WORRY, INTOLERANCE OF UNCERTAINTY, AND STATISTICS ANXIETY

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ABSTRACT

Statistics anxiety is a problem for most graduate students. This study investigates the relationship between intolerance of uncertainty, worry, and statistics anxiety. Intolerance of uncertainty was significantly related to worry, and worry was significantly related to three types of statistics anxiety. Six types of statistics anxiety were significantly lower by the end of the semester.

Keywords: *Statistics education research; Academic anxiety; Graduate students*

1. INTRODUCTION

It is quite common for graduate students to avoid taking statistics classes for as long as possible, frequently waiting until their last semester to enroll in a statistics course. This is not new: Roberts and Bilderback (1980) noted as much when discussing student attitudes toward statistics. The authors pointed out that the fear students feel when finally forced to enroll is often detrimental to a successful experience in statistics classes. Other authors also acknowledge the problem of graduate students' procrastination when it comes to enrolling in statistics classes (e.g., Onwuegbuzie, 1997), attributing their avoidance to high levels of statistics anxiety. Statistics anxiety has been related to several variables, such as academic outcomes, attitudes, self-concepts, and personal characteristics such as the tendency to procrastinate. Statistics anxiety has also been shown to be detrimental to students in several ways, but cognitive processes related to this form of anxiety have apparently not been explored. Specifically, intolerance of uncertainty, and worry have each been related to generalized anxiety, and worry has been related to other forms of anxiety, but neither construct has yet been related to statistics anxiety.

2. REVIEW OF THE LITERATURE

2.1. STATISTICS ANXIETY

Statistics anxiety has been defined as "a feeling of anxiety when taking a statistics course or doing statistical analysis; that is gathering, processing, and interpreting data" (Cruise, Cash, & Bolton, 1985, p. 92). Statistics anxiety is believed to be a multi-dimensional construct, comprised of six types of anxiety: worth of statistics, interpretation anxiety, test and class anxiety, computation self-concept, fear of asking for help, and fear of statistics teachers (Cruise et al.). *Worth of statistics* refers to students' perception of the usefulness of statistics in everyday life. Cruise et al. state that students scoring high on this factor see no purpose in taking statistics courses and a higher score may indicate a negative attitude toward the subject. *Interpretation anxiety* refers to the anxiety felt when students are required to interpret statistical results or decide which type of analysis to use. Those who score high on this factor find statistical interpretation difficult and anxiety provoking. *Test and class anxiety* pertains to the general anxiety experienced by taking a statistics class. Students who score high on this factor feel anxiety when enrolling in a statistics course, attending statistics classes, or taking exams. *Computation self-concept* refers to anxiety experienced when computing statistical problems. Students who score high on this dimension doubt their ability, regardless of true ability, to solve statistical problems which may reflect their attitude toward the subject. *Fear of asking for help* reflects the

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anxiety students feel when asking for help. Students who score high on this factor experience higher levels of anxiety when approaching their instructor, or a classmate, for help understanding statistical problems or statistical descriptions in journal articles. The last factor, *fear of statistics teachers*, refers to the students' perceptions of the statistics instructor. Those who score high on this dimension are more likely to perceive the instructor as being unable or unwilling to relate to the students as a human being, and to regard the instructor as someone to fear.

Zeidner (1991) furthers the definition by adding that statistics anxiety is accompanied by worry, tension, and physiological symptoms of stress when students are faced with taking a statistics class. Similarly, Onwuegbuzie, Da Ros, and Ryan (1997), through a qualitative study, found that students affected by statistics anxiety experience symptoms ranging from mild discomfort to depression, panic, stress, headaches, sweating, emotionality, and other psychological and physical manifestations of anxiety.

Adverse effects of statistics anxiety have also been reported. For example, students' performance is often affected in both statistics and research classes (Chiesi & Primi, 2010; DeVaney, 2010; Keeley, Zayac, & Correia, 2008; Lalonde & Gardner, 1993; Murtonen & Lehtinen, 2003; Onwuegbuzie, 1997; Onwuegbuzie, 2000; Onwuegbuzie & Seaman, 1995; Perepiczka, Chandler, & Becerra, 2011; Zanakis & Valenza, 1997). In a sample of undergraduate psychology students, Lalonde and Gardner (1993) found that statistics anxiety had affected students' attitude and motivation toward the subject, thereby affecting their learning. Similarly, Zanakis and Valenza (1997) explored the relationship between student grades and statistics anxiety in 166 students enrolled in business statistics courses. The authors found that students' anxiety, though still high at course end, was reduced simply as a result of exposure and that this contributed to a reduction in interpretation anxiety. Further, the increase in perceived worth of statistics had the greatest influence on student achievement, with the increase contributing to higher grades. More recently, Chiesi and Primi used structural equation modeling to explore in a sample of 487 students both cognitive and non-cognitive factors related to statistics performance. They found that achievement was indirectly affected by statistics anxiety through poor attitude toward statistics, with the overall model explaining 67% of the variance in achievement. Specifically, pre-course attitude was significantly related to anxiety (r = -0.37, $p < 0.05$), which was related to negative post-course attitude (r = -0.38, $p < 0.05$), which was in turn related to achievement (r = 0.21, $p < 0.05$). This suggests that students' preconceived ideas about statistics classes affect their anxiety, and that anxiety in turn affects their attitudes toward statistics even at course end. Comparatively, Kesici, Baloglu, and Deniz (2011), in a sample of 320 college students, used canonical correlation analysis to explore the relationship between the six dimensions of statistics anxiety (Cruise et al., 1985) and a set of nine types of self-regulation. These authors found that the three significant canonical variants combined accounted for 54% of the variability in self-regulated learning strategies and 65% of the variability in statistics anxiety. These authors contend that students who use higher-level learning strategies (e.g., elaboration and organization) also have lower levels of statistics anxiety.

Onwuegbuzie and Seaman (1995) found that students who were given statistics tests under timed conditions showed significantly lower levels of performance than students who were tested under untimed conditions. In a later study, Onwuegbuzie (1997) explored anxiety in 81 graduate students in a research class and showed that anxiety over writing research proposals was comprised of library anxiety, statistics anxiety, composition anxiety, and research anxiety. Two forms of statistics anxiety (interpretation anxiety and fear of asking for help) and two types of library anxiety (affective barriers and knowledge of the library) significantly lowered scores on students' research proposal assignments. Additionally, these factors explained 35.9% of the variance in proposal writing propensity.

Students' self-perceptions are also affected by statistics anxiety. In a sample of 146 graduate students, Onwuegbuzie (2000a) found that perceived creativity, intellectual ability, and academic competence were all significantly related to six dimensions of statistics anxiety, indicating that students who had higher levels of statistics anxiety also perceived themselves as less creative, as well as having less intellectual ability and competence for learning. In a different look at self-perception, Perepiczka et al. (2011) examined the effects of statistics anxiety, attitude toward statistics, and social support on students' self-efficacy for learning statistics. In their sample of 166 graduate students, 52.8% of the variance in self-efficacy to learn statistics was accounted for by the combination of

statistics anxiety, attitude toward statistics, and social support. Individually, statistics anxiety and attitude toward statistics were significant predictors, accounting for 3% and 7% of the variance in self-efficacy to learn statistics, whereas social support was not significant. From these data, it appears that students' anxiety and attitudes affect their perception of whether they are capable of learning statistics.

Statistics anxiety has been found to contribute even to students' academic procrastination. In a sample of 135 graduate students, Onwuegbuzie (2004) measured students' levels of procrastination and the extent to which their procrastination was due to fear of failure or to task aversion. The author also measured students' levels of statistics anxiety in the six areas delineated by Cruise et al. (1985), and found that 40%-60% of the students reported procrastination on reading assignments and studying for exams, and that both the task aversion and fear of failure components were significantly related to the six types of statistics anxiety. Additionally, the author reports that as many as 41.5% of the students surveyed felt that procrastination was a concern.

Less attention in the research has been focused on alleviating statistics anxiety in students. Dillon (1982) described how students' anxiety may be reduced by encouraging them to discuss their concerns, and then suggesting ways that they can cope with their anxiety. Schacht and Stewart (1990) explored the use of humorous cartoons in statistics classes to reduce anxiety. By introducing cartoons and applying statistical applications to the content (e.g., calculating probability of runaway pets using fictitious data based on a cartoon depicting a man looking for his runaway cat), the authors found that this type of humor not only lowered the students' anxiety levels, but also improved their learning. In 1991, the same authors reported on their use of attention-getting teaching techniques (termed "gimmicks") in statistics classes, asserting that such techniques should be utilized more often in statistics classes. By gathering opinion-related data from the students themselves, and then having them perform simple calculations such as obtaining the mean, they found that students' anxiety was reduced and their motivation to become involved in the class was increased. Wilson (1996) found that although humor was somewhat effective in reducing students' anxiety in statistics class, instructor personality and reassurances were even more effective. In subsequent studies, Wilson (1999, 2000) found that the instructor's interpersonal style was more effective than specific strategies used to address students' anxiety. After gathering answers to the open-ended question "What, if anything, did your instructor do to reduce anxiety in the statistics class?" for three years, the author concluded that instructor behaviors such as conveying a positive attitude, encouragement, reassurances of the students' ability, acknowledgement of students' anxiety, and use of humor reduced their anxiety at higher rates than did allowing students to work together or "making it easy to get an A." Additionally, Pan and Tang (2005) used a focus group format to find that when the instructor was sensitive to students' concerns, students' anxiety was reduced and learning was enhanced.

2.2. ANXIETY AND WORRY

Statistics anxiety is a problem not only because of the adverse affects on student outcomes, attitudes, self-concepts, and tendency to procrastinate, but also because it can affect students' decisions to enroll in statistics courses early in their programs of study (Onwuegbuzie, 1997; Roberts & Bilderback, 1980). This delay may contribute to further avoidance, thereby increasing student anxiety. As Rachman (2004) states, avoidance is successful in the short term for relieving anxiety, but in the long run it contributes to further avoidance and helps strengthen the original anxiety.

Anxiety is described as "a tense, unsettling anticipation of a threatening but vague event; a feeling of uneasy suspense" (Rachman, 2004, p. 3). A person feeling anxiety has a difficult time identifying a specific cause, yet the anxiety is persistent and encompassing. There are two main types of anxiety: trait anxiety and state anxiety. *Trait anxiety* refers to a relatively enduring characteristic of a person, whereas *state anxiety* is a response to a specific threatening situation that is only present when the threat is present. Barlow (2002) points out that anxiety also involves a perception of lack of control over future events and that it may become associated with any number of different situations. A common response to anxiety is the attempt to escape the threat and to avoid situations where the threat may be encountered (Rachman, 2004). An example of this response might be students who avoid statistics courses in order to reduce the discomfort of anxiety.

Anxiety is characterized by worry, which was originally described by Borkovec, Robinson, Pruzinsky, and Dupree (1983):

> Worry is a chain of thoughts and images, negatively affect-laden and relatively uncontrollable; it represents an attempt to engage in mental problem-solving on an issue whose outcome is uncertain but contains the possibility of one or more negative outcomes; consequently, worry relates closely to the fear process. (p. 10)

A later description of worry is provided by MacLeod, Williams, and Bekerian (1991), who proposed that worry is "a cognitive phenomenon, … concerned with future events where there is uncertainty about the outcome, the future being thought about is a negative one, and this is accompanied by feelings of anxiety" (p. 478). Barlow (2002) adds to this description the idea that worry is "an anxious apprehension for future, negative events." He goes on to say that worry represents an attempt to cope with anxiety, so in effect as anxiety increases, worry increases as well.

In clinical studies, worry is the main feature of generalized anxiety disorder (GAD) and is present in many other anxiety disorders as well (American Psychiatric Association, 2000; Barlow, 2002). Research studies have shown that individuals with GAD report significantly higher levels of worry than in non-pathological samples (Fresco, Mennin, Heimberg, & Turk, 2003; Molina & Borkovec, 1994), while others (Ruscio, 2002; Ruscio & Borkovec, 2004) find that high levels of worry are not necessarily associated with GAD. For example, Ruscio found that only 20% of high-worriers were also diagnosable as experiencing GAD. This finding helped illustrate that the tendency to worry out of proportion can also be found outside clinical samples.

There have been fewer studies utilizing non-clinical samples investigating worry, with or without anxiety. In one of the first studies investigating worry in non-clinical participants, Tallis, Davey, and Capuzzo (1994) asked 128 college students and working adults about their experiences with worry. Thirty-eight percent reported worrying at least once a day and that the typical time spent worrying was 10 minutes or less, typically about upcoming events or interpersonal interactions. Smaller percentages were reported for worrying more than once a day and for longer than 10 minutes.

Similarly, Szabo and Lovibond (2002) assessed a sample of 57 psychology students concerning the content of naturally-occurring worry episodes. Fifteen were classified as analogue GAD participants (scoring high enough on GAD measures to be diagnosable, yet not clinically diagnosed), 21 were classified as moderate worriers, and 21 as low worriers. The authors found that 20% of the worry content reported by participants focused on negative potential outcomes while 50% of the content was focused on problem-solving thoughts. Additionally, those who scored higher on worry-proneness did not differ significantly from moderate or low worriers on this outcome. The only difference suggested by the data indicates that high worriers judge their own problem-solving thoughts to be significantly more ineffective than those who worry moderately or less, pointing to a negative relationship between worry-proneness and problem-solving effectiveness.

In a comparable study, Ladouceur, Blais, Freeston, and Dugas (1998) investigated problem orientation and problem-solving skills in relation to anxiety in a sample of college students and GAD patients. Fifteen of the students were classified as moderate worriers and 14 as analogue GAD worriers, with the remaining sample made up of 14 participants clinically diagnosed with GAD. Across all groups, problem orientation was related to anxiety levels, but problem-solving skill was not related. The authors also found that those worriers with higher levels of anxiety also expressed a stronger belief that worry is beneficial while reporting a lower tolerance for uncertainty.

2.3. ANXIETY, WORRY, AND INTOLERANCE OF UNCERTAINTY

Another characteristic of anxiety appears to be intolerance of uncertainty, which is believed to lead directly to the tendency to worry (Koerner & Dugas, 2006). These authors describe a model of GAD that incorporates not only worry as a function of anxiety, but also describes the intolerance of uncertainty as the instigator of worry, which in turn is due to negative problem orientation, the belief that worry is valuable, and cognitive avoidance. Intolerance of uncertainty is defined as a dispositional characteristic that affects how a person perceives and responds to uncertain situations on a cognitive, emotional, and behavioral level. Those who show an intolerance of uncertainty experience uncertainty as stressful, believe that situations where uncertainty exists are best avoided, and experience an undermining of their ability to function (Buhr & Dugas, 2002).

Researchers have demonstrated a significant relationship between worry and intolerance of uncertainty (Dugas, Freeston, & Ladouceur, 1997; Freeston, Rheaume, Letarte, Dugas, & Ladouceur, 1994; Ladouceur, Gosselin, & Dugas, 2000; Tallis & Eysenck, 1994). For example, Dugas, Gosselin, and Ladouceur (2001) examined the specificity of the relationship between the two by adding other variables known to be related to worry. In the sample of 347 undergraduate students, the authors found that intolerance of uncertainty was highly related to worry (r = 0.70), moderately related to obsessions/compulsions (r = 0.48), and weakly related to panic sensation (r = 0.33). Further, through regression analysis, the authors found that intolerance of uncertainty explained 42% of the variance in worry after accounting for other variables. In a second regression, worry explained 34% of the variance in intolerance of uncertainty beyond that of the other variables. Similarly, Buhr and Dugas (2006) surveyed 197 college students concerning intolerance of uncertainty, worry, intolerance of ambiguity, perfectionism, and perceived control. Though worry was related to all of the variables except other-oriented perfectionism (a subscale of perfectionism) and perceived mastery (a subscale of sense of control), the strongest relationship among the variables occurred between worry and intolerance of uncertainty (r = 0.63).

As the literature suggests, anxiety, worry, and intolerance of uncertainty appear to be inseparable components. Researchers have explored the relationship between worry and anxiety largely in terms of GAD, but many have expanded our understanding by investigating other types of anxiety such as the myriad of evaluative anxieties (e.g., test anxiety, math anxiety, social anxiety, sports anxiety, computer anxiety) in which worry is recognized as a major cognitive component (see Zeidner & Matthews, 2011). The development of the intolerance for uncertainty construct (Koerner & Dugas, 2006) helps explain worry, and research concerning the relationship between intolerance of uncertainty, worry, and anxiety has been growing. However, one type of anxiety has thus far not been studied in relation to worry and intolerance of uncertainty, that of statistics anxiety. Considering the ample research relating generalized anxiety and other forms of anxiety to the worry construct, and the evidence of intolerance of uncertainty also relating to worry and anxiety, it is logical to expect worry and intolerance of uncertainty to have some relationship with statistics anxiety. Therefore, the current study seeks to investigate the relationship between intolerance of uncertainty, worry, and statistics anxiety.

3. PURPOSE OF THE STUDY

The focus of the current study is on the relationships among intolerance of uncertainty, worry, and statistics anxiety. If intolerance of uncertainty leads to worry, and worry is the main characteristic of anxiety (Koerner & Dugas, 2006), then it is reasonable to expect this relationship to exist in terms of statistics anxiety. In short, intolerance of uncertainty should be related to worry, and worry should be related to statistics anxiety. Specifically, the research hypotheses are:

1. Intolerance of uncertainty is significantly correlated with worry in statistics students at pretest.
2. Worry is significantly correlated with six types of statistics anxiety at pretest.
3. Student levels of intolerance of uncertainty, worry, and statistics anxiety will be significantly reduced from pretest to posttest.

4. METHOD

4.1. PARTICIPANTS

The participants for the study were recruited from the college of education in a large public southwestern university. Students in three sections of a graduate level introductory statistics course over the fall and spring semesters of 2010 were asked to volunteer, and all students agreed to participate. Of the ninety-seven (n = 97) participants, most were female (66.0%), and white (64.9%), and just over half were master's students (53.6%). The great majority of the students (90.7%) were more than halfway through their degree programs, with 61.9% having less than 33 hours remaining. Though students were not specifically asked to indicate their majors, enrollment records indicate that the fields of educational psychology, sports psychology, higher education, counseling, hospitality

administration, nutritional science, mass communications, and family/consumer science were represented. Table 1 presents the demographic characteristics of the participants.

Table 1. Sample demographics (n = 97)

	n	*%*	*mean*	*SD*
Male	33	34.0		
Female	64	66.0		
Age			31.47	8.78
White	63	64.9		
Asian	16	16.5		
Hispanic	9	9.3		
African-American	2	2.1		
Other ethnicity	7	7.2		
Master's level	52	53.6		
Doctorate level	45	46.4		

4.2. INSTRUMENTS

Intolerance of uncertainty was assessed with the Intolerance of Uncertainty Scale-12 (IUS-12; Carleton, Norton, & Asmundson, 2007), consisting of 12 items designed to measure one's tolerance for uncertainty. The twelve statements are measured on a 5-point Likert scale ranging from strongly disagree to strongly agree. Items are summed for a total intolerance score, and higher scores indicate higher levels of intolerance. Sample items include "It frustrates me not having all the information I need" and "When it's time to act, uncertainty paralyzes me." Factor analysis was used to support validity of the 12-item scale, shortened from the original 27-item French version (Freeston et al., 1994), and showed an internal consistency reliability coefficient of 0.91 (Carleton et al., 2007). In the current study, Cronbach's alpha reliability coefficient for the IUS-12 scale was 0.85 at pretest and 0.86 at posttest.

The Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) was employed as a measure of students' tendency to worry. Tendency to worry is assessed via 16 statements, with 5 being reverse-scored. All items are measured on a 5-point Likert scale and then summed for a total worry score. Higher scores indicate a higher tendency toward worry. Sample items include "I know I should not worry about things, but I just cannot help it" and "Once I start worrying, I cannot stop." An example of a reverse-scored item is "I find it easy to dismiss worrisome thoughts." The authors conducted factor analysis to support construct validity, and found that the items loaded on one general factor with loadings ranging from 0.38 to 0.73. Reliability was established through internal consistency with a coefficient of 0.93 for the 16 items. For the current study, Cronbach's alpha reliability coefficient for the PSWQ was 0.91 at pretest and 0.88 at posttest.

Statistics anxiety was measured using the Statistics Anxiety Rating Scale (STARS; Cruise et al., 1985), which consists of 51 items measured on a 5-point Likert scale. The instrument consists of six factors designed to assess anxiety in the areas of worth of statistics, interpretation anxiety, test and class anxiety, computation self-concept, fear of asking for help, and fear of statistics teachers. Worth of statistics refers to students' perceptions of the usefulness of statistics either in their personal, academic, or future professional lives. Sample items include "I feel statistics is a waste" and "I'm never going to use statistics, so why should I have to take it?" and are scored along the continuum of 1 (strongly disagree) to 5 (strongly agree). Interpretation anxiety, referring to how much anxiety students feel when faced with having to interpret statistical data or make a decision about an analysis outcome, is scored from 1 (no anxiety) to 5 (high anxiety). Sample items reflecting this type of anxiety include "Making an objective decision based on empirical data" and "Figuring out whether to reject or retain the null hypothesis." Test and class anxiety are measured on the same scale, with items such as "Doing the homework for a statistics course" and "Finding that another student in class got a different answer than you did to a statistical problem." Computation self-concept is intended to represent students' anxiety concerning working on math problems as well as their self-perceptions of mathematical ability (rather than actual mathematical ability). Sample items from this subscale,

measured on a 5-point Likert scale from strongly disagree to strongly agree, include "I haven't had math for a long time. I know I'll have problems getting through statistics" and "I could enjoy statistics if it weren't so mathematical." The final two subscales, fear of asking for help and fear of statistics teachers, are also measured on a 5-point Likert scale with 1 indicating no anxiety and 5 indicating high anxiety. These subscales are designed to assess students' anxiety over asking for help in understanding statistics material, and students' perceptions of statistics teachers. Sample items include "Asking one of your professors for help in understanding a printout" and "Most statistics teachers are not human." Higher scores on each of the subscales indicate higher anxiety levels for that area. Cruise et al. (1985) reported that factor analysis was used to establish construct validity for the instrument, resulting in loadings for the 51 retained items of 0.50 or greater for the six factors. The authors also reported test-retest reliability for the six factors ranging from 0.67 to 0.80, and internal consistency reliabilities ranging from 0.68 to 0.94. For the current study, Cronbach's reliability coefficients for the six subscales were, at pretest and posttest respectively, 0.93 and 0.91 (worth of statistics), 0.88 and 0.88 (interpretation anxiety), 0.93 and 0.92 (test and class anxiety), 0.88 and 0.86 (computation self-concept), 0.89 and 0.86 (fear of asking for help), and 0.77 and 0.82 (fear of statistics teachers).

4.3. PROCEDURE

At the beginning of the fall and spring semesters, graduate students in three sections (one in the fall and two in the spring) of introductory statistics classes were invited to participate in the study. The students were told that the researcher was interested in how they felt about statistics and how they perceived themselves in terms of worry and uncertainty, and were assured of confidentiality and anonymity. Before any statistics instruction began, students who agreed to participate were given an envelope containing a pretest and a posttest. In addition to demographics questions, the pretest and posttest instruments consisted of the IUS-12, PSWQ, and STARS instruments. Students were then instructed to complete the pretest questionnaires only. Upon completion, the students were asked to return the pretest instruments to their envelopes, seal the envelopes, and write the last four digits of their phone numbers on the outside for temporary identification purposes. Near the last day of the semester, the sealed envelopes were returned to the students and they were asked to complete the posttest instruments and destroy the outer envelopes in order to preserve anonymity.

5. RESULTS

Descriptive statistics were calculated for the research variables. Means and standard deviations for intolerance of uncertainty, worry, and the six dimensions of statistics anxiety are given in Table 2.

Table 2. Means and standard deviations for IUS-12, PSWQ, and STARS

	Pretest		Posttest	
Variable	*mean*	*SD*	*mean*	*SD*
Intolerance of Uncertainty	34.55	7.89	33.44	7.35
Worry	54.56	11.97	52.05	12.55
Worth of statistics	33.32	10.42	30.94	8.55
Interpretation anxiety	27.97	8.61	22.71	7.40
Test and class anxiety	25.87	8.65	20.87	8.45
Computational self-concept	16.60	6.30	14.06	4.90
Fear of asking for help	8.88	4.31	7.39	3.61
Fear of statistics teacher	11.22	3.81	8.95	3.12

In order to test hypotheses one and two, Pearson's *r* correlation coefficients were calculated among intolerance of uncertainty, worry, and the six types of statistics anxiety. As a control for the family-wise error rate, the Bonferroni adjustment was applied using a 0.05 alpha level (0.05/28 = 0.002). Therefore, only those correlations that were significant at the adjusted level of 0.002 or lower were deemed significant at the desired 0.05 level when overall error was controlled. The results are presented in Table 3. As expected, intolerance of uncertainty and worry were significantly and

positively correlated, with a large effect size (i.e., $d > 0.50$; Cohen, 1988). Intolerance of uncertainty was significantly positively related to four of the six dimensions of statistics anxiety with the exceptions being worth of statistics and fear of statistics teachers. Worry was significantly positively related to three dimensions of statistics anxiety with the exceptions being worth of statistics, fear of asking for help, and fear of statistics teachers. Effect sizes were moderate (i.e., $0.30 \leq d \leq 0.50$) for the relationships between intolerance of uncertainty and the STARS factors of interpretation anxiety, test/class anxiety, computation self-concept, and fear of asking for help. Effect sizes were also moderate for the relationships between worry and the STARS factors of interpretation anxiety, test/class anxiety, and computation self-concept. Therefore, hypothesis one is supported and hypothesis two is partially supported.

Table 3. Pearson's r correlation coefficients among research variables at pretest

Variable	IUS	PSWQ	WS	IA	TCA	CSC	FAH	FST
IUS	-	.55*	.14	.34*	.41*	.32*	.47*	.21
PSWQ		-	.16	.32*	.38*	.32*	.27	.25
WS			-	.22	.33*	.58*	.21	.35*
IA				-	.64*	.48*	.47*	.38*
TCA					-	.61*	.61*	.40*
CSC						-	.39*	.49*
FAH							-	.40*
FST								-

Note. IUS: Intolerance of Uncertainty Scale; PSWQ: Penn State Worry Questionnaire; WS: Worth of Statistics; IA: Interpretation Anxiety; TCA: Test and Class Anxiety; CSC: Computation Self-Concept; FAH: Fear of Asking for Help; FST: Fear of Statistics Teacher
*overall error rate controlled at $\alpha = 0.05$

Hypothesis three predicted that students' intolerance of uncertainty, worry, and statistics anxiety would be significantly reduced from pretest to posttest. A repeated-measures within-subjects multivariate analysis of variance (MANOVA) was utilized to test this hypothesis. Due to the strength of the relationship between uncertainty, worry, and the six dimensions of statistics anxiety, all were included in the analysis as the dependent variables with stage of test (pretest or posttest) as the independent variable. Dependent variable difference scores were investigated for normality using the Kolmogorov-Smirnov test prior to analysis and found to be slightly skewed. Transformation of the data as a solution to the lack of normality was dismissed due to the robustness of analysis of variance procedures (Wilcox, 2005), adequacy of sample size ensuring normality of the sampling distribution (i.e., $n > 30$), and potential changes to the constructs being tested (Games, 1984). The assumption of sphericity is necessarily met since there are only two levels of the independent variable (O'Brien & Kaiser, 1985). Results of the multivariate test indicate an overall statistically significant change from pretest to posttest for the combination of dependent variables, $\lambda = 0.61$, $F(8, 89) = 7.16$, $p < 0.001$, $\eta^2 = 0.39$.

Follow-up repeated-measures within-subject ANOVAs indicated statistically significant effects on all dependent variables except intolerance of uncertainty and worry. The Bonferroni adjustment was applied to the alpha level of the follow-up ANOVAs to control for family-wise error rate, generating an adjusted significance level of 0.006 (0.05/8 = 0.006). At this significance level, there is evidence that the six types of statistics anxiety are significantly reduced from pretest to posttest, but intolerance of uncertainty and worry were not significantly reduced. Therefore, hypothesis three was partially supported. Results of the univariate ANOVAs are presented in Table 4.

6. DISCUSSION AND CONCLUSIONS

The goal of the current study was to explore the association between intolerance of uncertainty, worry, and statistics anxiety. Through their work over the preceding decade a research group led by Koerner and Dugas (2006) found evidence that intolerance of uncertainty led to worry in both clinical

Table 4. Follow-up repeated-measures within-subject ANOVAs for repeated-measures within-subject MANOVA

Test Variable	*F*	*df*	*p*	η^2
IUS	1.88	96	.063	.04
PSWQ	2.72	96	.008	.07
WS	2.90*	96	.005	.08
IA	5.93*	96	.000	.27
TCA	6.02*	96	.000	.27
CSC	4.77*	96	.000	.19
FAH	3.18*	96	.002	.10
FST	5.56*	96	.000	.24

Note. IUS: Intolerance of Uncertainty Scale; PSWQ: Penn State Worry Questionnaire; WS: Worth of Statistics; IA: Interpretation Anxiety; TCA: Test and Class Anxiety; CSC: Computation Self-Concept; FAH: Fear of Asking for Help; FST: Fear of Statistics Teacher

*overall error rate controlled at $\alpha = 0.05$

and non-clinical samples in terms of generalized anxiety, with intolerance of uncertainty accounting for as much as 42% of the variance in worry scores (Dugas et al., 2001). Due to the stability of their findings, it was expected that intolerance of uncertainty would account for a substantial amount of variance in worry scores in regards to statistics anxiety. This hypothesis was supported with the finding that intolerance of uncertainty accounted for 30.2% of the variance in worry scores for the current sample of graduate statistics students.

With intolerance of uncertainty being significantly related to worry, and because worry is the main component in generalized anxiety (American Psychiatric Association, 2000; Barlow, 2002), it was expected that worry would then be significantly related to statistics anxiety. Moderate effect sizes for correlations between worry and three of the six dimensions of statistics anxiety proposed by Cruise et al. (1985) indicated that this relationship exists at least somewhat. The exceptions were the dimension of worth of statistics, fear of asking for help, and fear of statistics teachers. Worth of statistics is much more of an attitude construct (see Cruise et al.,) than a direct anxiety construct, which may explain the lack of relationship between this construct and worry. Fear of asking for help and fear of statistics teachers are more social in nature, as both require interaction with another person, and perhaps tap into more of a social apprehension construct rather than an anxiety construct. Even so, the data provide evidence that worry is related to some forms of statistics anxiety.

A decrease was expected for all of the variables from pretest to posttest. Through repeated-measures MANOVA, this hypothesis was also partially supported. Levels of all six types of statistics anxiety were significantly lower in the current sample at posttest, but worry and intolerance of uncertainty was not significantly different. It is unclear whether simply going through the statistics course or other factors not measured in the current study may be influencing worry and intolerance of uncertainty in statistics students. Indeed, Koerner and Dugas (2006) suggest as much with their contention that intolerance of uncertainty, which leads to worry, is a function of three other constructs: positive beliefs about worry, cognitive avoidance, and negative problem orientation. Also, it seems likely that since intolerance of uncertainty is defined as a dispositional construct (Koerner & Dugas), and anxiety is an affective construct (Rachman, 2004; Startup & Erickson, 2006) that tends to be transitory (Rachman, p. 30), becoming familiar with statistics would be more likely to have an effect on the latter. Even so, the current study provides a beginning to the potentially useful investigation of the relationship between worry, related constructs, and statistics anxiety in graduate students.

The results of the current study should certainly be generalized with caution. The eight dependent variables were utilized simultaneously which may have resulted in loss of power for detecting differences from pretest to posttest on those variables found to be unaffected. With the strongest effect sizes indicating that change from pretest to postest explains just 27% of the variance in both interpretation anxiety and test/class anxiety, it is clear that other variables are also having an effect on students' statistics anxiety. Fewer variables included over multiple studies, as well as the addition of a

control group, could enhance the information given by this study. With the significant correlations found between the majority of the research variables, the nature of the relationships between intolerance of uncertainty, worry, and statistics anxiety bears further investigation. Future research should continue this endeavor with the addition of other variables known to relate to intolerance of uncertainty, worry, and anxiety.

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