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# Sex differences in the relation between statistics anxiety and cognitive/learning strategies

Bertha Rodarte-Luna, Alissa Sherry *

*Department of Educational Psychology, University of Texas at Austin, 1 University Station D5800, Austin, TX 78712, USA*

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**Abstract**

Three hundred twenty three students were recruited in order to investigate sex differences on measures of statistics anxiety and learning strategies. Data was analyzed using descriptive discriminant analysis and canonical correlation analysis. Findings indicated that sex differences on these measures were statistically significant, but with small effect sizes. However, the relationship between statistics anxiety and learning strategies varied between men and women. Men showed a much more clear relationship where procrastination was positively related to fear of asking for help and organization, peer learning, and procrastination was positively related to test and class anxiety and interpretation anxiety. For women, all of the learning strategies except procrastination and peer learning were negatively related to aspects of statistics anxiety. Procrastination was positively related to statistics anxiety. Results are discussed evaluating the role of procrastination as a means of avoiding anxiety. Suggestions are provided to instructors based in the framework of exposure to the anxiety-provoking stimulus (statistics) as a means of helping students maximize their potential in statistics courses.
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*Keywords:* Statistics anxiety; Learning strategies; Sex differences

## 1. Introduction

Statistics anxiety is a pervasive problem in the teaching of statistics courses (Birenbaum & Eylath, 1994; Gal & Ginsburg, 1994; Zeidner, 1991). Approximately 66–80% of graduate students experience statistics anxiety (Onwuegbuzie & Wilson, 2003) and

* Corresponding author. Fax: +1 512 475 7641.
*E-mail address:* alissa.sherry@mail.utexas.edu (A. Sherry).

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some researchers propose that many students identify statistics courses as the most anxiety-inducing courses in their academic curriculums (Zeidner, 1991). Such anxiety has led many students to dread taking statistics courses and postpone taking them until the end of a degree program (Roberts & Bilderbeck, 1980). Statistics anxiety may even hinder a student from completing a degree or deter a talented student from thinking about a career as a professor (Onwuegbuzie, 1997). Further complicating the issue is the fact that students often self-select to fields or careers in which they feel most comfortable or efficacious. For example, math anxiety in women has been shown to correlate negatively with an interest in scientific careers (Chipman, Krantz, & Silver, 1992). However, particularly in fields like educational psychology or counselor education, students who are attracted to the counseling/humanistic aspects of the field may underestimate the extent to which scientific methods and procedures, like statistics, are employed. If this creates anxiety for them, they may engage in an active avoidance of such classes for as long as possible (Maner & Schmidt, 2006). This is concerning since such postponement likely increases anxiety about the topic. In addition, anecdotal evidence indicates that curriculum sequences are often organized in a way that helps the student capitalize on their learning experiences. Waiting until the end of a degree program to take statistics could potentially compromise one's understanding of their chosen field, a likelihood even more true for graduate students.

Some researchers indicate that statistics anxiety may have its origin in a student's experience with mathematics and related math anxiety (Zeidner, 1991). Self-perceived math ability has been found to be related to statistics anxiety (Rounds & Hendel, 1981) and both math anxiety and statistics anxiety have been found to be a two-factor construct (test anxiety and content-specific anxiety) (Rounds & Hendel, 1981; Zeidner, 1991). Although statistics anxiety is distinct from mathematics anxiety, there is some evidence that the two constructs are related (Onwuegbuzie, Daros, & Ryan, 1997). In fact, prior research conducted on math anxiety is a good place to begin understanding statistics anxiety. For example, math self-concept and previous math experience has been shown to be negatively related to statistics anxiety (Baloglu, 2003; Bandalos, Yates, & Thorndike-Christ, 1995), however the pathways for how math self-concept is related to statistics anxiety has been shown to differ between men and women (Bandalos et al., 1995). Overall, it is important to remember that math and statistics are different, particularly in terms of understanding their applications. As such, the anxiety associated with math and the anxiety associated with statistics is not understood to be perfectly correlated or to have identical etiologies. Therefore, the importance of understanding statistics anxiety as a separate entity remains.

While general anxiety involves both a cognitive and affective component (Liebert & Morris, 1967; Morris, Davis, & Hutchings, 1981), research suggests that the cognitive perspective is the most influential in test anxiety and course performance (Morris et al., 1981; Sarason, Sarason, & Pierce, 1990). For example, a high-test anxious person must divide his or her attention between self-evaluation (e.g., "I'm worried I'm not going to perform well") and task relevant factors during an examination (i.e., computation; problem solving). As anxiety consumes a portion of a student's processing capacity, it thus leaves a smaller portion for learning and problem solving (Wine, 1980). As such, researchers agree that there is a significant relationship between statistics anxiety and performance (Lalonde & Gardner, 1993; Onwuegbuzie & Seaman, 1995; Onwuegbuzie & Wilson, 2003; Zanakis & Valenza, 1997).

### 1.1. Cognitive/learning strategies

The extent to which students cognitively process academic material effectively depends on the learning strategies that are employed. However, studies investigating statistics anxiety and learning strategies are limited. Investigating the ways in which these two constructs are related makes sense considering the cognitive aspect of anxiety thought to persist in academic-type anxiety (Morris et al., 1981; Sarason et al., 1990; Wine, 1980). For example, learning strategies focused on the learner's self-directed process of maintaining thoughts and behaviors to reach one's academic goals have been associated with an increase in computational skills (Schunk, 1983), mathematical achievement (Ascher, 1985), and comprehension. In addition, research shows that such self-regulation increases motivation and may decrease test anxiety (Zimmerman & Schunk, 1989). Research also suggests that rehearsal and practice may improve performance although typically at the expense of efficiency (Shute, Gawlick, & Gluck, 1998). Students who perform well in statistics classes tend to utilize learning strategies such as self-monitoring, visualization, relating the material to the real world, and keeping up with the material more than students who do not perform well. These strategies tended to discriminate between high and low performers in statistics courses in that both groups utilized memorization, working through problems, reading, highlighting and studying the text, and reviewing notes about equally (Schutz, Drogosz, White, & DiStefano, 1998). However, these studies did not assess the extent to which anxiety was related to the selection of cognitive or learning strategies.

One cognitive strategy that might be related to statistics anxiety is procrastination. There are some indications that general academic procrastination may be associated with statistics anxiety, but little research exists (Onwuegbuzie, 2000, 2004). However, procrastination may be a viable, though likely ineffective cognitive strategy for some students. Onwuegbuzie (2004) observed that in a sample of graduate students enrolled in an introductory level educational research course, academic procrastination was related to a fear of failure and task aversiveness. Additionally, this relationship predicted several aspects of statistics anxiety including worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of the statistics instructor. Procrastination has also been shown to be related to interpretation anxiety, fear of asking for help, and fear of statistics teachers when considered in combination with trait anxiety and intrapersonal perfectionism (Walsh & Ugumba-Agwunobi, 2002). However, its relation to other learning strategies in the prediction of statistics anxiety is unknown.

### 1.2. Sex differences

Of considerably more controversy is the role of sex differences in math or statistics interest, achievement, and related anxiety in these academic areas. Overall, relatively few studies have been conducted on the sex differences of statistics anxiety and most hypotheses about statistics anxiety are garnered from math and test anxiety studies. In general, studies appear to support the notion that women report more test anxiety than men (Bradley & Wygant, 1998; Demaria-Mitton, 1987; Fulk, 1998; Hembree, 1988; Hojat, 1999; Rozendaal, Minnaert, & Boekaerts, 2003; Williams, 1996).

Research on math anxiety and learning has progressed to the point of being able to identify some sex differences in domain-specific learning strategies. For example, Bandalos et al. (1995) found that women with higher levels of math self-concept were more likely to attribute success in statistics to behavioral causes while those with lower levels of math self-concept attributed success in statistics to external causes. On the other hand, men who attributed failure to external causes were more likely to worry about their statistical abilities. High school women reported higher math anxiety although women and men did not differ in their math self-efficacy (Pajares & Kranzler, 1995). These differences in math and statistics anxiety persist with little evidence to suggest it is related to performance. Hall, Davis, Bolen, and Chia (1999) found no sex differences in math performance in 5th and 8th grade students and no sex differences in statistical performance for students in an urban environment was found in an earlier study by Fenster (1992). Additionally, stereotype threat may also explain these differences. Stereotype threat refers to "the immediate situational threat that derives from the broad dissemination of negative stereotypes about one's group—the threat of possibly being judged and treated stereotypically, or of possibly self-fulfilling such a stereotype" (Steele & Aronson, 1995, p. 798). Research has supported the notion that stereotype threat exists in women given that the culture sees math and math-related topics as largely a "male" academic pursuit (Inzlicht & Ben-Zeev, 2000; Keller & Dauenheimer, 2003; Quinn & Spencer, 2001; Schmader, Johns, & Barquissau, 2004; Spencer, Steele, & Quinn, 1999). While other theories offer explanations for why men outperform women on math tests (e.g., socialization theories, inherent ability theories, educational resource theories), the stereotype threat hypothesis may also provide insight into the anxiety that accompanies outperformance (or perceived outperformance). It does so by accounting for the additional social pressure women may feel to not confirm to the stereotype of a woman who does poorly in math. Such additional pressure might be an additional contributor to statistics anxiety (Schmader & Johns, 2003).

Other researchers suggest that math anxiety are experienced by both sexes, but just in different ways. Haynes, Mullins, and Stein (2004) found no sex differences in math anxiety, but did find sex differences between math anxiety and various specific factors. For example, math anxiety for men was more likely to be related to general test anxiety and ACT math scores. Men were also more likely to have an inverse relationship between math anxiety and ACT math scores. However, for women, higher math anxiety was associated with less perceived math ability and a lower perception of their high-school math teachers' teaching ability. Interestingly, there was a positive correlation between their math anxiety and their ACT math scores. As scores increased, so did their math anxiety levels. Miller and Bichsel (2004) found math anxiety to be a factor in math calculation and applied math performance for women but only in math calculation performance in men.

Available research comparing men and women on general learning strategies is more scant and even less conclusive. While one study suggested men are more likely than women to possess more superficial learning strategies, such as memorization or rote-learning (Niemivirta, 1997), other studies indicate men more often show a deep level approach to learning where women display more surface level processing (Rozendaal et al., 2003; Slaats, 1999). Women have been shown to be more likely than men to persist in getting an answer correct in a sample of 6th graders (Vermeer, 1997) although what motivates women and men to persist in such situations also appears to differ by sex (Bartlett, 1994). Another study indicated that women implemented significantly more strategy use than men (Wolters, 1999). No studies could be found using domain-specific learning strategies in statistics.

### 1.3. Current study

The aim of the current study is to (1) identify sex differences in statistics anxiety and learning strategies and (2) identify differences between men and women in how statistics anxiety is associated with various learning strategies that each sex might employ. It is hypothesized that women will display more statistics anxiety than men and the relationship between statistics anxiety and learning strategies will differ between men and women.

## 2. Methods

### 2.1. Participants

Students were recruited in two ways. First, as part of an Educational Psychology departmental requirement, having been selected based on their response to the following question: "Have you ever taken (or are you currently taking) a statistics course." They had the option of participating in a number of studies or participate in an alternative project that satisfied this course requirement. Second, volunteers were recruited based on the same criteria, having taken or currently enrolled in a statistics course. Participants completed measures online, in order to protect their anonymity. Use of online surveys has been shown to increase disclosure (Locke & Gilbert, 1995; Turner et al., 1998). It was hoped this approach would decrease measurement error in two ways. First, through the increased assurance of anonymity resulting in more honest disclosure and second because data was collected in this manner, manual entry of data points, a procedure prone to human error, was not needed.

Three hundred twenty three students from a large Southwestern university were recruited for the study with a mean age of 22-years-old (range 18–50). Of these students, 40.9% were male, 59.1% were female. In addition, the sex of their statistics professors was relatively equal as well with 50.3% male and 49.7% female. Ethnically, the sample was largely Euro-American (60.4%) followed by Latino/Latina American (17.6%), Asian/Asian American (12.1%), African/African American (5.6%), Native American (1.9%), and Middle Eastern/Middle Eastern American (.6%). Another 1.9% self-classified as "other." The majority of the sample was college seniors (64.7%) followed by juniors (18%), graduate students (6.2%), sophomores (5.9%) and freshmen (5.3%). Only 21.1% considered statistics to be a core part of their degree program. The remaining 78.9% needed statistics to satisfy a requirement for their degree.

### 2.2. Instruments

#### 2.2.1. Statistics anxiety rating scale (STARS; Cruise & Wilkins, 1980)

Statistics anxiety was assessed using the STARS. The STARS is a 51-item, self-report, six subscale measure. The subscales and their internal consistency coefficient alpha estimates for the current sample are as follows: worthlessness of statistics (.95), interpretation anxiety (.93), test and class anxiety (.88), lack of computational self-concept (.88), fear of asking for help (.87), and fear of the statistics instructor (.85). Using a 5-point Likert rating scale, participants were asked to indicate level of anxiety that pertain to questions that load on one of each of these six subscales. The items on each subscale are averaged to find the subscale score. Higher scores indicated high levels of anxiety on the relative scale.

Although much of the information on the STARS comes from an unpublished manuscript, recent studies have confirmed its adequate concurrent validity, internal consistency, and split-half reliability with other samples (Baloglu, 2002).

#### 2.2.2. *Procrastination assessment scale for students (PASS; Solomon & Rothblum, 1984)*

The PASS is two-part questionnaire consisting of 52 self-report items measured on a 5-point Likert scale that include six areas of academic procrastination. The first part asks participants to answer questions regarding writing a term paper, studying for exams, keeping up with weekly reading assignments, administrative tasks, attendance, and general school activities. The second half of the measure required participants to recall the last writing assignment where the participant procrastinated. However, only the first part of the scale was used for the current study and it yielded an internal consistency coefficient alpha estimate of .85. Elevated scores indicate high levels of academic procrastination.

#### 2.2.3. *Motivated strategies for learning questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1991, 1993)*

The MSLQ is an 81-item questionnaire designed to assess one's motivational orientations and learning strategies. For the purposes of the current study, the learning strategies subscales were used. These consist of 31 self-report items measured on a 7-point Likert scale. The subscales and the internal consistency coefficient alpha estimates for the current sample are as follows: rehearsal (reciting or naming items from a list to be learned; .66), elaboration (such as paraphrasing, summarizing, creating analogies, and generative note-taking; .78), organization (selecting appropriate information and constructing connections among the information to be learned; .68), critical thinking (ability to report applying previous knowledge to new situations in order to solve problems; .83), metacognitive self-regulation (awareness, knowledge, and control of cognition; .78), time and study environment (manage time and study environments, planning, and scheduling; .71), effort regulation (ability to control effort and attention in the face of distractions and uninteresting tasks; .68), peer learning (collaborating with peers; .67), and help seeking (knowing when it is time to get help from peers, instructor or tutor; .67).

### 2.3. *Data analysis*

Quantitative data were analyzed in two ways. First, two descriptive discriminant analyses (DDA) were conducted comparing men and women on (1) the six statistics anxiety subscales and (2) the 10 learning strategies (the nine MSLQ subscales plus procrastination). DDA is a multivariate technique that is superior to other group comparison methods such as MANOVA in that minimizes Type I, or experimentwise error, by simultaneously identifying (1) whether the groups differ and (2) if so how, without having to conduct a series of post hoc univariate analyses like ANOVA (Sherry, 2006). Two DDA were conducted in order to preserve the theoretical groupings of the two variable sets of interest, statistics anxiety and learning strategies. In this analysis, gender was coded as a dichotomous variable where 1 = male and 2 = female.

Second, two canonical correlation analyses (CCA) were conducted to investigate how statistics anxiety was related to learning strategies for men and then for women. Because statistically significant differences were found in both DDAs, pooling the two groups for the CCA analysis would have been inappropriate. Similar to DDA, CCA is a multivariate technique that minimizes the risk of Type I error. This statistical technique is able to investigate the relationships between the six aspects of anxiety and the 10 learning strategies simultaneously. In addition, it is not only able to investigate relationships between the two variable sets, but also in terms of the shared variance between the subscales within a variable set (Sherry & Henson, 2005).

## 3. Results

### 3.1. Differences between men and women on anxiety and learning

The first DDA investigated differences between men and women on the six statistics anxiety subscales. Table 1 lists the means and standard deviations for each group on the variables of interest. The data were analyzed using SPSS version 11.0.4. The assumption of multivariate normality was evaluated by plotting the Mahalanobis distances and paired $\chi^2$ values in a scattergram and the plots were evaluated. Because the plots formed a straight, diagonal line, the data was considered to meet the assumption of multivariate normality. The homogeneity of variance assumption was evaluated using Box's M. A non-significant Box's M is desired in order to determine that variances are equal across the two groups. However, because Box's M is an overly sensitive test of homogeneity, more stringent $\alpha$ levels can be determined such as .001 or greater in some cases (Sherry, 2006). It was determined that the homogeneity of variance assumption was met for this analysis as noted by Box's M, $F(21, 209956) = 1.931$, $p = .006$, indicating that covariance matrices can be pooled for this analysis.

In examining the canonical discriminant functions, there was a moderate canonical correlation (.295) on function 1 with an effect size of $R_c^2 = 8.70\%$. The full model test of function 1 was statistically significant at $p < .001$. Table 2 represents these findings. Standardized discriminant function coefficients and structure coefficients were examined in order to investigate what variables contributed to group separation. Table 3 reports

Table 1
Means and standard deviations for the statistics anxiety and learning strategies scales for males and females

| Variable | Males | | Females | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Worthlessness of statistics | 2.44 | .846 | 2.57 | .928 |
| Interpretation anxiety | 2.02 | .755 | 2.47 | .845 |
| Test and class anxiety | 2.63 | .874 | 2.99 | .907 |
| Lack of computational self-concept | 2.12 | .805 | 2.41 | .914 |
| Fear of asking for help | 2.09 | .870 | 2.39 | .988 |
| Fear of statistics teachers | 2.33 | .821 | 2.35 | .900 |
| Procrastination | 2.85 | .586 | 2.80 | .631 |
| Time and study environment | 4.28 | .944 | 4.42 | 1.03 |
| Rehearsal | 4.04 | 1.14 | 4.23 | 1.13 |
| Elaboration | 4.14 | .851 | 4.27 | 1.21 |
| Organization | 3.83 | 1.08 | 4.29 | 1.28 |
| Critical thinking | 3.65 | 1.01 | 3.35 | 1.25 |
| Metacognitive self-regulation | 3.93 | .802 | 4.10 | .890 |
| Effort regulation | 4.47 | 1.11 | 4.57 | 1.16 |
| Peer learning | 3.57 | 1.32 | 3.52 | 1.41 |
| Help seeking | 3.97 | 1.40 | 4.06 | 1.37 |

Table 2
Wilks' $\lambda$ and canonical correlation for sex

| Function 1 | Wilks' $\lambda$ | $\chi^2$ | df | $p$ | $R_c$ | $R_c^2$ (%) |
|---|---|---|---|---|---|---|
| *Statistics anxiety findings* | | | | | | |
| | .913 | 23.524 | 6 | .001 | .295 | 08.70 |
| *Learning strategies findings* | | | | | | |
| | .904 | 25.233 | 10 | .005 | .310 | 09.61 |

Table 3
Standardized discriminant function and structure coefficients for sex

| Scale | Coef. | $r_s$ | $r_s^2$ (%) |
|---|---|---|---|
| Worthlessness of statistics | −.386 | .228 | 05.20 |
| Interpretation anxiety | .992 | .895 | 80.10 |
| Test and class anxiety | .033 | .647 | 14.86 |
| Lack of computational self-concept | .523 | .523 | 27.35 |
| Fear of asking for help | −.168 | .515 | 26.52 |
| Fear of statistics teachers | −.242 | .033 | 00.11 |
| Procrastination | .044 | .127 | 01.61 |
| Time and study environment | .148 | −.219 | 04.80 |
| Rehearsal | .104 | −.253 | 06.40 |
| Elaboration | −.169 | −.185 | 03.42 |
| Organization | −.749 | −.582 | 33.87 |
| Critical thinking | 1.065 | .394 | 15.52 |
| Metacognitive self-regulation | −.589 | −.298 | 08.88 |
| Effort regulation | .071 | −.128 | 01.64 |
| Peer learning | .071 | .060 | 00.36 |
| Help seeking | .050 | −.094 | 00.88 |

these values. Interpretation anxiety, test and class anxiety, lack of computational self-concept, and fear of asking for help were primarily responsible for group differences with women being significantly more anxious in these four areas than men. Feeling that statistics had little worth made a slight additional contribution with women believing this more than men. This is supported by both the standardized discriminant function coefficients and the structure coefficients with the slight exception of fear of statistics and test and class anxiety, which had low function coefficients but high structure coefficients. This suggests the variance being explained by these two subscales is in part being explained by its correlation with the other variables in the variable set.

The second DDA investigated differences between men and women on the 10 learning strategies. Table 1 lists the means and standard deviations for each group on the variables of interest. The assumption of multivariate normality was met in the same manner as the first DDA. The homogeneity of variance assumption was also met for this analysis as noted by Box's M, $F(55, 155999) = 1.378$, $p = .033$, indicating that covariance matrices can be pooled for this analysis.

In examining the canonical discriminant functions, there was a moderate canonical correlation (.310) on function 1 with an effect size of $R_c^2 = 9.61\%$. The full model test of function 1 was statistically significant at $p < .005$. Table 2 represents these findings. Standardized discriminant function coefficients and structure coefficients were examined and reported in Table 3. Organization and critical thinking made primary contributions followed to some extent by metacognitive self-regulation and to a much lesser extent by rehearsal. Women had higher scores on organization, metacognitive self-regulation, and to a small extent rehearsal while men had higher scores on critical thinking. In other words, women appeared to use organizational strategies (clustering, outlining, selecting the main idea of a passage), planned, monitored, and set goals more often, and used rehearsal to activate working memory where men were more likely to apply previous knowledge to new situations to solve a problem. This is supported by both the standardized discriminant function coefficients and the structure coefficients. To a small extent, critical thinking functioned as a suppressor variable in this function. In other words, while its structure coefficient suggests its prediction of group separation is useful, its standardized coefficient indicates the strength of this usefulness is being underestimated in the structure coefficient.

### *3.2. Differences between men and women in relation between anxiety and learning*

The first CCA was conducting using the men (1 = men) in the sample with the six subscales of statistics anxiety predicting the 10 learning strategies. The analysis yielded six functions with squared canonical correlations ($R_c^2$) of .445, .317, .175, .133, .042 and .011 for each successive function. Collectively, the full model across all functions was statistically significant using the Wilks' $\lambda = .25701$ criterion, $F(60, 408.48) = 2.01546$, $p < .001$. Because Wilks' $\lambda$ represents the variance unexplained by the model, $(1 - \lambda)$ yields the full model effect to be .743, which indicates that the full model can explain a substantial portion, about 74.3%, of the variance shared between the variable sets.

Table 4
Canonical solution for learning strategies predicting statistics anxiety for males ($N = 93$)

| Variable | Function 1 | | | Function 2 | | |
|---|---|---|---|---|---|---|
| | Coef. | $r_s$ | $r_s^2$ (%) | Coef. | $r_s$ | $r_s^2$ (%) |
| Procrastination | .664 | .651 | 42.39 | .831 | .405 | 16.40 |
| Time and study environment | .351 | −.281 | 07.90 | .593 | .224 | 05.02 |
| Rehearsal | .078 | −.233 | 05.43 | .360 | .452 | 20.43 |
| Elaboration | −.048 | −.292 | 08.53 | −.205 | −.002 | 00.00 |
| Organization | −.745 | −.562 | 31.58 | .653 | .408 | 16.65 |
| Critical thinking | .398 | −.100 | 01.00 | .200 | .095 | 00.90 |
| Metacognitive self-regulation | .458 | −.229 | 05.24 | −.541 | .013 | 00.02 |
| Effort regulation | −.213 | −.141 | 01.99 | −.055 | −.108 | 01.17 |
| Peer learning | .054 | −.377 | 14.21 | −.286 | −.025 | 00.06 |
| Help seeking | −.626 | −.617 | 38.07 | .330 | .231 | 05.34 |
| $R_c^2$ | | | 44.50 | | | 31.70 |
| Worthlessness of statistics | .320 | −.214 | 04.58 | .047 | −.004 | 00.00 |
| Interpretation anxiety | .445 | −.053 | 00.28 | .272 | .652 | 42.51 |
| Test and class anxiety | −.630 | −.105 | 01.10 | .832 | .856 | 73.28 |
| Lack of computational self-concept | −.510 | −.274 | 07.51 | −.228 | −.042 | 00.18 |
| Fear of asking for help | 1.399 | .604 | 36.48 | .007 | .587 | 34.46 |
| Fear of statistics teachers | .055 | −.101 | 01.02 | −.447 | −.219 | 04.80 |

Coef., standardized canonical coefficients.
$r_s$, structure coefficient.
$r_s^2$, structure coefficient squared or variance explained.

The dimension reduction analysis allows the researcher to test the hierarchal arrangement of functions for statistical significance. As noted, the full model (functions 1–6) was statistically significant. Function 2–6 was also statistically significant with $F(45, 352.02) = 1.468$, $p < .05$. with an effect size of .527. Functions 3–6, 4–6, 5 and 6, and 6 (which is the only function that is tested in isolation) did not explain a statistically significant amount of shared variance between the variable sets. Given the $R_c^2$ effects for each function as well as their statistical significance, only the first two functions are considered noteworthy in the context of the current study (44.5% and 31.7% of shared variance, respectively). The last four functions explained some additional variance after the extraction of the prior functions, but were not found to be statistically significant and were thus omitted from further interpretation.

Table 4 presents the standardized canonical function coefficients and structure coefficients for functions 1 and 2. Regarding the criterion variable set in function 1 and based on the structure coefficients, procrastination is negatively related to organization, peer learning, and help seeking and all are primary contributors to the criterion synthetic variable. This conclusion is supported by the squared structure coefficients as well as the function coefficients. However, the function coefficient for peer learning is somewhat lower than its structure coefficient suggesting it shares some variance with some of the other criterion variables and this shared variance accounts for some of its contribution to the criterion synthetic variable. Regarding the predictor variable set, fear of asking for help is the only variable that contributes to the predictor synthetic variable. Overall, it can be said that for function 1, the more men procrastinate, the more likely they are afraid to ask for help. In addition, the more they utilize organization, peer learning, and help seeking, the less likely they will be afraid to ask for help.

Regarding the criterion variable set in function 2, procrastination is positively related to rehearsal and organization. This is supported by both the function and structure coefficients and the squared structure coefficients. Regarding the predictor variable set, interpretation anxiety, test and class anxiety, and fear of asking for help are all positively related to each other. However, much of the contribution from fear of asking for help can be accounted for by its shared variance with other variables in the predictor variable set as evidenced by its low function coefficient and its more substantial structure coefficient. Overall, it can be said that for function 2, the more men procrastinate, uses rehearsal and organizational strategies, the more likely one is to have interpretation anxiety, test and class anxiety, and to some extent a fear of asking for help.

The second CCA was conducted using the women (2 = women) in the sample with the six subscales of statistics anxiety predicting the 10 learning strategies. The analysis yielded six functions with squared canonical correlations ($R_c^2$) of .407, .249, .205, .058, .048, and .007 for each successive function. Collectively, the full model across all functions was statistically significant using the Wilks' $\lambda = .31560$ criterion, $F(60, 576.14) = 2.3636$, $p < .001$. Because Wilks' $\lambda$ represents the variance unexplained by the model, $(1 - \lambda)$ yields the full model effect to be .684, which indicates that the full model can explain a substantial portion, about 68.4%, of the variance shared between the variable sets.

The dimension reduction analysis allows the researcher to test the hierarchal arrangement of functions for statistical significance. As noted, the full model (functions 1–6) was statistically significant. Function 2–6 was also statistically significant with $F(45, 495.16) = 1.6681$, $p < .005$. with an effect size of .468. Functions 3–6, 4–6, 5 and 6, and 6 did not explain a statistically significant amount of shared variance between the variable sets. Given the $R_c^2$ effects for each function as well as their statistical significance, only the first two functions are considered noteworthy in the context of the current study (40.7% and 24.9% of shared variance, respectively). The last four functions explained some additional variance after the extraction of the prior functions, but were not found to be statistically significant and were thus omitted from further interpretation.

Table 5 presents the standardized canonical function coefficients and structure coefficients for functions 1 and 2. Regarding the criterion variable set for function 1 and in examining the structure coefficients specifically, all of the learning strategies contributed to the criterion synthetic variable except for peer learning. Procrastination was negatively related to all of the other learning strategies. There were some multicollinearity issues among the variables. Contributions from rehearsal, elaboration, organization, critical thinking, and effort regulation to the criterion synthetic variable can be partially accounted for by shared variance among other variables in the criterion variable set. Regarding the predictor variable set for function 1, all of the statistics anxiety variables contributed to the predictor synthetic variable and were all positively related to each other. Similar to the criterion variable set, there were also some multicollinearity issues among these variables. Contributions from interpretation anxiety, test and class anxiety, and fear of statistics teachers to the predictor synthetic variable can be partially accounted for by shared variance among other variables in the criterion variable set. Overall, procrastination was positively related to all aspects of statistics anxiety where the other learning strategies were negatively related to statistics anxiety. However, the most useful relationships are between procrastination, time and study environment, metacognitive self-regulation, and help seeking as they predicted worthlessness of statistics, lack of computational

Table 5
Canonical solution for learning strategies predicting statistics anxiety for females ($N = 125$)

| Variable | Function 1 | | | Function 2 | | |
|---|---|---|---|---|---|---|
| | Coef. | $r_s$ | $r_s^2$ (%) | Coef. | $r_s$ | $r_s^2$ (%) |
| Procrastination | −.444 | −.596 | 35.52 | −.646 | −.324 | 10.50 |
| Time and study environment | −.346 | .480 | 23.04 | −.448 | −.285 | 08.12 |
| Rehearsal | .074 | .423 | 17.89 | −.682 | −.757 | 57.30 |
| Elaboration | .054 | .637 | 40.58 | −.172 | −.380 | 14.44 |
| Organization | .135 | .605 | 36.60 | −.197 | −.364 | 13.25 |
| Critical thinking | −.117 | .421 | 17.72 | −.279 | −.175 | 03.06 |
| Metacognitive self-regulation | .445 | .771 | 59.44 | .671 | −.088 | 00.77 |
| Effort regulation | .170 | .664 | 44.09 | −.199 | −.164 | 02.69 |
| Peer learning | −.299 | .265 | 07.02 | −.099 | −.169 | 02.86 |
| Help seeking | .606 | .705 | 49.70 | .151 | −.199 | 03.96 |
| $R_c^2$ | | | 40.70 | | | 24.90 |
| Worthlessness of statistics | −.765 | −.772 | 59.60 | .192 | .022 | 00.05 |
| Interpretation anxiety | .012 | −.595 | 35.40 | −.319 | −.588 | 34.57 |
| Test and class anxiety | .075 | −.468 | 21.90 | −1.109 | −.798 | 63.68 |
| Lack of computational self-concept | .390 | −.453 | 20.52 | .347 | −.038 | 00.14 |
| Fear of asking for help | −.740 | −.844 | 71.23 | .475 | −.132 | 01.74 |
| Fear of statistics teachers | −.006 | −.551 | 30.36 | .005 | −.036 | 00.13 |

Coef., standardized canonical coefficients.
$r_s$, structure coefficient.
$r_s^2$, structure coefficient squared or variance explained.

self-concept, and fear of asking for help. Again, procrastination is negatively related to these variables.

Regarding the criterion variable set for function 2, procrastination, rehearsal, elaboration, and organization contributed to the criterion synthetic variable and were all positively related to each other. This was largely supported by both the function and structure coefficients although contributions from elaboration and organization can be attributed to the shared variance with the other variables in the predictor set. Regarding the predictor variables, interpretation anxiety and test and class anxiety were positively related to each other and the primary contributors to the predictor synthetic variable. This was supported by both the function and structure coefficients. Overall it can be said that the more procrastination, rehearsal, and to some extent elaboration and organization strategies women use, the more likely they are to experience interpretation anxiety, and test and class anxiety.

## 4. Discussion

The current study suggests that statistically significant differences do exist between men and women on subscales of both statistics anxiety and learning strategies. However, interesting, the low effect size on the comparison of the two groups indicate that the clinical significance of these differences are likely minimal. In other words, while differences do exist, they are relatively small and weak. However, the ways in which men and women's statistics anxiety is related to their learning strategies reveals a much different picture that is potentially more useful to statistics instructors and educators. Procrastination and organization play a large role in statistics anxiety for men. Procrastination gets in the way of asking for help, possibly because of a fear on the students' part of exposing the fact that he has not been keeping up with assignments or readings. This is in turn negatively related to organization, an active, effortful learning strategy that results in the learner being closely involved in the task (Pintrich et al., 1991). Again, this makes sense in that if someone is procrastinating, they are not engaging in an active, effortful approach to learning. Procrastination is also positively related to rehearsal strategies, which are akin to memorization techniques that do not appear to help students construct meaningful internal connections (Pintrich et al., 1991). Procrastination, rehearsal, and organization all jointly and positively predict interpretation anxiety and test and class anxiety. If a student has not been keeping up with his assignments or reading, he may likely use rehearsal and organization strategies as an ineffective means of trying to catch up, resulting in higher levels of anxiety when understanding concepts in class and on tests. With these findings, one might suggest that for men with statistics anxiety, assisting them with strategies addressing procrastination might be helpful. Such things as daily class assignments or in-class assignments may help them stay current in their study habits, making them less reliant on ineffective learning strategies and more open to asking for help when it is needed.

The relation between learning strategies and statistics anxiety for women varies. All of the learning strategies, except for peer learning, are related to all of the statistics anxiety subscales. Similar to men, procrastination is positively related to all types of statistics anxiety. All of the other learning strategies are negatively related to statistics anxiety. In other words, women appear to be better able at utilizing a wide range of learning strategies and this utilization impacts their anxiety significantly. The second function for women closely resembles the findings for men: procrastination, rehearsal, organization, and elaboration is positively related to interpretation and test and class anxiety. It appears that for women, learning strategies like rehearsal, organization, and elaboration can have both positive and negative effects on statistics anxiety. With quite a large amount of multicollinearity between the learning strategies in the first function, it could be that for women, these strategies are more effective at combating statistics anxiety when combined with other strategies. Revisiting the concept of stereotype threat (Steele & Aronson, 1995) it is plausible that women have had to develop multiple ways of dealing with statistics anxiety. The results of the current study suggest that such an approach has been adaptive and successful for the most part. In a meta-analysis of studies on gender differences in math affect and attitudes, Hyde, Fennema, Ryan, Frost, and Hopp (1990) found the only large effect was stereotyping—that articles tended to stereotype math as a male domain. The effect of stereotype threat on statistics anxiety has also been supported in African American samples (Onwuegbuzie, 1999). The stereotype threat hypothesis does not guarantee that a stereotyped group will do poorly or be unable to manage certain skills or emotions that are stereotypically difficult for them. What the current study suggests is that those who must deal with stereotyping likely adapt by developing different approaches to problems that are more likely to secure their success.

For both men and women, procrastination emerged as a consistent predictor of statistics anxiety. This is consistent with research that has demonstrated how avoidance contributes to anxiety (Maner & Schmidt, 2006), leading to a conditioned response when exposed to an anxiety-provoking stimulus (statistics). Foa and Kozak (1985) explain that exposure to feared situations using newly acquired cognitive skills is an effective method in the treatment of anxiety. Statistics fears might be altered to thoughts focused on how one might better study the material. This distracts a student from magnifying negative expectations related to statistics by giving attention to the process of self-regulated learning (Sarason, 1985). Collectively, this line of research allows for some speculation as to teaching strategies that may help students manage their statistics anxiety. The concept of exposure plus newly acquired cognitive skills suggests that routine homework assignments that are not only graded, but evaluated for consistent errors, may help. This would provide three important elements: (1) accountability to reduce avoidance behaviors (procrastination) (2) exposure to the feared stimulus and (3) assistance in helping the student identify and hone newly acquired cognitive skills and cognitive learning strategies. More specifically, cognitive learning strategies may assist in modifying a conditioned response to statistics. Although there is limited research in this area, it is plausible that the introduction of learning strategies may alleviate statistics anxiety since they provide a basis for modifying thought and behavioral habits. Motivational orientations and learning strategies, such as organization, elaboration, critical thinking, and metacognitive self-regulation, may serve as a form of cognitive restructuring. As a result, learning strategies may lead to a re-labeling of feelings and thoughts about statistics ultimately forming a new set of arousal cues that support the critical role of the neurological constructs that mediate anxiety.

Exposure can be coupled with other techniques that have demonstrated some effectiveness in managing anxiety when it does surface. Schunk (1998) explains that the use of models in mathematical instruction is a contextual factor that can encourage self-efficacy, motivation, self-regulation, and achievement. Thus, students observe models demonstrating organizational skills, self-monitoring, and other strategies to cope with statistics anxiety. Additionally, Wilson (1996) reported a list of 16 anxiety-relieving strategies listed by students. The top five included: (1) open book examinations, (2) working with a partner,

(3) instructor's positive attitude, encouragement, and reassurance (4) humor, and (5) addressing anxiety. Lastly, Onwuegbuzie (2000) found that students felt that untimed examinations and the use of supporting materials during testing created the least amount of anxiety, more higher order thinking, and higher levels of performance when compared to timed tests.

Dolinsky (2001) briefly describes an active learning approach to teaching statistics. Through her own personal experience as a statistics lecturer, she found her students were more engaged and understood what statistical outcomes meant when she placed less emphasis on statistical theory and abstract mathematical concepts and more emphasis on a collaborative teaching environment. Such a shift did not change grade distributions or teaching evaluations, but did appear to shift student attitudes. Students comment they understand statistics more, feel more pride and self-confidence in their ability, and more insight into their learning style strengths and weaknesses. Such shifts may potentially impact statistics anxiety as well as such a model provides more opportunity for exposure to the anxiety-provoking stimulus.

Other possible teaching strategies have also been noted in the literature. Previous research has found that academic or learning goals are negatively related to test anxiety and positively related to deep-processing learning strategies (Bandalos, Finney, & Geske, 2003). These learning goals were also found to be related to self-efficacy. It is possible that framing statistics to students in a way that helps them see connections to their own personal learning goals might help reduce statistics anxiety in the long-run. Several applied researchers have discussed the idea of "Plain English" statistics as a way to engage students and increase their sense of self-efficacy in statistics courses (Lewis-Beck, 1995; Sherry, 2006; Urdan, 2005). Schacht and Stewart (1990) noted a reduction in math anxiety when classes included the use of humorous cartoons and incorporated gimmicks such as using the students as the source of statistical data. Dilevko (2000) suggests applying statistics to the "real world" with use of current news stories and approaching anxiety by using statistical concepts in examples that students find interesting. Finally, conceptually oriented equations facilitate learning better than computationally oriented equations, particularly when applied to novel problems (Atkinson, Catrambone, & Merrill, 2003).

There are several limitations to the current study. First, because this study is self-report, responses are vulnerable to reactivity, response bias, and response sets. More specifically, previous research has found that men were more susceptible than women to social desirability responding on measures of math anxiety (Zettle & Houghton, 1998). This may also apply to statistics anxiety and account for the differences between men and women in the current study. Second, the current sample would be more generalizable if it were more diverse in terms of ethnicity, region, and age. Third, there are a number of variables that were not considered in the current analysis that could have been impactful. Examples include grades, an interaction of sex of student and sex of professor, or undergraduate or graduate major. Fourth, anxiety was assessed domain specifically, but learning strategies were assessed generally. Additional research should begin to explore domain-specific learning strategies for statistics. Fifth, a larger sample size would allow for more confidence in the findings. Sixth, the CCAs done on each group were not statistically compared to each other. Therefore, there is no way to truly know whether men and women are statistically different in the ways in which their learning strategy is related to statistics anxiety. Finally, the current study was a point in time study. Particularly for the variables of interest to this study, there is no way to conclude whether statistics anxiety influenced choice of learning strategy or learning strategy influenced statistics anxiety. The findings are correlational, not causal.

Future research might investigate how age influences the relation between learning strategies and statistics anxiety. Baloglu (2003) found that in general, older students were more able to recognize the value of statistics, but had more anxiety about doing statistics than did younger students. Other research has suggested that as students age they become more accurate in their ability appraisals, thus possibly impacting their anxiety levels (bad experiences = more anxiety) (Pajares & Kranzler, 1995). Other factors such as an interaction with sex of the professor, studies encompassing a more racially or ethnically diverse group, differences in graduate/undergraduate rank, or differences in chosen field may all yield different and interesting findings. Additionally, the researchers considered using domain-specific strategies identified in the math literature as domain-specific strategies for statistics, but other research we encountered suggested this was not appropriate because they are conceptually different skill sets. No studies could be found that identified domain-specific learning strategies in statistics. Therefore, the current study was primarily interested in how does one's general learning strategic approach impacted their anxiety when it came to statistics. Future research might generate hypotheses about what those domain-specific strategies for statistics might be. Lastly, research should focus on the neurocognitive aspects of statistics anxiety and the use of cognitive learning strategies.

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