performance were evaluated. Higher levels of math anxiety were related to a low academic achievement, but a high level of test anxiety was related only to an increase in the number of errors. Moreover, although women reported higher levels of trait, math and test anxiety than their male peers, their academic achievement was similar. We conclude that math anxiety is the main emotional factor that can affect students' performance in these courses and some proposals to help highly math-anxious students are discussed.

Key words: Math anxiety; Test anxiety; Trait anxiety; Academic performance; Higher education.

Introduction

Improving students' academic achievement is the main aim of educators at all academic levels (e.g., Rivkin, & Schiman, 2015; Sointu, Savolainen, Lappalainen, & Lamber, 2016). A great deal of effort has been expended on improving certain aspects of instruction and on helping students to develop strategies to enhance their learning skills (Aronson, 2002). A particularly important element of this approach is the study of emotional factors, because people's thoughts and feelings about their capacity to learn may have a strong bearing on their learning processes inside an educational setting (e.g., Steinmayr & Spinath, 2009). Among these emotional factors, anxieties that arise in academic context have a special relevance.

Cassady (2010a) used the term "academic anxieties" to refer to the collection of anxieties learners experience in academic settings. He focused on several types of anxiety (test anxiety, math anxiety, foreign language anxiety, science anxiety and so on) which may interfere with students' capacity to learn and hamper their ability to succeed in specific areas of knowledge and at all academic levels. In the present study, we focused on the impact of three types of anxiety on students' academic achievement in methodological courses. These types of course (e.g., Research designs, Statistics, etc.) are particularly difficult for university social sciences students (i.e., those studying degrees in Psychology, Science Education, Pedagogy, Sociology, etc.), many of whom feel totally unable to pass them (Onwuegbuzie, Slate, & Schwartz, 2001); this feeling of powerlessness increases the number of students who fail or drop out of the course (Núñez-Peña, Suárez-Pellicioni, & Bono, 2013). Moreover, it is not unusual to find students who postpone the completion of their degree because they have not passed their methodological courses (Paxton, 2006). Therefore, it would be important to identify the emotional factors that contribute the most to underachievement on these courses.

In the present study, we focused on three types of anxiety (namely, math, trait and test anxiety) that may influence students' academic achievement in a methodological course. Math anxiety was chosen because methodological courses, like the one used in this study (i.e., a Research Design course), have a high mathematical content: often, it is the mathematical content of these courses that students highlight as the main cause of their learning difficulties. Our main aim was to determine which of these types of anxiety have the greatest impact on students' performance in methodological courses. This knowledge will be useful to help instructors of these courses to design specific intervention programs focused on helping students who find them difficult due to the emotional reaction that they elicit.

Math anxiety is defined as "feelings of tension, apprehension or even dread that interfere with the ordinary manipulation of numbers and the solving of mathematical problems" (Ashcraft & Faust, 1994, p. 98). Students suffering from it feel they are incapable of doing activities and classes that involve numbers, feel low math self-confidence, experience no enjoyment of math, and obtain lower grades in math courses (Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016). Moreover, they tend to avoid math courses and degrees in the Science, Technology, Engineering and Mathematics (STEM) fields, thus missing out on important career and life opportunities (Foley et al., 2017). Several tests have been developed to measure math anxiety, and one of the most frequently used is the Shortened Math Anxiety Rating Scale (sMARS; Alexander & Martray, 1989). One of the main advantages of this scale is that it measures three dimensions of math anxiety: namely, *math test anxiety*, *numerical task anxiety* and *math course anxiety*. The first one refers to the anxiety caused by math exams, the second to the anxiety caused by the execution of any task that involves the handling of numbers, and the third to anxiety caused by mathematics courses. In the field of higher education, Núñez-Peña et al. (2013) analyzed the relationship between math anxiety, attitudes toward mathematics, and students' grades on a Research Design course. Students who failed this course showed a higher level of math anxiety (specifically on math test and math course anxiety) than those who passed it, and also reported negative attitudes toward math (low level of math enjoyment, motivation and self-confidence).

Whereas math anxiety is an anxious reaction in situations involving mathematics, trait anxiety is defined as a stable disposition to feel stress, worry, and discomfort in everyday situations (Spielberger & Sydeman, 1994). High trait anxious people tend to respond fearfully to a wide variety of unspecific stressors (Spielberger, 1972), and perceive more environment stimuli as threatening as compared to individuals with low trait anxiety (Mathews & MacLeod, 2005). In the field of education, higher levels of trait anxiety are associated with lower academic achievement (Mazzone et al., 2007).

As for test anxiety, it is a response characterized as tense, uneasy, disquieted, nervous and fearful in evaluative situations (Cassady, 2010b). Zeidner (1998) defined it as a phenomenological, physiological, and behavioral response that accompanies concern about possible negative consequences of failure on exams. It is widely accepted that test anxiety includes two components, *emotionality* and *worry* (Cassady, 2010a; Deffenbacher, 1980). Emotionality is a set of physiological responses in evaluative settings (i.e., galvanic skin response, elevated heart rates, feelings of panic, or disruption to sleep/rest; Stöber, 2004). The second component of test anxiety is worry, consisting of cognitive reactions and ruminations before, during and after an examination (e.g., making comparisons with other learners, worrying over the possibility of failing and its consequences, etc.; Cassady, 2004). In addition to emotionality and worry, Hodapp (1991) suggested that test anxiety included two other factors: *interference* and *lack of confidence*. In fact, he developed the German Test Anxiety Inventory (*GTAI*; Hodapp, 1991) which measures four dimensions of test anxiety: *emotionality, worry, interference* and *lack of confidence.* Interference refers to distractive thoughts or cognitive blocking that interrupt performance during exams, and lack of confidence is the students' low self-efficacy and self-confidence in their capacity of performing successfully on the exam.

As for the relationship between test anxiety and academic achievement, highly test-anxious students obtain lower examination grades than non-test-anxious students (Putwain, 2007, 2008). In this regard, worry has been shown to have a higher impact on performance than emotionality (Bandalos, Yates, & Thorndike-Christ, 1995), although the latter may increase worry because it can focus the student's attention on the physical manifestations of anxiety and divert it from test preparation and execution (Cassady, 2004; Deffenbacher, 1980).

The Attentional Control Theory (ACT; Eysenck, Derakshan Santos & Calvo, 2007) provides an excellent explanation for why anxiety (e.g., math, test and trait anxiety) hampers academic achievement. This theory was developed from the processing efficiency theory (PET; Eysenck & Calvo, 1992) and proposes that anxiety impairs attentional control, a key function of the central executive, by increasing attention to threat-related stimuli. These threat-related stimuli can be external (e.g., task-irrelevant distractors) or internal (e.g. ruminations and worries about poor performance in the task). Thus, according to this theory, the high levels of worry and low self-confidence of high anxious students might distract them in academic settings and prevent them from learning during the course and performing successfully in the exam.

In two meta-analyses, Hembree (1988, 1990) found that math, trait and test anxiety were positively related. The mean correlations reported were .38 between math anxiety and trait anxiety, .52 between math anxiety and test anxiety, and .53 between trait anxiety and test anxiety. As these correlations were moderate, the three anxieties are considered to be different constructs (e.g., Hembree, 1990). Moreover, as we have mentioned above, it is well established that higher levels of these three types of anxiety are associated with lower academic achievement (math anxiety particularly with math courses), but it is not known at present which of them (or which of their specific dimensions) has the greatest impact on students' academic achievement. The aim of the present study was to address this question by examining the association between math, trait and test anxiety (and their subscales) and academic achievement on a Research Design course in the degree of Psychology. In order to have access to more indicators of students' performance, they were evaluated with a multiple-choice test, which gave us not only the final mark in the exam but also measures of number of hits, errors and unanswered questions. The results of this study may help to broaden our understanding of the ways these three types of anxiety can affect academic achievement, and may help methodological course instructors to develop intervention programs that enable anxious students to control the effect that these academic anxieties have on their performance.

A key factor that any study of anxiety has to take into account is gender. Females usually report higher levels of anxiety than males, suggesting they tend to react more anxiously to various situations. These gender differences have been found for trait (de Visser et al., 2010; McCleary & Zucker, 1991), test (Putwain, 2007) and math anxiety (Else-Quest, Hyde, & Linn, 2010; Hembree, 1990). Given that women are more anxious than men and because highly-anxious students tend to have lower grades than their low-anxious peers, in the present study we also aimed to explore whether female students' academic achievement may be hampered by their anxiety.

Methods

Participants

Participants were 180 second-year students enrolled in the compulsory Research Design course in the Psychology degree at the University of Barcelona during the 2015-2016 academic year. One hundred and thirty-six were women (75.6%, mean age 21.32 years, SEM = .27, range = 18-40) and 44 were men (24.4%, mean age of 25 years, SEM = 1.39, range = 19-51). All participants gave written informed consent before participating in the study.

Materials

Participants were administered the following tests:

Shortened math anxiety rating scale *(sMARS*; Alexander & Martray, 1989). The sMARS measures math anxiety with 25 items that represent situations that may cause math anxiety. Participants have to decide on the level of anxiety that each situation causes them on a five-point Likert scale ranging from 1 (no anxiety) to 5 (high anxiety). The total score for the test is the sum of the item scores with a minimum 25 and a maximum 125. Three factors are measured by the sMARS: math test anxiety (MTA), numerical task anxiety (NTA) and math course anxiety (MCA). The MTA scale consists of 15 items that measure concern about sitting a math exam or about future math exam grades (scores range from 15 to 75). The NTA scale consists of five items reflecting concern about having to perform numerical operations (scores range from 5 to 25). The MCA scale comprises five items that measures worry in math courses (scores range from 5 to 25). In the present study, the sMARS adapted to the Spanish population was used, whose psychometric properties have been demonstrated (Cronbach's alpha = .94

and 7-week test-retest reliability = .72; Núñez-Peña, Suárez-Pellicioni, Guilera, & Mercadé-Carranza, 2013). Reliability measures calculated for the data of the present study ranged from good to excellent for the sMARS and its subscales (Cronbach's alphas were .93 for the sMARS global scores, and .92, .86 and .82 for the MTA, NTA and MCA subscale scores respectively).

State-trait anxiety inventory *(STAI;* Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The STAI is a 40-item scale that measures general anxiety and comprises two subscales: the STAI-S to evaluate state anxiety, and the STAI-T to evaluate trait anxiety. Only the STAI-T subscale was used in this study. This subscale assesses how participants feel in general by answering 20 items describing different emotions on a four-point Likert scale (ranging from 0 "almost never" to 3 "almost always"). The scores on the scale range from 0 to 60. The Spanish version of the STAI-T (Spielberger, Gorsuch, & Lushene, 2008) was used in the present study (Cronbach's alpha = .95, and 20-day test-retest reliability with college students = .86). The STAI-T reliability was excellent (Cronbach's alpha = .91) for the data of the present study.

German test anxiety inventory (*GTAI*; Hodapp, 1991). In this 30-item test anxiety questionnaire, respondents use a four-point Likert scale (ranging from 1 "hardly ever" to 4 "nearly always") to indicate how they feel when sitting an exam. The score ranges from a minimum of 30 to a maximum 120. It has a four-factor structure: Emotionality, Worry, Interference and Lack of confidence. Emotionality (GTAI-E; range: 8-32) is measured by eight items related to perceptions of physiological arousal (e.g., "I feel anxious"). Worry (GTAI-W; range: 10-40) is measured by ten items related to thoughts about negative consequences of poor performance (e.g., "I think about how important the test is to me"). Interference (GTAI-I; range: 6-24) is measured by six items related to distractive thoughts or cognitive blocking (e.g., "Suddenly thoughts cross my mind which inhibit me"). Lack of confidence (GTAI-LC; range: 6-24) is measured by six items related to negative beliefs concerning students' own capacity to perform adequately in a test (e.g., "I trust in my performance" (item inverted)). In the present study, the Spanish adaptation of GTAI was used, which has an excellent alpha coefficient of 0.90 (Sesé, Palmer, & Pérez-Pareja, 2010). Reliabilities were calculated with the data of the present study, for both the GTAI and its subscales, and presented values from adequate to excellent (Cronbach's alphas were .81 for the GTAI scores and .90, .87, .76 and .93 for the GTAI-E, GTAI-W, GTAI-I and GTAI-LC scores respectively).

Multiple-choice exam. At the end of the academic year, students' learning in the Research Design course was assessed through an individual multiple-choice final exam. This is a fourth-semester compulsory course with a high mathematical content taught on the Psychology degree at the University of Barcelona. The objective of the course is to train students to carry out their own research in the field of Psychology, and special emphasis is placed on the statistical techniques most frequently used in research designs. By the end of the year, students are expected to be able to perform statistical analyses and interpret the results appropriately.

The exam consisted of 30 questions on two practical cases (15 questions per case), in which two psychological studies were described and the corresponding data were provided. For each case, students had to perform a statistical analysis with the SPSS software and had to answer questions on methodological aspects (e.g., "Which research design was used in this case?) and the statistical analysis and results (e.g., "What statistical technique should be used for this data analysis?", "What *p-value* allows you to study the treatment effect?"). Each question in the exam had four possible answers, and errors were penalized to avoid random hits. Cronbach's alpha for dichotomous items (KR20) was calculated and an adequate reliability was found for the exam (Cronbach's alpha = .76).

Procedure

At the beginning of the 2015-2016 academic year, students completed the three questionnaires (sMARS, STAI and GTAI) during class time as a voluntary activity in the Research Design course. At the end of the course, students performed the individual final multiple-choice answer exam to assess their learning on this course. Our participants were the students who completed the questionnaires and performed the final exam.

Data Analysis

Data analysis was conducted using SPSS v23. First, Spearman correlation analysis were performed to study the relationship between the global anxiety scores (math anxiety, test anxiety and trait anxiety) and subscales' scores of the three anxiety inventories. Then, the relationship between these anxiety scores and students' performance in the Research Design course was computed by the same statistical test. In this analysis, four measurements of students' performance (grades, hits, errors and non-answered questions) were assessed. Relationships between students' performance and the different types of anxiety score were also analyzed by regression analysis. Finally, gender differences for both anxiety and performance measurements were studied. Due to our unequal number of men and women, we first checked whether our data met the homogeneity of variances assumption by means of Levene's test. If so, gender comparisons were performed by means of independent *t-tests*; otherwise, Welch's *t-test* for unequal variances (or unequal variances *t-test*) was used.

Results

Relationship Between Test Anxiety, Math Anxiety and Trait Anxiety: Correlational Analysis

In this section, we show the relationship between the different global anxiety scores (test, math and trait anxiety) and their subscales' scores. The Spearman correlational analysis displayed in Table 1 showed that the three types of anxiety were positively related in both their global scores and their subscales' scores. Means and standard deviation for the three anxiety scales and their subscales' scores are given in Table 2.

Insert Tables 1 and 2 approximately here

Relationships Between Students' Performance and The Different Types of Anxiety Scores: Correlational Analysis

The relationship between the four measures of students' performance on the multiple-choice exam (grades, hits, errors and non-answered questions) and their level of anxiety was explored by means of Spearman correlations (results are shown in Table 3). Concerning math anxiety, the global sMARS scores were negatively related to grades (r = -.297) and number of hits (r = - .290), and positively related to number of errors (r = .203) and unanswered questions (r = .254). When the sMARS subscales were analyzed, results showed that the higher the level of MTA and MCA, the lower the grades and the number of hits, and the higher the number of errors and unanswered questions. The pattern of results changed for the NTA subscale; their scores were only positively related with the number of unanswered questions (r = .175). As for test anxiety measures, only global GTAI and GTAI-I scores were positively related to the number of errors on the multiple-choice exam (r = .158 and r = .170 respectively). Test anxiety was unrelated to the other achievement measures (grades, number of hits and number of unanswered questions). Similarly, trait anxiety was not statistically related to any achievement measurements.

Insert Table 3 approximately here

Relationships Between Students' Performance and The Different Types of Anxiety Scores: Regression Analysis

We applied stepwise multiple regression analysis to determine which predictor variables explained significant amounts of variance in grades, hits, errors and unanswered questions. The predictor variables in the regression model were sMARS, GTAI and STAI-T scores:

$$\text{Grade} = b_0 + b_1\text{sMARS} + b_2\text{GTAI} + b_3\text{STAI-T} + e \quad (1)$$

$$\text{Hits} = b_0 + b_1\text{sMARS} + b_2\text{GTAI} + b_3\text{STAI-T} + e \quad (2)$$

$$\text{Errors} = b_0 + b_1\text{sMARS} + b_2\text{GTAI} + b_3\text{STAI-T} + e \quad (3)$$

$$\text{Unanswered} = b_0 + b_1\text{sMARS} + b_2\text{GTAI} + b_3\text{STAI-T} + e \quad (4)$$

where b_0 is the constant, b_i are the unstandardized estimated coefficients in the regression analysis for each of the aforementioned predictor variables and e is the error term. The unstandardized estimated coefficients represent the predicted change in exam performance (grade, hits, errors or unanswered questions) for a one-unit change in the predictor variable. The estimated coefficients and *t*-statistics of equations 1, 2, 3 and 4 are presented in Table 4. The results showed that the sMARS score was the only significant predictor of grades, hits and unanswered questions (all p <.001), accounting for 8.7, 8.3 and 6.2 % of the variance respectively. The only significant predictor of the number of errors was the GTAI score (p = .033), although the sMARS predictor approached significance (p = .081).

Insert Table 4 approximately here

Differences Between Genders

The assumption of homogeneity of variances was violated for the NTA scores (F(1,178) = 5.587, p = .019), so Welch's *t-test* for unequal variances was used to analyze gender differences in this variable. Gender differences for the other variables were studied by means of independent *t-tests*. Women showed a greater level of mathematical anxiety (t(178) = 3.56, p < .001), MTA (t(178) = 3.66, p < .001) and NTA t(178) = 2.91, p = .004) than males. Moreover, women tended to score higher on the MCA (t(178) = 1.66, p = .09). For test anxiety, women had higher global scores on the GTAI than their male peers (t(178) = 3.84, p < .001), as well as higher levels on the GTAI-E (t(178) = 3.26, p = .001), GTAI-W (t(178) = 2.46, p = .015) and GTAI-LC (t(178) = 3.81, p < .001). Finally, for trait anxiety, women again tended to be more anxious than their male counterparts (t(177) = 31.88, p = .06). Despite this higher anxiety in women, however, no differences between genders were found in academic performance; only one gender comparison approached significance, showing a tendency for females to commit more errors than their male peers (t(162) = 1.69, p = .09). Means and standard errors for all performance measures, separated by gender, are given in Table 5.

Insert Table 5 approximately here

Discussion

General Discussion

The main objective of this study was to explore the possible effects of math anxiety, test anxiety and/or trait anxiety (and their dimensions) on students' academic achievement in a methodological course with a high mathematical content. Moreover, since women are in general more anxious than men, we also wanted to explore whether their increased level of anxiety may harm their performance on such courses.

The findings revealed the expected relationships between trait, test and math anxiety. In agreement with previous research (Hembree, 1988; Hembree, 1990), positive correlations were found between all of them, in both their global and their subscale scores. Importantly, and despite the fact that the three types of anxiety were related to each other, the academic achievement measurements were mainly related to the math anxiety scores. Specifically, students with higher scores on the global sMARS and the math test and math course anxiety subscales obtained lower grades in the course. Moreover, these students made fewer hits, committed more errors and left more questions unanswered in their tests than their lower math-anxious peers. It is worth noting that although test anxiety (specifically, the GTAI and GRAI-I scores) were positively related to the number of errors on the test, students' final grades were not related to any test anxiety score. Regression analysis confirmed that the only predictor for grades was the sMARS score. These findings suggest that math anxiety is the main emotional factor that hampers academic achievement on this methodological course. These results are consistent with those of Núñez-Peña et al. (2013), who found that students who failed a methodological course showed higher levels of mathematical anxiety (more specifically, of math test and math course anxiety). The numerical task anxiety factor was not related to failing or passing the course in Núñez-Peña et al.'s study nor was it related to our students' grades. This factor includes items referring to the uses of mathematics in daily settings (e.g., "Reading a cash register receipt after making a purchase"), and so we did not expect an association with having lower grades (or failing) in the Research Design course. Instead, both studies showed that academic achievement is related only to aspects of math anxiety in academic settings (i.e., taking a course or being assessed in mathematics).

Several explanations can be put forward to explain why students high in math anxiety have low performance in methodological courses (for a review of possible explanations of the relationship between math anxiety and math performance, see

Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016). According to the processing efficiency theory (PET; Eysenck & Calvo, 1992), the anxious reaction (i.e., worrying intrusive thoughts) consumes the limited attentional resources of the central executive of working memory and, therefore, highly-anxious individuals have fewer resources available to perform the task properly. The term “working memory” (WM) refers to a temporary, limited capacity system that integrates, computes, stores, and manipulates the information required to perform important cognitive tasks as reasoning, comprehension, and learning (Baddeley, 1983). Ashcraft and colleagues (Ashcraft & Faust, 1994; Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007) extended the PET theory to the math anxiety field, suggesting that the interfering thoughts about their low self-efficacy in math would make math-anxious individuals consume valuable working memory space on perform the math task, thus preventing them from performing the task properly (i.e., as they were unable to focus on their negative thoughts and on their task at once, they would underperform on the main task).

Another proposal to explain why high math-anxious students have low performance in math is that they might be unable to focus their attention on relevant information and thus inhibit irrelevant information (i.e., they may be more vulnerable to distraction in numerical tasks: Hopko, Mcneil, Gleason, & Rabalais, 2002; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2014). This proposal is based on the attentional control theory (ACT; Eysenck et al., 2007), which was developed from the PET. The main assumption of the ACT is that anxiety affects two executive functions of the WM that involve attentional control: inhibition, and shifting.

All in all, our students with high math anxiety might have lower academic achievement because their attentional/working memory resources may be devoted to the anxious reaction (i.e., worrying and intrusive thoughts about their low self-efficacy) generated by the course content (i.e., the math task). This anxious reaction may distract them during classes and the test preparation as well as during the examination phase, and so their performance in the course would worsen. This explanation (which is based on the previous proposals) may help us account for the results of this study, but as working memory was not measured we do not know whether it was actually involved in the relationship we found between math anxiety and performance. Future studies may want to investigate the role that working memory plays in explaining the low academic achievement of highly math-anxious students in academic settings.

Finally, although females reported higher trait, test and math anxiety than males (in agreement with previous studies; de Visser et al, 2010; Hembree, 1990; McCleary & Zucker, 1991; Putwain, 2007), their academic achievement was not worse than that of their male peers. This absence of gender differences in academic achievement corroborates previous reports; although women experience more math anxiety than men, these higher levels do not appear to affect mathematics performance, as the differences are small or non-existent (Else-Quest et al., 2010; Hyde, Lindberg, Linn, Ellis, & Williams, 2008).

Why, then, does the higher degree of anxiety in female students not affect their academic achievement in methodological courses? Several possible explanations can be put forward. First, female students may be more willing to admit their feeling of anxiety than males because it is less socially acceptable for men to communicate emotions of this kind (i.e., men may feel inhibited about reporting symptoms of anxiety; Bekker & van Mens-Verhulst, 2007). Second, and in the case of math anxiety, female students may be more likely to answer questionnaires in view of the long-held stereotype that women are less skilled in mathematics than men (Steffens, Jelenec, & Noack, 2010; Steffens & Jelenec, 2011): statements like “Girls and mathematics are a bad fit” or

"Mathematics is clearly a male domain" are socially accepted and constitute the basis for the stereotype threat for women. It has been suggested that these stereotypes might lead women to avoid careers that require high mathematical knowledge (i.e., the STEM disciplines; Miller, Eagly, & Linn, 2015). A third explanation for why the higher levels of anxiety in women might not affect their academic achievement is that they might use efficient coping strategies that would help them to manage stress and regulate their behavior (Panyiotou, Karekla & Leonidou, 2017). In the exam situation, highly-anxious female students may deploy useful coping strategies that help them to maintain their academic performance in methodological courses.

Recommendations

So, what can instructors do to help these high math-anxious students in methodological courses? How can they avoid or mitigate the impact their students' anxious responses can have on their academic achievement? Several measures can be applied (for a review of some of them, see Suárez-Pellicioni et al., 2016), but here we focus on the ones that are suitable in the context of higher education. It is important to note that math anxiety impacts mainly on two phases of the "learning-testing cycle" (Cassady, 2004). First, it can affect the *test preparation phase*, where high math-anxious students may have deficits in encoding, organizing and storing the course content due to their anxiety (Mueller, 1980). Second, it can affect the *test performance phase* (i.e., the time period during which the student completes the examination). Instructors can introduce measures to help their students in both phases.

In the *test preparation phase*, math-anxious students may engage in ineffective preparatory strategies driven by their low self-confidence and feeling of helplessness with regard to understanding the course content. Obviously, ineffective strategies during the preparation phase are likely to lead to failure in the test. Instructors during this phase can help highly anxious students to build up competencies for more efficient learning and performance. Núñez-Peña, Bono and Suárez-Pellicioni (2015) demonstrated the effectiveness of a formative assessment system to improve high math-anxious students' academic achievement in a methodological course. This system consisted of providing students with information on their performance in a series of assignments carried out during the course, focusing mainly on their mistakes. In this way, students can learn from their errors, thus avoiding them (or similar ones) in the future, gaining self-confidence and reducing their worry about their ability to perform well in the course. In fact, several studies have demonstrated that highly math-anxious individuals are more worried about committing errors in numerical tasks than in non-numerical tasks (Núñez-Peña, Tubau, & Suárez-Pellicioni, 2017; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2013). Thus, a formative assessment system of this kind based on feedback on errors might help highly math-anxious students to approach errors without worrying or thinking negatively about them, and may raise their confidence in their ability to engage in the test with success.

During the preparation phase, instructors should also take care not to transmit the message that the course is very difficult and may be too hard for some people who are "not good at math" (Beilock & Willingham, 2014). This message may validate the idea that those who are "bad at math" have no chance of passing the course, thus lowering highly math-anxious students' motivations and expectations. Instead, the message should be that although some students may believe the course is difficult, working hard and making an effort will help them to overcome these difficulties. The relation between self-efficacy (in this case, the confidence in one's ability to engage in math with success) and math anxiety has been widely demonstrated (e.g., Cooper & Robinson, 1991; Meece, Wigfield, & Eccles, 1990), so it is important to avoid sending messages that threaten self-efficacy in highly math-anxious individuals.

Instructors on methodological courses can also introduce measures to help students to deal with their math anxiety in the *test performance phase*. Three studies merit attention here. First, Park, Ramirez and Beilock (2014) showed that writing before an exam (during 10 minutes) about emotions (i.e., thoughts and feelings regarding the upcoming test) reduced the difference in performance between low and high math anxiety students. They suggested that expressive writing before a test would release the working memory from worries and negative thoughts that might capture the attention during the test, helping highly math-anxious students to demonstrate their true competency in the subject evaluated. Ramirez and Beilock (2011) demonstrated that this brief intervention was also useful to improve grades for students anxious about taking exams. The second intervention that has been shown to help highly math-anxious students to regulate their negative emotions before a math test situation is a brief focused breathing exercise (Brunyé et al. 2013) in which students are guided through instructions that center their attention on the sensations of inhalation and exhalation. Brunyé et al. showed that this exercise allowed highly math-anxious individuals to approach the performance levels of their low math-anxious counterparts in an arithmetic test. Finally, the third intervention consists of giving specific instructions to students in order to influence the way they interpret the physically arousing response in test situations and thus free up their working memory resources for the upcoming test. For instance, Jamieson, Mendes, Blackstock and Schmader (2010) found that simply instructing participants that arousal would not hinder their performance, and might actually improve it, helped them to achieve better grades on the Graduate Record Examination (GRE)-math exam compared to control participants. These three brief interventions are relatively easy to implement and can be used by instructors before an exam to help students overcome the detrimental effects of math anxiety on their performance.

Limitations and Future Directions

The present study has some limitations that should be highlighted. First, although math anxiety was the main factor associated with students' academic achievement, the present study was correlational in nature, so we cannot establish a direct causal relationship between high level of math anxiety and underachievement. Math anxiety is a personal trait that cannot be experimentally manipulated, and so this limitation is difficult to resolve; but it is essential to bear it in mind and to be careful interpreting the results. Second, we did not examine potential moderators between math anxiety and academic achievement (e.g., working memory, self-concept, intelligence, academic engagement, attitudes towards mathematics, etc.); future research should address their possible role in the association between math anxiety and academic achievement. For example, Sesé, Jiménez, Montaño, and Palmer (2015) found that students who achieved better on statistics courses had a more positive attitude towards the subject, and that attitudes were negatively affected by anxiety. Thus, attitudes play a mediating role on the relationship between anxiety and performance. Finally, the majority of students in our sample were female (76%). This was due to the fact that our study focused on the difficulties that social sciences students have in methodological courses, and students enrolled in the Psychology degree are predominantly women. This overrepresentation of female students is a general feature of social sciences studies (Blackburn, 2017; Shapiro & Sax, 2011); therefore, a sample with 50% men and 50% women would be unrepresentative of the social sciences student population. Future research might want to replicate the current study in other degrees where the proportion of women and men is more similar.

Conclusion

To conclude, and despite the limitations just mentioned, this study demonstrated that math anxiety is the emotional aspect that seems to have the greatest effect on academic achievement in a methodological course. Students high in math anxiety obtained lower grades, probably because the thoughts and ruminations about their low self-efficacy with math distracted them from the main task. This anxious response may affect learning during the test preparation period and/or their performance during the test itself. Importantly, no gender differences emerged for academic achievement, even though female students reported higher levels of trait, test and math anxiety than their male counterparts. This may be because females are more willing than males to admit to their anxious symptoms and may have developed efficient coping strategies to deal with this situation.

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Table 1. Correlation coefficient values (Spearman's rho) between the anxiety scores and the subscale scores.

Anxiety measures	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. sMARS	-								
2. MTA	.942**	-							
3. NTA	.623**	.421**	-						
4. MCA	.816**	.675**	.505**	-					
5.GTAI	.419**	.440**	.221**	.255**	-				
6.GTAI-E	.401**	.427**	.229**	.204**	.850**	-			
7.GTAI-W	.279**	.318**	.084	.177*	.783**	.539**	-		
8.GTAI-I	.290**	.253**	.249**	.244**	.612**	.423**	.270**	-	
9.GTAI-LC	.313**	.323**	.148*	.184*	.762**	.551**	.429**	.511**	-
10.STAI-T	.344**	.334**	.225**	.208**	.702**	.585**	.522**	.478**	.592**

* $.05 \geq p > .001$; ** $p \leq .001$

Note. sMARS: Shortened Math Anxiety Rating Scale; MTA: Math Test Anxiety factor; NTA: Number Task Anxiety factor; MCA: Math Course Anxiety factor; GTAI: German Test Anxiety Inventory; GTAI-E: Emotionality factor; GTAI-W: Worry factor; GTAI-I: Interference factor; GTAI-LC: Lack of Confidence factor; STAI-T: Trait anxiety factor from the State-Trait Anxiety Inventory.

Table 2. Means and standard error (in brackets) for all the anxiety measures.

	sMARS	MTA	NTA	MCA	GTAI	GTAI-E	GTAI-W	GTAI-I	GTAI-LC	STAI-T
Global	67.18 (1.16)	48.94 (.81)	8.69 (.27)	9.86 (.46)	70.86 (1.15)	18.48 (.44)	29.15 (.48)	9.53 (.24)	13.86 (.31)	23.04 (.80)
Women	69.47 (1.26)	50.59 (.87)	9.08 (.326)	10.29 (.57)	73.30 (1.28)	19.27 (.51)	29.82 (.52)	9.68 (.26)	14.51 (.35)	23.89 (.93)
Men	60.09 (2.51)	43.86 (1.79)	7.48 (.44)	8.52 (.57)	63.32 (2.27)	16.02 (.75)	27.09 (1.11)	9.07 (.57)	11.82 (.56)	20.37 (1.58)

Note. sMARS: Shortened Math Anxiety Rating Scale; MTA: Math Test Anxiety factor; NTA: Number Task Anxiety factor; MCA: Math Course Anxiety factor; GTAI: German Test Anxiety Inventory; GTAI-E: Emotionality factor; GTAI-W: Worry factor; GTAI-I: Interference factor; GTAI-LC: Lack of Confidence factor; STAI-T: Trait anxiety factor from the State-Trait Anxiety Inventory.

Table 3. Correlation coefficient values (Spearman's rho) between the performance measurements in the Research Design course and the different anxiety scores.

	sMARS	MTA	NTA	MCA	GTAI	GTAI-E	GTAI-W	GTAI-I	GTAI-LC	STAI-T
Grades	-.297**	-.296**	-.116	-.278**	-.129	-.076	-.067	-.107	-.107	-.018
Hits	-.290**	-.286**	-.117	-.275**	-.123	-.066	-.068	-.087	-.151	-.017
Errors	.203**	.221**	.028	.194*	.158*	.145	.060	.170*	.137	.047
Unanswered	.254**	.229**	.175*	.230**	.027	-.043	.056	-.062	.094	-.005

* $.05 \geq p > .001$; ** $p \leq .001$

Note. sMARS: Shortened Math Anxiety Rating Scale; MTA: Math Test Anxiety factor; NTA: Number Task Anxiety factor; MCA: Math Course Anxiety factor; GTAI: German Test Anxiety Inventory; GTAI-E: Emotionality factor; GTAI-W: Worry factor; GTAI-I: Interference factor; GTAI-LC: Lack of Confidence factor; STAI-T: Trait anxiety factor from the State-Trait Anxiety Inventory.

Table 4. Stepwise multiple regression results.

	Grade		Hits		Errors		Unanswered	
Predictors	Estimated Coefficient	*t*-Ratio	Estimated Coefficient	*t*-Ratio	Estimated Coefficient	*t*-Ratio	Estimated Coefficient	*t*-Ratio
Constant	9.743	14.387**	29.304	16.179**	0.616	0.495	0.049	0.041
sMARS	-0.030	-3.531**	-0.078	-3.428**	0.027	1.757	0.051	3.370**
GTAI	-0.015	-1.401	-0.039	-1.335	0.043	2.156*	-0.004	-0.233
STAI-T	0.025	1.644	0.063	1.529	-0.044	-1.570	-0.018	-0.651

Note. sMARS: Shortened Math Anxiety Rating Scale; GTAI: German Test Anxiety Inventory; STAI-T: Trait anxiety factor from the State-Trait Anxiety Inventory.

* $p < .05$; ** $p < .001$

Table 5. Means and standard error (in brackets) for all the performance measures separated by gender.

	Grade	**Hits**	**Errors**	**Unanswered questions**
Women	7.3 (.14)	22.87 (.36)	4.33 (.24)	2.80 (.23)
Men	7.1 (.27)	22.32 (.75)	5.21 (.48)	2.47 (.49)