Gender Differences in Mathematics Anxiety:
A Function of Response Bias,
Math Background or Socialization?

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I dedicate this paper to the memory of my mother, Drina Flessati, who died in 1980. I know she would be proud of me. I also want to thank my family, specifically my father John, my brother Gene, and my sister Carla.

The person that I am is a result of taking risks. If I had never tried anything, I never would have learned about the things that I now know, nor would I have accomplished much. By choosing to take risks, I have learned much about life, people, and myself. I am grateful for all of my opportunities to take risks. It was comforting for me to know that when I did take a chance, I would have my family to love, encourage and support me in my endeavors. My words cannot express the love that I feel for them.

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Abstract

Previous research has found that females are more vulnerable to experiencing mathematics anxiety. The present study examined two explanations for the gender difference, the "sex-role" hypothesis, which suggests that gender differences occur as a result of differences in socialization, and the response bias hypothesis, which suggests that males and females may hold different views about the acceptability of expressing math anxiety. Introductory psychology students completed a series of questionnaires examining mathematics anxiety, attitudes and mathematical background. Neither of the explanations were supported by the data. An alternative explanation for the gender difference in math anxiety is proposed based on the finding that females are more self critical.

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INTRODUCTION

Number anxiety was probably first described by Dreger and Aiken (1957). They identified it as an emotional reaction to arithmetic and mathematical concepts. The current term, math anxiety, has been defined by Tobias and Weissbrod (1980) as "the panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem" (p. 65). Fennema and Sherman (1976) felt that mathematics anxiety specifically involved "feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics" (p. 4). The most widely cited definition belongs to Richardson and Suinn (1972). They described math anxiety as involving "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 551). Indeed, on the basis of these few definitions, it is easy to understand how debilitating math anxiety can be.

Interest in math anxiety has generally focused on explanations underlying the generally reported finding that males report lower mathematics anxiety than do females (Bander & Betz, 1981; Betz, 1978; Brush, 1978; Dew, Galassi, & Galassi, 1983; Levitt & Hutton, 1983; Llabre & Suarez, 1985). Various explanations for the gender difference have been proposed. A recent study by Hunsley and Flessati (1988) showed that males and females did not differ in their reported experiences with math, and they suggested that gender differences in mathematics anxiety may simply be a reflection of reporting biases. The purpose of the present study was to evaluate whether the proposed reporting biases exist, and to replicate this recent finding by Hunsley and Flessati (1988).

Sex differences in math ability

Sex differences in mathematical ability have been widely studied (Benbow & Stanley, 1980, 1981, 1983a, 1983b; Fennema & Sherman, 1977, 1978; Sherman, 1979, 1980; Stanley & Benbow, 1983). One explanation for these differences is that males and females differ genetically. Benbow and Stanley (1980, 1983b) have renewed the belief that males are inherently better in mathematics than females. They have stated that any observed differences in mathematical performance favouring males lie in nature rather than in nurture. In their study (1980), they had reported that differences in mathematical reasoning ability (as measured by scores on the Scholastic Aptitude Test-Math) among gifted grade seven students were too great to be attributed to socialization factors. The fact that both males and females had equivalent math backgrounds helped these authors to come to their somewhat controversial conclusion that males have a greater natural ability when it comes to math.

Studies by others (e.g. Pallas & Alexander, 1983; Sherman, 1982; Stallings, 1985) suggest this is not the case. If genetics play a role in mathematical achievement, and these differences in fact favour males, then genetic differences should be evident during all ages. Such is not the case, for consistent sex differences on quantitative-type tests (e.g. mathematics) do not emerge until around the tenth grade. Usually what happens is that males and females score about the same on such tests up until that point. Once mathematics becomes an optional subject to enrol oneself in, differences between the genders become significantly greater, with males producing higher math grades. It appears that the different types and number of courses that males and females choose to take might be responsible for explaining sex-related differences in math performance (Pedro, Wolleat, Fennema, & Becker, 1981). In fact, several authors (e.g., Fennema & Sherman, 1977, 1978; Pallas & Alexander, 1983; Sherman, 1982; Stallings, 1985) have suggested that there are no significant differences on tests of math ability between females and males when a person's mathematical background has been controlled for.

It has also been suggested (Sherman, 1979) that spatial skills are somehow related to an individual's achievement level in mathematics. In fact, mathematical performance level has been associated with the presence of appropriate spatial skills. As with gender differences in mathematics performance, it has been documented (Maccoby & Jacklin, 1974) that there is a gender difference in spatial ability, one which also favours males. It has been suggested that this latter sex difference may underlie the sex difference in mathematical aptitude (Benbow, 1988). Results that support (Stallings, 1985) and dispute (Armstrong, 1981; Very, 1967) this idea exist in the literature.

The major alternative to the genetic explanation is that sex differences in math performance and achievement are due to differences in the socialization of males and females. It is possible that parents and teachers as well as other people might contribute to this effect. They do so through the attitudes and behaviours conveyed to children while serving as role models. Meece et.al. (1982) stated that the above individuals may contribute to these differences in three ways: (a) those males and females who socialize children (e.g. teachers, parents, counsellors) tend to have different attitudes and behaviours toward math; (b) depending upon the child's gender, socializers have different expectations and goals regarding the child's performance and achievement in mathematics; (c) different activities which strengthen certain skills and interests are provided for male and female children. Ernest (1976) found that teachers expect male students to perform better than females in mathematics. If such attitudes are conveyed to students, it would not be a surprise to discover that they influence students' performance.

Relationship between math anxiety and math ability

In general, low levels of math achievement have been found to be associated with high levels of math anxiety (Betz, 1978; Boswell, 1985; Brush, 1978). Typically, individuals who score high on measures of mathematics anxiety also score low on mathematical achievement tests. For example, on the basis of her past research, Fennema (1980) placed "confidence in mathematics" and "mathematics anxiety" at the opposite ends of a continuum, and found that confidence in mathematics correlated .40 with mathematics achievement.

Sex differences in math anxiety

With respect to math anxiety, one frequent finding in the literature is that females tend to report more math anxiety than males (Bander & Betz, 1981; Betz, 1978; Brush, 1978; Dew, Galassi, & Galassi, 1983). Again several explanations have been proposed to account for the gender variation on this variable.

The first explanation is related to the belief that mathematical skills and behaviours are a part of the male behaviourial repertoire (Boswell, 1985; Fox, Tobin & Brody, 1979; Sherman, 1980). The above explanation suggests that females are socialized into believing that they are not to excel at behaviours that are not a part of their own domain. Sex-typing mathematics performance as a masculine domain encourages females to be less motivated to achieve in math. When females are required to participate in math-related activities, they become quite anxious. To avoid the anxiety, they avoid any situations requiring these types of skills. Thus, avoidance of math leaves individuals with little faith in their mathematical abilities.

Another explanation for sex differences in math anxiety is that it is due to one's mathematical skills and previous experiences (Richardson & Woolfolk, 1980). This explanation suggests that when an individual's mathematical background is controlled for, any existing differences in math anxiety disappear. Such was the case in a recent study by Hunsley and Flessati (1988). These authors attempted to clarify some issues pertaining to the causes of mathematics anxiety.

Hunsley and Flessati (1988) pitted two hypotheses against each other. The first, "sex-role socialization" hypothesis posits that females are more math anxious than males because they have had fewer positive experiences with math (and more unfavourable encounters with math), and have more negative opinions toward the subject. This hypothesis suggests that gender differences exist because the female sex-role does not encourage females to achieve in the science or mathematical areas. In the latter area, mathematical skills and achievement are seen as being a part of the male domain. When females attempt to achieve in these areas, they get anxious because they will be displaying behaviours not previously emphasized during their socialization. To avoid a conflict with their sex-role, they avoid math-related situations. Thus avoidance of math-related situations has an adverse effect on their mathematical skills. The end result is that females are very concerned and feel anxious about their skills in math.

The second, "math experiences" hypothesis states that math anxiety is not related to gender, but rather it is due to one's preparation in mathematics, regardless of gender. For example, the most math anxious individuals will have the most impoverished math backgrounds, poorest grades, and will report the most negative opinions about math. This relationship is hypothesized to be the same among males and females.

To test these hypotheses, Hunsley and Flessati (1988) had university students complete a Math Anxiety Rating Scale (MARS), and collected information on students' experiences with mathematics, their enjoyment of math in comparison to other school subjects, and their math grades. Students had to recall such information as it applied to the public school, high school, and university levels.

Overwhelmingly, the math experiences hypothesis was supported. Clear differences were found between the low, moderate and high math anxious groups on most of the above measures, with the more anxious subjects reporting the most negative experiences with mathematics. This occurred regardless of whether subjects were male of female.

Support was not obtained for the sex-role hypothesis. Few gender differences were found, and those gender differences which did exist were opposite to what the sex-role hypothesis suggests. For example, females reported higher marks in public school and in grades 9 and 11 when compared to males. According to the sex-role hypothesis, it should have been males rather than females who reported higher math grades.

While the Hunsley and Flessati (1988) study's conclusions were clear in supporting the math experiences hypothesis, there was one inconsistent finding which needs to be explored further.

Gender differences were found on the MARS, with females being significantly more math anxious than males. This is odd because no other results which support the sex-role hypothesis were found. Hunsley and Flessati (1988) were puzzled by the existence of gender differences on the MARS. They had proposed that perhaps a response bias was responsible for that particular gender difference. They suggested that males, compared to females, may be less likely to admit to being math anxious. Consequently, males may report less mathematics anxiety than they actually experience. Alternatively, females may over-report the amount of anxiety they experience.

Nolen-Hoeksema (1987) hypothesized that the inaccurate reporting, or rather under reporting of symptoms may be a potential problem in the literature of depression. She stated that the gender difference in depressive symptomatology might be a result of men's "unwillingness to admit to and seek help for depressive symptoms" (p. 266). She thought that because depressive symptoms are seen as being more feminine, men may report them less frequently. Further, men may behave in such a fashion so as to avoid appearing feminine. She stated that this may occur even though men experience depression as often and to the same degree as women.

It is possible that a similar response bias may be operating for mathematics anxiety, however, no such investigation into the role of response bias has taken place. 'Meece et.al. (1982) recognized the possibility that "men might be less willing to admit to feelings of anxiety, especially with regard to an area of achievement that is viewed as masculine, particularly by men" (p. 333). These same authors also noted that social desirability and defensiveness are two factors that need to be taken into account when assessing an individual's level of mathematics anxiety. Similarly, Vrendenburg, Krames, & Flett (1986) posed the question of why so few men apparently experience episodes of depression. They proposed that men are an important group to study especially if their hesitancy to express depression is a result of perceived and/or actual social disapproval. They stated that studies need to examine "the importance of social acceptability of symptom expression for males" (Vrendenburg, Krames, & Flett, 1986).

THE PRESENT INVESTIGATION

The present study examined how male and female subjects view the expression of mathematics anxiety. Differential views about the acceptability of mathematics anxiety could underly a response bias. For example, if males believe that it is socially unacceptable to express math anxiety, then this might inhibit their reporting of mathematics anxiety. Similarly, if females believe that it is acceptable to experience anxiety toward math, then such attitudes may facilitate the reporting of these feelings.

In the present study, two issues were examined to assess the possible presence of a response bias: (1) gender-related stereotypes of anxiety towards different school subjects, including math, and (2) gender-related attitudes about the expression of math anxiety. First, subscription to a cultural stereotype may cause an individual to indicate that one particular gender is more likely to be anxious about participation in different subject areas. For example, if a male subject indicates that females are more susceptible to being anxious about math, then this belief may influence the subject's perceived level of his own math anxiety. This belief may result in reporting a lower level of math anxiety than he actually experiences.

The existence of a belief that there are negative repercussions associated with experiencing/expressing math anxiety (i.e., it is viewed as being inappropriate) was examined as a second mechanism which might underly a response bias. A subject who feels that negative repercussions accompany the expression of math anxiety may become defensive, and subsequently report a lower level of math anxiety than he/she is actually experiencing. Similarly, subjects who feel that there are not any repercussions associated with math anxiety (i.e.,it is acceptable) might be more willing to reveal higher levels of math anxiety.

If the gender difference on the MARS is due to a response bias, then females should report that the expression of math anxiety is acceptable while males should report that they are embarrassed to express math anxiety. Such attitudes could influence the extent to which a person reports his/her level of math anxiety. For example, lower scores on the MARS may be associated with a belief that reflects a lot of embarrassment, shame, or inappropriateness (low acceptability rating) in expressing math anxiety. Likewise, higher MARS scores may be associated with an attitude that reflects little embarrassment or shame (high acceptability rating) in expressing math anxiety.

The main goal was to determine whether gender differences in mathematics anxiety remained after response biases had been partialled out. If the gender differences exist even after the effects of a response bias have been partialled out, there is reason to believe that gender differences are real, and not an artifact of response bias. If the gender difference does not appear after partialling out the response bias, then it may be concluded that males and females probably do not differ in the amount of math anxiety they experience.

Method

Subjects

The participants consisted of 151 undergraduate students (61 males, 90 females) from an introductory psychology class at Lakehead University in Thunder Bay, Ontario. The subjects ranged in age from 17 to 49, with an average age of 22.11 years. Most of the participants were in their first or second year of university. Involvement in the study was voluntary, and those students who agreed to participate received credit for their participation.

Procedure and Measures

Subjects were asked to participate in a study which examined the relationships between mathematics anxiety, mathematical background and experiences, and attitudes about math anxiety. Subjects were informed that participation in the study was voluntary. Those students who agreed to participate were asked to complete several measures: a mathematics anxiety scale an extensive math biography questionnaire, and a questionnaire about attitudes toward math anxiety.

The questionnaires were administered to small groups of students in a classroom setting. Prior to receiving the measures, subjects were given a cover letter and a consent form. The cover letter, presented in Appendix A, explained the general nature of the study. Subjects were also required to read and sign the consent form if they agreed to participate in the research project. A copy of this form is shown in Appendix B. To ensure the subjects' anonymity, the consent forms and measures were collected separately. This was done so that subjects' names would not be associated with their completed measures. The completion of the measures took approximately 30 to 40 minutes.

Math anxiety was assessed using the Mathematics Anxiety Rating Scale (MARS; Richardson & Suinn, 1972). This particular scale consists of 98 items which are presented in a Likert format. Subjects indicated on a 5-point scale (from 1 = "not at all" to 5 = "very much") how much anxiety is felt while performing each of the items. By summing the items together, a single score for the MARS was obtained. The scores on the MARS range from a minimum of 98 points to a maximum of 490, and reflect the degree of mathematics anxiety that a person experiences, with higher scores reflecting greater levels of math anxiety. The authors (Richardson & Suinn, 1972) of the MARS reported a high internal consistency coefficient (alpha = .97) and a seven-week test-retest coefficient of .85 (Richardson & Suinn, 1972). A copy of this measure is shown in Appendix C.

Subjects were also requested to complete a Math Biography Questionnaire. This questionnaire was based upon the one which was used in the Hunsley and Flessati (1988) study. The questionnaire is presented in Appendix D. The questions attempt to gather information about a subject's mathematical background, opinions about mathematics, and experiences. The questionnaire is divided into four sections: public school information, high school information, general information, and math anxiety attitudes. For the public and high school information sections, subjects were asked to indicate on a 5-point Likert scale: how they felt about taking math (from 1 = "disliked it very much" to 5 = "liked it very much"); how they liked math in comparison to other subjects (from 1 = "much less" to 5 = "much more"; and, how their marks in mathematics compared to marks in other school subjects (from 1 = "much lower" to 5 = "much higher"). They were also requested to provide information on math marks which they received at the elementary and high school levels on a 6-point scale (from 5 = "A" to 0 = "F"). Subjects recalled any positive or negative experiences which they had encountered throughout their school years.

In the general information section, subjects reported information on their overall grade point average (GPA) on a 13-point scale (from 12 = "A+" to 0 = "F"), their perceived overall ability in mathematics on a 5-point scale (from 1 = "very poor" to 5 = "very good"), and they were asked to indicate on a 5-point scale which gender they believe is more likely to be anxious about mathematics and other school subjects (from 1 = "mostly female" to 5 = "mostly male"). Finally, subjects were required to complete an 18-item scale on the attitudes toward math anxiety. Three subscales of six items each were used to assess the attitudes of math anxiety as it occurs among males (Male subscale), females (Female subscale), and self (Self subscale). Six phrases which tapped different connotations or consequences associated with the expression of math anxiety were selected. The phrases focused upon feeling silly, ashamed, embarrassed, or weak if a person was anxious about mathematics. Subjects were also asked to indicate whether it would be appropriate or acceptable for a person to have anxiety about math. The same six phrases were used on all three subscales with the focus being on either males (Male subscale), females (Female subscale) or self (Self subscale). Each item was rated on a scale of 1 = "strongly agree" to 5 = "strongly disagree". A score for each of the Male, Female, and Self subscales was obtained by summing across the 6 items (reverse scoring where appropriate). The scores range from a minimum of 6 to a maximum of 30 with 18 being a neutral point, and higher scores reflecting little negative connotations/consequences associated with the expression of math anxiety (higher degree of acceptability).

Results

Subjects in this study were more anxious than those who participated in the Hunsley & Flessati (1988) study. In the present study, male and female subjects reported MARS scores (M's = 189.18 and 235.73, respectively) that were significantly higher than those reported by males and females in the original study (M's = 163.1 and 189.9, respectively). The t-values for the MARS score comparisons across the two studies are presented in Appendix E. The differences may reflect the different populations used in the two studies. Introductory psychology students were used in this study, whereas in the previous study, statistics students were the participants.

A t-test calculated to determine gender differences on the MARS was found to be significant (t (148) = 4.21, $p < .001$). Female subjects (M = 235.73) reported significantly higher MARS scores than their male counterparts (M = 189.18).

In order to obtain comparable analyses to the Hunsley & Flessati (1988) study, three distinct math anxiety groups were created using the tercile split method. Subjects were assigned to one of three groups, each of which contained 50 subjects: a) low math anxious group (MARS scores between 98 and 178); b) moderately math anxious group (MARS scores between 179 and 243); and, c) highly math anxious group (MARS scores greater than 243). The one-way ANOVA and Newman-Keuls comparisons confirmed that the three groups were significantly different from each other at the .05 level of significance (F (2,147) = 319.76, p < .001). The means of the low, moderate and high math anxious groups were 145.54, 211.96, and 295.89, respectively.

In the following MANOVA's an ANOVA's, the main effects of gender and math anxiety, as well as the interactions between these independent variables will be examined. It is important to note that the independent variables of gender and math anxiety are not "independent". Thus, some of the variation predicted from each will be common or shared variance (Keppel & Zedeck, 1989). The ANOVA's and MANOVA's conducted here deal with this shared variance by ignoring it. A regression approach is used which deletes this shared variance from each main effect (and interaction). Thus the effects reported in the following analyses represent partialled relationships (e.g., the effect of gender which is not predictable from math anxiety).

The purpose of the analyses (in the next three sections) is to attempt to replicate the results obtained in the Hunsley & Flessati (1988) study. As in that study, two hypotheses were tested: (a) Sex-Role Hypothesis: it suggests that the extent of one's math-related opinions, grades and positive/negative encounters (as assessed by open-ended questions) vary as a function of gender (i.e., a main effect of gender should appear); (b) Math-Experiences Hypothesis: it suggests that these same variables differ as a function of one's level of math anxiety, regardless of gender (i.e., no main effect of gender should appear). Math experiences were analyzed in three sets: (1) ratings of public school experiences; (2) ratings of high school experiences; and, (3) number of reported positive and negative experiences to open ended questions.

Public School Variables

In order to examine the effects of gender and math anxiety level on reported public school grades and opinions about mathematics at the public school level, a multivariate analysis of variance (MANOVA) was performed on these four variables. It indicated a main effect of math anxiety level (approximate multivariate F (12,278) = 2.72, p = .002), but no main effect of gender or gender by math anxiety level interaction.

To analyze the main effect of math anxiety level, one-way ANOVA calculations were performed on all public school variables. All ANOVA's were found to be significant. Subsequently, to determine how the math anxiety level groups differed from each other, Newman-Keuls comparisons set at the .05 level of significance were calculated. The results of the mean comparisons are presented in Table 1.

For math grades obtained in public school, the low math anxiety group obtained significantly higher math grades than both the moderately and highly math anxious groups. When comparing math grades to grades in other subjects, the one-way ANOVA's revealed that the highly math anxious group obtained significantly lower math grades than those math grades reported by the moderately and low math anxious groups. On the math opinion variable (Like Math?), all groups were significantly different from each other. The low math anxious group reported that they liked math more than all subjects in the other groups; the moderately math anxious group liked math more compared to the low math anxious group. Finally, when comparing the opinions of other subjects to one's opinions toward math, it was found that all groups were different from each other.

Table 1: Comparisons Among Math Anxiety Groups on Public School Variables

Math Anxiety Group

Public School Variable	**Low**		**Moderate**		**High**			
	M	S.D.	...	S.D.	M	S.D.	F.	p.
Math Grades	3.40_a	.83	3.00_b	.97	2.82_b	.81	5.79	<.01
Math Grades in Comparison to Grades in Other Courses	3.38_a	1.05	3.08_a	.94	2.63_b	1.01	6.95	<.01
Like Math?	4.16_a	1.04	3.68_b	1.27	3.12_c	1.21	9.82	<.001
Like Math in Comparison to Other Courses	3.64_a	1.22	2.94_b	1.17	2.36_c	1.17	14.53	<.001

Degrees of freedom for F range from (2, 148) to (2, 149).

Means which share identical subscripts are not significantly different (.05 Neuman-Keuls comparisons).

The low math anxious subjects revealed that in relation to other school courses, they enjoyed math much more than the two other groups; the moderately anxious subjects, compared to the highly anxious, stated that they liked math more in relation to their other school courses.

High School Variables

A MANOVA was conducted on the variables describing reported opinions and grades regarding math during subjects' high school years. It indicated a main effect of math anxiety level (approximate multivariate $\underline{F}$ (20,156) = 3.56, $\underline{p} < .001$), but no main effect of gender or gender by math anxiety level interaction.

To examine the main effect of math anxiety level on the various high school variables, one-way ANOVA's were calculated. For high school math grades, all of the one-way ANOVA's produced significant results. In each case, the low math anxious subjects reported significantly higher math grades than both the moderately and highly math anxious students. Furthermore, it was also found that the math marks of the moderately and highly math anxious students did not differ significantly. The means and standard deviations of the math grades are presented in Table 2.

When comparing the math grades with grades obtained in other courses, the ANOVA revealed that all three math anxiety groups were different from each other. Low math anxious individuals reported having math grades significantly higher than both the moderately and highly math anxious individuals. In turn, compared to the highly math anxious group, moderately math anxious subjects rated their marks in math as being significantly higher in relation to other courses.

Analyzing the opinions (Like Math?) that one holds about mathematics revealed that all three groups were different from each other. Subjects who were low in math anxiety reported liking math significantly more than both the moderately and highly math anxious subjects. Furthermore, the moderately math anxious group indicated that they liked math more than the subjects classified as being high in math anxiety. Finally, when comparing the opinions of other courses to the opinions that one holds about math, it was discovered that all math anxiety groups were different from each other. In comparison to the members of the other groups, low math anxiety subjects stated that they liked math more than their other courses. Similarly, in comparison to the highly math anxious

Table 2: Comparisons Among Math Anxiety Groups on High School Variables

High School Variable	Low M	Low S.D.	Moderate M	Moderate S.D.	High M	High S.D.	F.	p
Math Grades:								
Grade 9	3.40_a	.81	2.45_b	1.10	2.46_b	1.03	15.21	<.001
Grade 10	3.26_a	.88	2.42_b	.96	2.29_b	1.00	15.43	<.001
Grade 11	3.14_a	.81	2.34_b	1.12	1.98_b	1.11	16.58	<.001
Grade 12	2.94_a	1.03	2.12_b	1.15	2.12_b	.95	9.40	<.001
Grade 13	2.90_a	.99	2.22_b	1.05	1.96_b	1.08	7.29	<.01
Math Grades in Comparison to Grades in Other Courses	3.00_a	1.12	2.35_b	1.11	1.80_c	.97	15.77	<.001
Like Math?	3.80_a	1.11	2.88_b	1.22	2.16_c	1.67	24.92	<.001
Like Math in Comparison to Other Courses	3.30_a	1.30	2.36_b	1.33	1.82_c	1.04	18.47	<.001

Degrees of freedom for F range from (2, 91) to (2, 148).

Means which share identical subscripts are not significantly different (.05 Neuman-Keuls comparisons).

group, subjects classified as moderately math anxious stated that they liked math more in relation to other courses. All means and standard deviations of the above variables are presented in Table 2.

Math-Related Encounters

Subjects were asked to document any math-related experiences that they had encountered during their public school and high school years. The content of the encounters were rated as being positive, negative, or neutral. Positive encounters were defined as anything which enhanced an individual's enjoyment of mathematics, while negative encounters were defined as those encounters which increased an individual's level of anxiety or distaste for mathematics. Examples of positive encounters that were documented include: having a good attitude toward mathematics, receiving high grades, winning mathematics achievement awards, being asked to tutor students in math, being able to grasp mathematical concepts, and having an encouraging teacher. Examples of negative encounters that subjects documented include: failing math tests, having a poor teacher, having to drop to a lower level of math, being asked to withdraw from a math course due to poor grades, not being able to grasp mathematical concepts, and disliking the teacher.

The four reports of encounters (public school positive, public school negative, high school positive, high school negative) were examined as two within subject variables: valence (positive versus negative), and school level (public school versus high school) in an ANOVA with gender and group (math anxiety level) as between subject factors. The results indicated that there was a main effect of gender (F (1,143) = 12.30, p =.001). Overall, females reported more math-related encounters (M = 6.21) than males (M = 5.08). The main effect of school was significant (F (1,143) = 4.35, p = .039). Subjects reported more math-related encounters at the high school level (M = 3.01) than at the public school level (M = 2.75).

The math anxiety level by valence interaction was significant (F (2,143) = 7.41, p =.001). The means and standard deviations of this interaction are presented in Table 3. The diagram of the interaction is presented in Figure 1. Subjects who were low and moderate in math anxiety reported more positive than negative math-related encounters. This tendency was reversed for high math anxiety subjects. These latter subjects reported more negative math-related encounters.

Table 3: Comparisons Among Math Anxiety Groups on Type of Math Experience (Valence)

Math Anxiety Group

	Low		**Moderate**		**High**			
Valence	M	S.D.	M	S.D.	M	S.D.	F	p
Positive	3.44_a	1.57	3.02_{ab}	1.29	2.72_b	1.05	3.74	<.05
Negative	2.36_a	1.08	2.86_a	1.44	2.94_a	1.45	2.75	n.s.
t - values	4.26		.65		-.95			
p =	<.001		n.s.		n.s.			

Degrees of freedom for F are (2,148).

Means which share identical subscripts are not significantly different (.05 Neuman-Keuls comparisons).

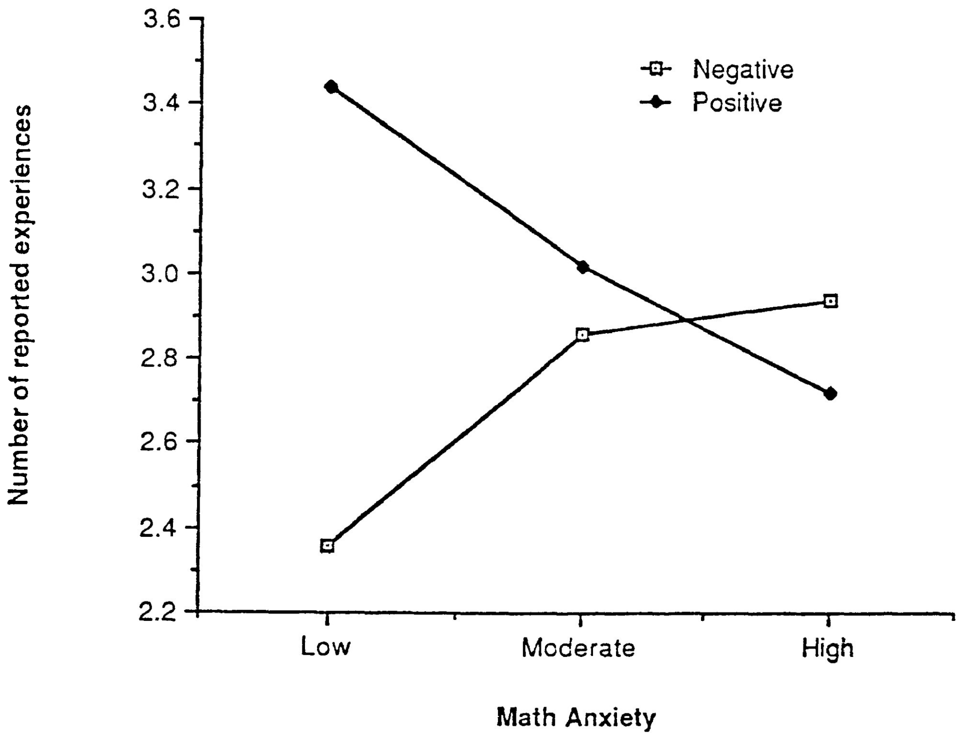

Figure 1: Mean number of reported math experiences according to valence and math anxiety level

The results of the analyses of math experiences are consistent with those results obtained previously (Hunsley & Flessati, 1988), suggesting that once again the math experiences hypothesis is supported. The only main effect of gender was a greater number of experiences (regardless of valence) reported by females to the open ended questions. Thus, there is no evidence that females reported more negative experiences (e.g., poorer grades, negative opinions and grades). However, there remains one puzzling phenomenon: why do gender differences on the MARS continue to exist? This question leads into the second underlying purpose of the study: to examine the possibility that a response bias exists. For example, a bias that reflects a high degree of embarrassment, shame, or inappropriateness in expressing math anxiety (low acceptability rating) may be associated with low scores on the MARS, while a bias indicating that a person feels little shame/embarrassment in expressing math anxiety (high acceptability rating) may be associated with high MARS scores. If there is a gender-linked response bias in the attitudes towards the expression of math anxiety, then females would report that math anxiety is appropriate/acceptable to express, while males report that they are embarrassed to express math anxiety.

RESPONSE BIAS HYPOTHESIS FINDINGS

One mechanism which could underlie response bias would be the existence of "gender-related stereotypes" that females are more likely to be anxious than males in a variety of situations, especially math. Individuals were asked to rate whether males or females are more likely to be anxious about participation in a variety of subject areas (fine arts, social sciences, mathematics, engineering). The rating scale ranged from 1 = "females more" to 5 = "males more", with 3 serving as a neutral point (neither males or females). Table 4 contains the mean ratings for males and females for each of these subject areas. Males and females did not differ in their opinion of which gender was more likely to be anxious about participation in different subject areas. Both males and females reported that anxiety about participation in fine arts, mathematics, social sciences, and engineering is something that both genders share equally. As well, none of the mean ratings were significantly different from the neutral rating (3).

A second mechanism which might underlie response bias is the existence of a belief that it is

Table 4: Males' and Females' Mean Ratings for Gender-Related Anxiety in Different Subject Areas

	Gender					
	Males		Females		univariate	
Course	M	S.D.	M	S.D.	F.	p
Fine Arts	3.00	1.00	2.90	1.17	.043	r
Mathematics	2.75	1.00	3.01	.91	2.79	n.s.
Social Sciences	2.98	1.24	2.94	1.26	.84	n.s.
Engineering	3.27	1.55	3.10	1.51	1.38	n.s.

Degrees of freedom for F are (1,149).

Rating scale ranged from 1 = "Females more" to 5 = "Males more", with 3 serving as a neutral point (neither males nor females).

Note: None of these means are significantly different from 3.0.

unacceptable or inappropriate to experience/express math anxiety. Subjects who feel it is less acceptable to experience math anxiety might be defensive and thus report lower levels of math anxiety, while subjects who feel it is acceptable to experience math anxiety might be more willing to reveal higher levels of math anxiety. If it were perceived by males to be more acceptable for females to experience math anxiety, or if females report feeling it is more acceptable for themselves to experience math anxiety, then these attitudes might promote a background against which females might be freer to report math anxiety, while males would be more defensive.

An 18 item scale was used to assess attitudes toward the expression of math anxiety, with 6 items referring to each of males (Male subscale), females (Female subscale) and self (Self subscale). Each item was rated on a scale of 1 = "strongly agree" to 5 = "strongly disagree". A score for each of the Male, Female, and Self subscales was obtained by summing across the 6 items (reverse scoring where appropriate). Alpha coefficients calculated for each of the subscales were found to low (Male: alpha = .682; Female: alpha = .402; Self: alpha = .593).

To determine the relations between gender, math anxiety level, and the type of object (Male, Female or Self) in the statements, a MANOVA was calculated on the subscale scores. The main effect of object (approximate multivariate $\underline{F}$ (2,143) = 32.07, $\underline{p}$ < .001) was significant.

Paired t-tests were used to compare the scores on each of the three object subscales. All t-test comparisons found that scores on all three subscales were significantly different from each other. Individuals were significantly more embarrassed and/or unaccepting of math anxiety when it occurs within themselves (M = 20.92) than when it occurs in other males (M = 24.05) or females (M = 23.44). Furthermore, individuals were significantly more accepting of math anxiety when it occurs among males than when it occurs among females ($\underline{t}$ (150) = -2.26, $\underline{p}$ =.025). A graph of the object main effect is presented in Figure 2. This finding is particularly interesting because it is contrary to what the response bias hypothesis predicts. If the results were consistent with the hypothesis, it was expected that subjects would be much more tolerant of females who experience math anxiety rather than males. What actually occurred was that subjects were significantly more tolerant of males who experience math anxiety and not females.

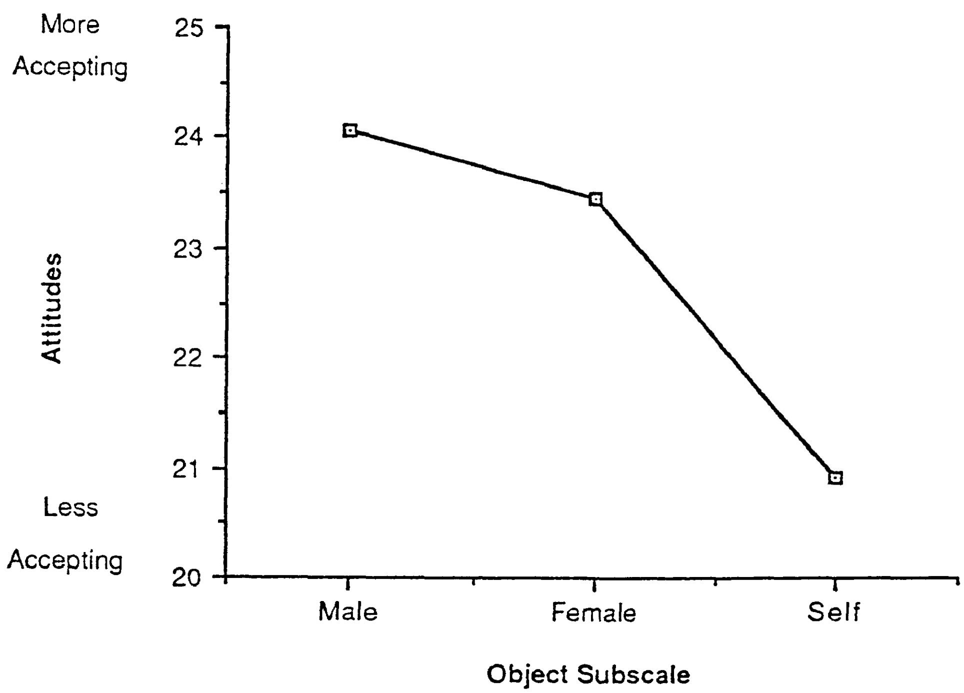

Figure 2: Mean ratings of attitudes toward the expression of math anxiety for each subscale

The gender by object interaction was significant (approximate multivariate F (2,143) = 8.79, p < .001). Compared to males, female subjects are more tolerant of other males and females who have math anxiety. When females are required to rate their attitudes toward the acceptability of math anxiety within themselves, they are less tolerant than males. The means and standard deviations of this interaction are presented in Table 5. A diagram of this interaction is presented in Figure 3. It should be noted that this particular interaction also yielded findings opposite to those predicted by the response bias hypothesis. Again, if the results were to be consistent with the hypothesis, it was expected that females, rather than males, would yield scores on all three subscales (Males, Females, Self) that would indicate that they have more positive attitudes about the expression of math anxiety. While it is true that females were more tolerant of the expression of math anxiety by other males and females, the trend reversed when it came to the assessment of attitudes about their own self expression of math anxiety. It was found that females were less tolerant about their own self expression of math anxiety.

The group by object interaction was found to be significant (approximate multivariate F (4,288) = 3.66,

Table 5: Males' and Females' Mean Ratings of Attitudes toward Math Anxiety for Male, Female, and Self subscales

	SubScale					
	Male		**Female**		**Self**	
Gender	M	S.D.	M	S.D.	M	S.D.
Male	23.43_a	4.05	22.75_a	3.29	21.37_a	4.23
Female	24.46_a	4.01	23.89_a	3.48	20.54_a	4.57
t - values	1.45		2.01		1.12	
p =	n.s.		.046		n.s.	

Degrees of freedom for F are (2,149).

Means which share identical subscripts are not significantly different (.05 Neuman-Keuls comparisons).

Higher scores indicate that subjects are more accepting of math anxiety as it occurs among other males, females, or themselves.

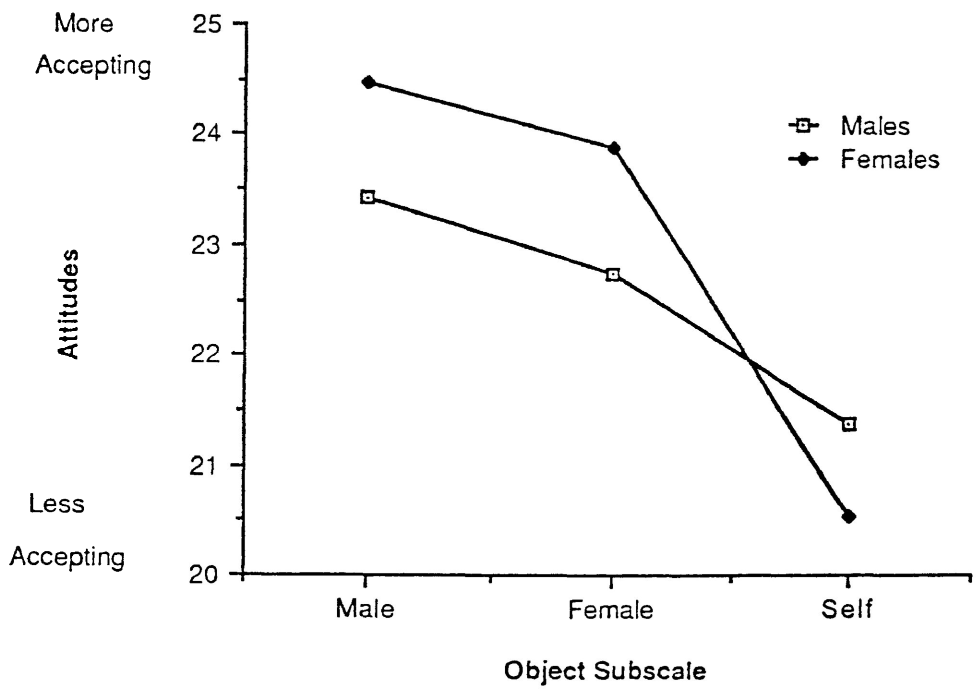

Figure 3: Mean ratings of attitude toward the expression of math anxiety for each subscale by male and female subjects

$p < .01$). In order to determine how the three math anxiety groups differed on each of the scales, one-way ANOVA's were calculated. The one-way ANOVA's on the male and female subscales were nonsignificant, however on the Self subscale there were significant differences between the math anxiety levels (univariate F (2,149) = 6.61, $p = .002$). A Newman-Keuls comparison, set at the .05 level of significance indicated that the highly math anxious subjects felt significantly less ashamed and embarrassed about expressing math anxiety, and were more accepting of math anxiety within themselves than were the moderate and low math anxious subjects. The means and standard deviations of this interaction are presented in Table 6. A graph of this interaction is also presented in Figure 4.

For each math anxiety group, paired t-tests were used to compare the scores on each of the three object subscales (Appendix F). For the low math anxious subjects, all t-test comparisons found that scores on the three subscales were significantly different from each other. Individuals were significantly more embarrassed and/or unaccepting of the expression of math when it occurred within themselves than when it occurred in either males or females. Furthermore, low math anxious individuals were significantly more

Table 6: Math Anxiety Groups' Mean Ratings of Attitudes toward Math Anxiety for Male, Female, and Self subscales

Math Anxiety Group

Acceptability Scale	Low M	Low S.D.	Moderate M	Moderate S.D.	High M	High S.D.	F	p
Male	24.04_a	3.89	23.78_a	4.20	24.38_a	4.13	.27	
Female	22.96_a	3.59	23.16_a	3.47	24.22_a	3.16	1.97	
Self	19.66_a	4.79	20.40_a	3.86	22.64_b	4.09	6.61	<.01

Degrees of freedom for F are (2,149).

Means which share identical subscripts are not significantly different (.05 Neuman-Keuls comparisons).

Higher scores indicate that subjects are more accepting of math anxiety as it occurs among other males, females, or themselves.

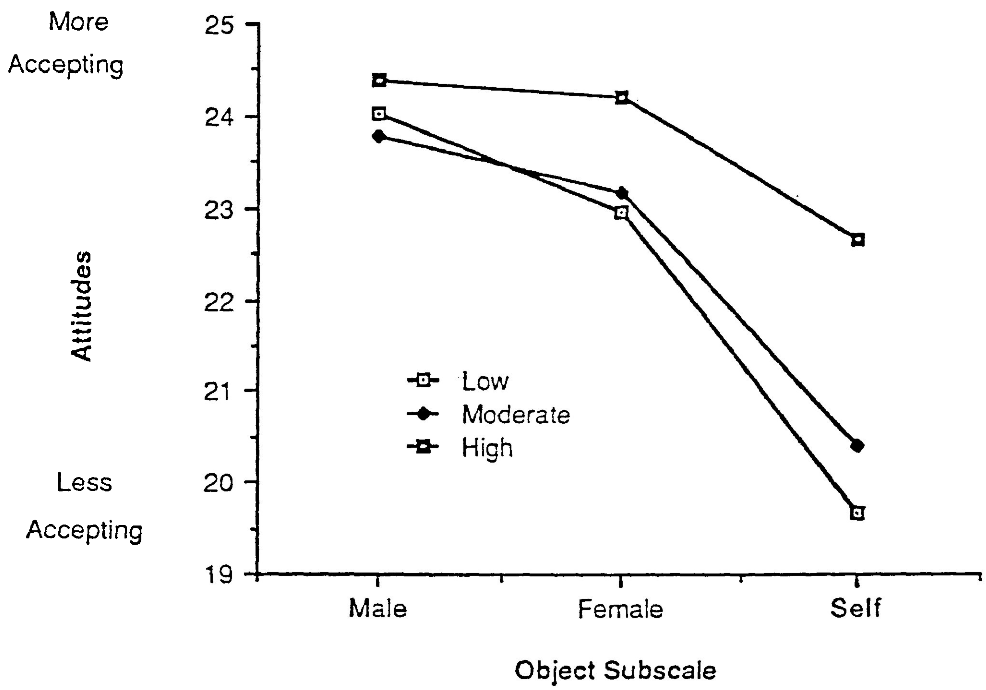

Figure 4: Ratings of attitudes toward the expression of math anxiety for each subscale according to the math anxiety level

accepting of math anxiety when it occurred in males than in females.

For moderate and high math anxious subjects, a similar pattern emerged with respect to differences on the subscales. Again individuals were more embarrassed and/or unaccepting of math anxiety within themselves. Differences in the attitude scores on the Male and Female subscales were not significantly different for moderate or high math anxious subjects.

The three way interaction between gender, group and object was not significant.

Additional Analyses

Subjects were also asked to indicate whether their positive and negative math-related experiences (e.g., grades, opinions, encounters) had an impact on their choice of university major. The chi square analyses indicated that the occurrence of negative experiences had different effects on the three math anxiety groups (χ^2 (2, N = 150) = 17.49, $p < .001$). More moderate and high math anxious subjects (40.7% and 45.8%, respectively) indicated that negative experiences did play a role in their choice of university major, whereas only 13.6% of low math anxious subjects stated that these experiences did influence them. Positive experiences did not have differential influences on the three groups of math anxious subjects.

Chi square analyses also showed that the impact of any type of experiences did not affect males and females differently.

Perceived Math Ability

An ANOVA was calculated on the variable that assessed an individual's perceived ability in mathematics. It indicated that there was a main effect of math anxiety level (F (2,148) = 25.59, $p < .001$). The gender main effect and the gender by math anxiety level interaction were not statistically significant. Newman-Keuls comparisons showed that all three math anxiety groups were significantly different from each other. Those subjects who had the lowest levels of math anxiety rated themselves as having higher levels of mathematical ability (M = 3.66) compared to the moderately math anxious group (M = 3.0). Similarly, the moderately math anxious group rated their mathematical ability as being significantly higher than the most math anxious subjects (M = 2.44).

MULTIPLE REGRESSION ANALYSES

An alternative method of analysis is to use multiple regression viewing the MARS score as the dependent variable. In this method, a set of variables is entered into the regression equation to evaluate whether this set is related to (predictive of) the MARS score. Gender is entered last into the equation, and, if gender differences are significant, the conclusion would follow that this set of variables did not account for, or explain, the relationship between gender and MARS score. Multiple regression analyses were performed on each of the preceding sets of variables. The results of these analyses are summarized in Table 7. In no case did any of the sets of variables eliminate the gender effect. Thus, the conclusions are identical to those revealed in the earlier analyses. Even when all of the variables are partialled out, the gender difference remains.

Table 7. Regression Analyses on All Sets of Variables

	R^2 Change		
Public school variables (4)	.182	4.83	.0014
Gender	.087	10.24	.0019
High school variables (8)	.325	4.99	.0000
Gender	.091	12.80	.0006
Math related encounters (4)	.074	1.75	n.s.
Gender	.123	13.14	.0005
Ratings of gender related anxiety (4)	.090	2.15	n.s.
Gender	.071	7.23	.0086
Attitudes about Math Anxiety (3)	.024	.71	n.s.
Gender	135	13.91	.0003
All of the above variables (23)	.453	2.45	.0023
Gender	.079	11.27	.0013

Numbers in parentheses indicate number of variables entered in each set.

Discussion

The main problem of interest in the present study was why males and females generally report different levels of math anxiety. Two possible explanations for these gender differences in mathematics anxiety were explored: (1) sex-role socialization and, (2) response bias. Neither of these explanations were supported by the present study.

The first explanation, the sex-role hypothesis (Hunsley & Flessati, 1988) suggests that females are more anxious about math than males because they have had fewer positive math experiences (and more negative experiences). Gender differences exist because the female sex-role does not emphasize or encourage achievement in the mathematical or science domains (Boswell, 1985; Fox, Tobin & Brody, 1979; Sherman, 1980). Displaying behaviours that are incongruent with a person's sex-role expectations produces anxiety. To avoid the conflict and subsequent anxiety, females avoid math-related situations. Consequently, they become very concerned and anxious about their mathematical skills. A study by Hunsley & Flessati (1988) found little evidence to support the sex-role hypothesis. Males and females were not significantly different in terms of the mathematical experiences that they reported (e.g., opinions about math, grades in math).

In the present study, this explanation was also not supported, for males and females did not report different types of math experiences. Their opinions about mathematics, previous grades, and the number of positive and negative math-related encounters that they have experienced in the past were not significantly different. Thus, the results found in this study were similar to those obtained in the Hunsley & Flessati (1988) study.

The present study also confirmed other results obtained by Hunsley & Flessati. It was found that an individual's mathematical background is related to his/her levels of math anxiety. Regardless of whether subjects were male or female, consistent differences on the math experiences variables were found between the low, moderate and high math anxiety groups. Thus, according to both studies, it appeared that individuals in the three math anxiety groups could be distinguished on the basis of their mathematical experiences.

The fact that gender differences in mathematics anxiety could not be accounted for by an individual's previous experiences led to the development of the second explanation, the response bias hypothesis. It suggests that males and females may hold different views about the expression of mathematics anxiety and about who experiences it. Two methods were used to determine the presence of a response bias: (1) gender-related stereotypes and, (2) gender-related attitudes about the expression of math anxiety.

First, the presence of gender-related stereotypes was evaluated. Individuals who subscribe to gender-related stereotypes may be more likely to indicate that one particular gender is more likely to be anxious about participation in different subject areas. For example, a male's level of math anxiety may be influenced if he feels that females are more susceptible to being anxious about math. The results did not support the presence of a gender-related stereotype, for both males and females reported that anxiety about participation in different subject areas is something that the genders have equally. Thus, neither males nor females are believed to be more prone to anxiety in different course areas.

An alternative method was also used to assess a possible response bias. If males believe that the expression of math anxiety is unacceptable while females believe that its expression is acceptable, then this might account for gender differences in math anxiety. If an individual views math anxiety as an emotion that is socially unacceptable to express, then this might cause an individual to inhibit his/her expression of anxiety toward mathematics. Similarly, if an individual perceives that it is acceptable to experience math anxiety, then such attitudes may encourage an individual to freely express these feelings. An 18-item questionnaire was used to assess attitudes toward the expression of math anxiety. Three subscales of 6 items each were used to assess the attitudes of math anxiety as it occurs among males, females, and self. This suggestion was not supported since females were not found to be significantly more accepting/unaccepting of the expression of math anxiety when it occurs within themselves or within males.

It is disappointing that neither of these explanations received any support. The relationship between math anxiety and gender is quite strong and was observed in both Hunsley & Flessati (1988) and the present study. As well, this relationship is well documented in other studies (Bander & Betz, 1981; Betz, 1979; Brush, 1978; Dew, Galassi & Galassi, 1983; Levitt & Hutton, 1983; Llabre & Suarez, 1985). The present study examined what seemed to be the two most plausible explanations for this relationship, and found no support for either one. At this point two issues will be considered. First, the possibility that the present study (and also Hunsley & Flessati, 1988) failed to validly test these explanations will be discussed in light of possible limitations to the methodologies utilized. Second, assuming that neither the sex-role socialization nor response bias explanations are correct, an alternative explanation will be presented.

Several limitations in this study might be considered. The first limitation relates to the validity of the person's recollections. Because the study was retrospective in nature, an individual's recall for earlier specific events may be of limited accuracy. On the other hand, it could be debated that subjects' recall of math-related events are quite accurate, for the self reports correlate very well with the level of math anxiety. Consistent differences on the math experiences variables were found between the low, moderate and high math anxiety groups.

A second criticism might be that an individual's recollections are "coloured" by his/her level of math anxiety at the time of data collection. Research on the effects of mood on memory shows that the recall of positive and negative events may be influenced by a person's mood at the time of recall (Alexander &

Guenther, 1986; Teasdale & Russell, 1983; Teasdale & Taylor, 1981). For example, studies by Alexander and Guenther (1986) and Teasdale and Taylor (1981) found that subjects in an induced mood (elated or depressed) recalled personal experiences, personality traits, and emotional associations that were consistent with their mood.

This second criticism is not totally compelling. If mood, or rather the level of an individual's math anxiety is actually having an effect on the recall of math-related events, then females, who differ from males in math anxiety, should also produce gender differences in their recall of events. According to the data, males and females are not significantly different in terms of the math experiences that they report.

Possible limitations to the response bias portion of the study should also be considered. Because no existing scales measure the attitudes toward the expression of math anxiety, it was necessary to develop a new scale for this study. The author had limited resources to fall back on for the development of this measure. Therefore, it was not clear what optimal questions should have been used (face validity). The author chose to select six phrases which tapped different aspects of attitudes about math anxiety. The phrases focused upon feeling silly, ashamed, embarrassed, and weak if a person was anxious about mathematics. In addition, subjects had to indicate whether it would be acceptable/appropriate for a person to have anxiety in math. The same six phrases were used on all three subscales (Males, Females, Self), with the focus being on either males, females, or self. A total score and individual subscale scores were used as a measure of the person's attitudes about math anxiety. Obviously this scale has unestablished psychometric properties, so conclusions from it should be treated cautiously.

However, there is some indication that the scale possesses some discriminant validity. It comes from the finding that the scale was able to discriminate between the attitudes toward the expression of math anxiety for males, females and self. The Self subscale consistently produced scores that were higher than both the Male and Female subscales. This might be seen as some evidence of the measure's discriminant validity.

ALTERNATIVE EXPLANATION

While the present study indicates that neither the sex-role socialization nor the response bias explanations can account for the gender difference in mathematics anxiety, an unexpected finding suggests a third explanation for this relationship. The strong interaction of gender with attitudes about the expression of math anxiety in themselves versus others revealed that females are much less tolerant about the expression of math anxiety in themselves. Not only is this finding quite strong, but it is opposite to the response bias explanation. Instead it suggests that a third process is operating. Females are much less tolerant toward their own self expression of math anxiety, and this high level of self criticism may account for the gender difference in math anxiety.

There is also evidence that females are more self critical regarding their own math ability. Females have been found to perform as well or better than males in mathematics (Hanna, 1986; Turnbull, 1989), yet have different beliefs about their competency in the subject. For example, a report by Turnbull (1989) for the London, Ontario Board of Education found that males and females in the advanced and general levels of math (grades 9 through 13), performed the same. It was also discovered that there were differences in males' and females' self-image of mathematical performance. Compared to males, females' self assessment rating of their perceived ability in mathematics was worse. In addition, females were found to suffer from higher levels of mathematics anxiety.

Together, the two findings that females are more self critical of math anxiety in themselves, and are more self critical of their performance in math can explain the gender difference in mathematics anxiety. Females view the consequences of failure (i.e., exhibiting anxiety) as more serious, and they also view their mathematical ability as being poorer than it actually is. Therefore it follows that females should be more apprehensive about engaging in any type of math-related event.

If this explanation is correct, two issues are raised that relate to future research. First, future research could focus on the reasons underlying why females are more self critical. Perhaps females' higher level of self criticism is a product of their socialization. It may be that females receive subtle messages from socialization agents which indicate that it is necessary for them to be more self-aware and to acknowledge any negative connotations/consequences associated with expressing emotions. Second, an equally important issue could be to determine whether this higher level of self criticism is specific to math, or if it is a general problem that females face.

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Appendix A

Cover Letter

COVER LETTER

Dear Participant:

I, Sonya Flessati, am conducting a study on mathematics anxiety for my Master's degree in Psychology at Lakehead University. The study will investigate the extent to which present feelings of anxiety are related to previous experiences with, and feelings about, mathematics.

In order to accomplish this goal, I would like you to fill out a series of questionnaires. These include questions concerning your current feelings about various situations involving mathematics, as well as questions about your previous experiences with mathematics.

Your participation in the study is voluntary, and you may withdraw from the study at any time. The completion of the above measures will take approximately 30 to 60 minutes of your time. All information that you provide will remain entirely confidential. However, the findings of this study will made available to you at your request, upon completion of the project. If you have any questions, you can contact me at 344-8441.

Respectfully yours,

Sonya L. Flessati
M.A. Candidate
Department of Psychology

Appendix B

Consent Form

CONSENT FORM

My signature on this sheet indicates that I will participate in a study by Sonya L. Flessati (M.A. Candidate, Department of Psychology) on "Mathematics Anxiety and Previous Mathematics Experiences" and indicates that I understand the following:

- I am a volunteer and can withdraw at any time from the study.
- I have received explanations about the nature of the study, its purpose and procedures.
- There is no risk of physical or psychological harm.
- The data which I provide will be strictly confidential.
- I will receive a summary of the study, upon request, following the completion of the project.

____________________________ _______________

Signature of participant — Date

Appendix C

Mathematics Anxiety Rating Scale

Total Score ______

MATHEMATICS ANXIETY RATING SCALE (MARS)

The items in the questionnaire refer to things and experiences that may cause fear or apprehension. For each item, place a check on the line under the column that describes how much <u>you are frightened by it nowadays</u>. Work quickly but be sure to consider each item individually.

	Not at all	A little	A fair amount	Much	Very much
I. Determining the amount of change you should get back from a purchase involving several items.					
2. Having someone watch you as you total up a column of figures.					
3. Having someone watch you as you divide a five digit number by a two digit number.					
4. Being asked to add up 976 + 777 in your head.					
5. Dividing a five digit number by a two digit number in private with pencil and paper.					
6. Calculating a simple percentage, e.g., the sales tax on a purchase.					
7. Listening to a salesman show you how you would save money by buying his higher priced product because it reduces long term expenses.					
8. Listening to a person explain how he figured out your share of expenses on a trip, including meals, transportation, housing, etc.					
9. Having to figure out how much it will cost to buy a product on credit (figuring in the interest rates).					
I0. Totaling up a dinner bill that you think overcharged you.					

	Not at all	A little	A fair amount	Much	Very much
27. Listening to another student explain a math formula.				____	
28. Walking into a math class.				____	____
29. Having to compute the miles/gallon on your car.					____
30. Watching someone work with a calculator.				____	
31. Looking through the pages of a math text.				____	
32. Working on an income tax form.				____	
33. Reading your W-2 form (or other statement showing your annual earning and taxes).				____	
34. Studying for a math test.					
35. Starting a new chapter in a math book.					
36. Walking on campus and thinking about a math course.					
37. Meeting your math teacher while walking on campus.					
38. Reading the word "Statistics."					
39. Sitting in a math class and waiting for the instructor to arrive.					
40. Solving a square root problem					
41. Signing up for a course in Statistics.					
42. Checking over your monthly bank statement.					
43. Taking the math section of a college entrance exam.					
44. Having someone explain bank interest rates as you decide on a savings account.					
45. Raising your hand in a math class to ask a question.					

	Not at all	A little	A fair amount	Much	Very much
58. Studying for a driver's license test and memorizing the figures involved, such as the distances it takes to stop a car going at differing speeds.					
59. Hearing friends make bets on a game as they quote the odds.					
60. Playing cards where numbers are involved, e.g., bridge or poker.					
61. Hearing a friend try to teach you a math procedure and finding that you cannot understand what he is telling you.					
62. Scheduling my daily routine to allocate set times for classes, for study time, for meals, for recreation, etc.					
63. Juggling class times around at registration to determine the best schedule.					
64. Deciding which courses to take in order to come out with the proper number of credit hours for full time enrollment.					
65. Working a concrete, everyday application of mathematics that has meaning to me, e.g., figuring out how much I can spend on recreational purposes after paying other bills.					
66. Working on an abstract mathematical problem, such as: "If x = outstanding bills, and y = total income, calculate how much you have left for recreational expenditures."					
67. Being given a set of numerical problems involving addition to solve on paper.					
68. Being given a set of subtraction problems to solve.					
69. Being given a set of multiplication problems to solve.					

	Not at all	A little	A fair amount	Much	Very much
85. Receiving your final math grade in the mail.					
86. Opening a math or stat book and seeing a page full of problems.					
87. Being responsible for collecting dues for an organization and keeping track of the amount.					
88. Getting ready to study for a math test.					
89. Listening to a lecture in math class.					
90. Figuring out your monthly budget.					
9l. Being given a "pop" quiz in a math class.					
92. Seeing a computer printout.					
93. Having to use the tables in the back of a math book.					
94. Being told how to interpret probability statements.					
95. Asking your math instructor to help you with a problem that you don't understand.					
96. Being asked to explain how you arrived at a particular solution for a problem.					
97. Tallying up the results of a survey or poll.					
98. Acting as secretary, keeping track of the number of people signing up for an event.					
TOTAL					

Total Score

Appendix D

Math Biography Questionnaire

MATH BIOGRAPHY QUESTIONNAIRE

Sex (circle one): Male Female

Age: ______________

Year of University: ______________

Major: ______________________

ELEMENTARY SCHOOL INFORMATION

On a 5-point scale how did you feel about taking mathematics in elementary school?

1	2	3		5
Disliked it very much		Neutral		Liked it very much

How much did you like mathematics in comparison to your other school subjects in elementary school?

1	2	3	4	5
Much less		About the same		Much more

Indicate on the 5-point scale the type of math grades you received in elementary school?

A B C

During your elementary school years, how did your marks in math compare to your marks in other subjects?

1	2	3	4	5
Much lower		About the same		Much higher

ELEMENTARY SCHOOL EXPERIENCES

5. Recall and describe any positive math-related experiences that occurred during elementary school that had an impact on you (e.g., a good teacher, getting high grades, understanding math). Try to document at least one positive experience.

Recall and describe any negative math-related experiences that occurred during elementary school that had an impact on you (e.g., failed a test, a poor teacher, disliking the teacher). Try to document at least one negative experience.

HIGH SCHOOL INFORMATION

7. On a 5-point scale, how did you feel about taking mathematics during your high school years?

	?	?	'	
Disliked it very much		Neutral		Liked it very much

How much did you like mathematics in comparison to your other school subjects during your high school years?

1	?	3	4	5
Much less		About the same		Much more

. Indicate on the 5-point scale the grades you received in math during each of your high school years.

Grade ?	
Grade 10	B
Grade 11	B
Grade 12	B
Grade 13	B

10. During high school, how did your marks in math compare to your marks in other subjects?

1	?	3		5
Much lower		About the same		Much higher

HIGH SCHOOL EXPERIENCES

. Recall and describe any positive math-related experiences that occurred during high school that had an impact on you (e.g., a good teacher, getting high math grades, understanding math). Try to document at least one positive experience.

12. Recall and describe any negative math-related experiences that occurred during high school that had an impact on you (e.g., failed a test, a poor teacher, disliking math). Try to document at least one negative experience.

GENERAL INFORMATION

13. Did your positive experiences in math have an impact on choosing your university major? (circle one)

Yes No

14. Did your negative experiences in math have an impact on choosing your university major: (circle one)

Yes No

15. What was your overall average for courses taken in the past year? (circle one)

A+ A A- B+ - C D+

16. How do you rate your overall ability in mathematics?

1	2	3	4	5
very poor	poor	Average	good	very good

. In your opinion, who are more likely to be anxious about participation in the following subject areas? (check the appropriate columns)

	1 Females More		3 About the same		5 Males more
Fine Arts			___		
Mathematical Sciences	___	___			
Engineering	___	___			
Social Sciences					

18. Read the following statements, and using the scale below as a guide, write a number beside each statement to indicate how much you agree with it.

```
  +       +       +       +       +
  1-------2-------3-------4-------5
strongly       Neutral        strongly
 agree                        disagree
```

_ 1. It is silly for males to experience math anxiety.

_ 2. It is acceptable for females to be anxious about math.

_ 3. Males should feel ashamed if they are afraid to take mathematics.

_ 4. Math anxiety is an appropriate emotion for me to express.

_ 5. Females who have a fear of math are weak.

6. I would feel embarrassed if I felt nervous when asked to do a math problem.

_ 7. It is silly for females to experience math anxiety.

___ 8. It is acceptable for males to be anxious about math.

_ 9. I would feel ashamed if I was afraid to take a math class.

_ 10. Math anxiety is an appropriate emotion for females to express.

__ 11. Males who have a fear of math are weak.

__ 12. It is acceptable for me to be anxious about math.

___ 13. Females should feel embarrassed if they feel nervous when asked to do a math problem.

_ 14. Math anxiety is an appropriate emotion for males to express.

__ 15. It is silly for me to experience math anxiety.

__ 16. Females should feel ashamed if they are afraid to take a math class.

_ 17. Males should feel embarrassed if they feel nervous when asked to do a math problem.

__ 18. I would consider myself weak if I had a fear of math.

Appendix E

Sample Comparisons on

the MARS Scores

Appendix E: Mean Sample Comparisons on MARS Scores

MARS Scores	**Hunsley & Flessati (1988)**	**Present Study**	*t*	*p*
Males	163.1	189.18	12.39	.01
Females	89.9	235.73	7.60	.01

Appendix F

T-Test Analyses on the Math Anxiety Attitudes Subscales

Appendix F: T-test Analyses on the Subscales According to Math Anxiety Level

Math Anxiety Group

T-values Comparing	**Low**		**Moderate**		**High**	
	t	*p*	*t*	*p*	*t*	*p*
Male vs Female Subscale	-2.56	.014	-1.43	n.s.	-.29	n.s.
Female vs Self Subscale	6.30	<.001	5.46	<.001	2.33	.024
Male vs Self Subscale	6.08	<.001	7.14	<.001	2.59	.013