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ABSTRACT

The contributions of acceptance of misconceptions about mathematics, mathematical self-concept, and arithmetic skills to mathematics anxiety and to statistics course performance were studied in 92 adult students aged 18 to 57 with a median age of 27, (16 males and 76 females). Results showed that acceptance of misconceptions and mathematical self-concept were significantly related to mathematics anxiety; the combination of misconceptions, mathematical self-concept and arithmetic skills was significantly related to statistics course performance. Older students returning to school after several years' absence were the ones most debilitated by negative attitudes toward mathematics. It was concluded that mathematics anxiety involves a mechanistic, nonconceptual approach to math, a low level of confidence and a tendency to give up easily when answers are not immediately apparent. (Author/MNS)

The Relationship of Misconceptions About Math and Mathematical Self-Concept to Math Anxiety and Statistics Performance

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Paper presented at the annual meeting of the American Educational Research Association, New Orleans, Louisiana, April 23-27, 1984.

Abstract

The contributions of acceptance of misconceptions about mathematics, mathematical self-concept, and arithmetic skills to mathematics anxiety and to statistics course performance were studied in 92 adult students. Results showed that acceptance of misconceptions and mathematical self-concept were significantly related to math anxiety; the combination of misconceptions, mathematical self-concept and arithmetic skills was significantly related to statistics course performance. Older students returning to school after several years' absence were the ones most debilitated by negative attitudes toward mathematics. It was concluded that math anxiety involves a mechanistic, nonconceptual approach to math, a low level of confidence and a tendency to give up easily when answers are not immediately apparent.

The Relationship of Misconceptions About Math and Mathematical Self-Concept to Math Anxiety and Statistics Performance

Much research has focused on anxiety in mathematical situations and its negative impact on mathematical performance. Dreger and Aiken (1957) were able to predict mathematics performance from number anxiety in college students; in a subsequent study they were able to predict female college students' final grades in mathematics from their attitudes toward mathematics (Aiken & Dreger, 1961). Many others have found anxiety and aversion toward mathematics to be common, especially among women (Betz, 1978; Elmore & Vasu, 1979; Kogelman & Warren, 1979; Tobias, 1978a), and to be significantly related to mathematics performance for both sexes (Betz, 1978; Feinberg & Halperin, 1978; Fennema & Sherman, 1977; Jacobs, 1973; Richardson & Suinn, 1972; Sepie & Keeling, 1978). Moreover, studies of the effects of math anxiety treatment have found that when math anxiety is alleviated, performance improves (Evans, 1977; Hendel & Davis, 1978; Kogelman, Nigro, & Warren, 1978; Richardson & Suinn, 1972). Mathematics anxiety has been found to be most severe among women with poor preparation in mathematics (Betz, 1978; Hendel & Davis, 1978).

Research has also indicated that self-concept of ability may strongly affect academic performance (Brookover, Paterson, & Thomas, 1962), and that an impaired self-concept of ability may play a part in mathematics anxiety as well, particularly for women; victims of math anxiety are often reported to have low self-esteem and feelings of incompetence which are manifested as self-deprecating remarks and a perpetual lack of success in mathematics (Kogelman et al., 1978; Tobias, 1976b). Other studies have found significant relationships among mathematics anxiety, mathematics confidence, and mathematics achievement (Fennema & Sherman, 1977; Sudweeks, Stoler, & Croker, 1980).

It has been suggested that victims of mathematics anxiety often hold misconceptions regarding the nature of mathematics and the abilities necessary to learn it, that such beliefs tend to increase anxiety, and that dispelling these beliefs would be likely to decrease anxiety (Kogelman et al., 1978; Kogelman & Warren, 1979; Tobias, 1978a; Wolfe, 1978 Commonly reported misconceptions about mathematics include the ideas that one must have a "mathematical mind" to understand math, that the one "right" method and "right" answer are of primary importance in learning mathematics, and that mathematics is a masculine activity (Kogelman & Warren, 1979). Similar beliefs have been reported in relation to a required statistics course (Wolfe, 1978). Though math anxiety treatment frequently focuses on "demystification" of mathematics, or dispelling commonly held myths about mathematics (for example, see Chapline, Newman, Denker, & Tittle, 1979, 1980), the existence of a relationship of misconceptions to math anxiety and to impaired performance has yet to be empirically estaclished.

In light of these findings, and of the fear and difficulty often encountered by adults required to learn statistics, i decided to study factors contributing to math anxiety and to impaired statistics course performance. Specifically, the following questions were addressed: (a) what is the nature of the relationship of math anxiety to acceptance of misconceptions about mathematics and to self-concept of mathematical ability, respectively? (b) what are the relative contributions of beliefs about math, mathematical self-concept and arithmetic skills to math anxiety and to statistics course performance? (c) Can beliefs about math and mathematical self-concept discriminate among the following groups: low anxiety, low performance; low anxiety, high performance; high anxiety, low performance; high anxiety, high performance?

Method

Subjects

Subjects were 92 undergraduate and graduate students, 16 male and 76 female, enrolled in a required basic statistics course at New York University's School of Education, Health, Nursing and Arts Professions. Most were in health-related programs such as health education, nursing and occupational therapy. They ranged in age from 18 to 57 years, with a median age of 27; 30% of the sample were over age 30. Slightly more than half, mostly younger students, had previously taken pre-calculus or calculus; 12%, mostly older students, had taken only high school algebra or general mathematics. Twenty-six percent of the sample had not taken a math course in ten years or longer. Seven additional students filled out the preliminary information but had to be eliminated from the main study because they withdrew from the course before the midterm examination was given.

Instruments

The Beliefs About Mathematics Scale. Categories and items of the BAM scale were derived from work by Kogelman and Warren (1979) on commonly held myths about mathematics, and from written statements of students taking a basic mathematics course at New York University. The following categories of misconceptions about math were defined:

1. Mathematics is separate from and irrelevant to other areas of life.

2. Mathematical thinking represents the only real intelligence.

3. Mathematics is a masculine activity.

4. The most important attributes of mathematics are logic, precision and mechanical procedure.

A scale of 25 items was constructed to reflect these categories, with a high score indicating a high degree of acceptance of misconceptions about math. Based on the results from two pilot samples of statistics students and on the judgments of three mathematicians experienced in remedial mathematics and math anxiety treatment, the scale underwent two revisions; the final version consisted of 17 items. Responses were based on a five-point scale ranging from Strongly Disagree (1) to Strongly Agree (5).

A principal components factor analysis of the final version of the scale showed it to be composed of six factors accounting for a total of 63% of the variance in the items. These data are presented in Table 1. The factors correspond closely to the category divisions specified prior to the development of the scale, supporting the theory on which the scale was based.

Insert Table 1 about here

The Mathematical Self-Concept Scale. The MSC scale was based on my observation in tutoring statistics students that students having difficulty frequently make disparaging remarks about their ability to learn mathematics, despite academic accomplishment in other areas of graduate study. Based on written statements from basic mathematics students, 32 items were derived reflecting attitude toward one's mathematical ability. Responses were based on a five-point scale ranging from Strongly Disagree (1) to Strongly Agree (5). Items were worded both positively and negatively; scoring on negatively worded items was reversed.

Based on the results from a pilot sample of statistics students and on the judgments of three mathematicians, minor revisions were made. The final version consisted of 27 items; these are presented in Table 2. The first version of the MSC scale correlated -.71 with self-report of anxiety about mathematics, lending support to its validity. The final version, based on the sample of 92 students, had an internal consistency reliability (coefficient alpha) of .80; additionally, a principal components factor analysis showed most of the variance in the items to be accounted for by one factor, providing further support for the internal consistency of the scale.

Insert Table 2 about here

The Arithmetic Skills Test. Examination of the course material covered in the first semester of basic statistics indicated the following basic mathematical skills as necessary for mastery of the required course material:

1. Basic arithmetic operations and their order involving whole numbers, fractions, decimals, and signed numbers;

2. The use of positive integer exponents to obtain a product;

3. Definition of a square root (hand calculation not necessary);

4. Solution of an equation with one unknown, using the above operations;

5. Ability to read and draw simple graphs;

6. Understanding of inequalities.

In order to measure mastery of these skills, students were given the following selections from the Metropolitan Achievement Test, Advanced (grades 7.0-9.5), Form F (Durost, Bixler, Wrightstone, Prescott, & Balow, 1970): Test 5 (Mathematics Computation), which reflects items 1 through 4 above; two questions from Test 6 (Mathematics Concepts), on inequalities; and three questions from Test 7 (Mathematics Problem Solving), which require reading of a graph.

The Mathematics Anxiety Rating Scale (MARS). The MARS was developed by Richardson and Suinn (1972) to measure general levels of mathematics anxiety in adults. The scale consists of 98 situations involving mathematics in both academic and everyday life settings. Respondents are asked to indicate on a five-point scale ranging from "not at all" to "very much" the degree to which they are frightened by each situation.

Information on the validity and reliability of the MARS has been reported for several samples of college students, showing it to be a reliable measure of mathematics anxiety and to correlate negatively with mathematics achievement (Brush, 1978; Richardson & Suinn, 1972; Suinn, Edie, Nicoletti, & Spinelli, 1972).

The Midterm Examination. Three parallel forms of a midterm examination were developed in cooperation with the Director of the Program in Educational Statistics, covering the following topics: construction of a frequency, relative frequency, cumulative frequency, and relative cumulative frequency table; calculation of the mean, median, mode, variance and standard deviation of a set of data; and graphing of a distribution of data. The examination consisted of nine questions; for the study, each was valued at 10 points, for a maximum possible score of 90.

Procedure

Five class sections of statistics, taught by four different instructors, participated in the study; none was taught by the researcher. All instruments other than the midterm examination were administered at the end of the first class session. Subjects were informed that participation was voluntary; approximately 20 students chose not to participate. Materials were presented in a different order to each class; however, the Arithmetic Skills Test was always given last because it was felt that it would be tiring and would be the most likely of all the instruments to affect responses to subsequent materials. The Arithmetic Skills Test was administered without the use of calculators. The midterm examination was administered during the eighth week of the semester.

Analysis

The first research question was analyzed by means of simple correlations; the second question was analyzed by means of multiple regression procedures; the third question was analyzed by means of a discriminant analysis.

Results

Table 3 presents the correlation matrix of the five instruments. All are moderately intercorrelated; as expected, math anxiety correlated positively with acceptance of erroneous beliefs about math (r = .32) and negatively with mathematical self-concept (r = -.[illegible]2).

Insert Table 3 about here

The results of the regression of math anxiety on beliefs about math, mathematical self-concept and arithmetic skills are presented in Table 4. The unique contribution of each variable (computed as the drop in R^2 when each variable is excluded from the model) is also provided. The set of predictors accounted for almost 40% of the variance in math anxiety; mathematical self-concept was the most important predictor, and the only one to reach significance, accounting for 26.2% of the variance, followed by beliefs about math, accounting for 0.6% of the variance, and, lastly, arithmetic skills, accounting for 0.2% of the variance.

Insert Table 4 about here

The results of the regression of statistics performance on beliefs about math, mathematical self-concept and arithmetic skills are presented in Table 5, along with the unique contribution of each predictor. The set of predictors accounted for 13% of the variance in statistics performance; in this case arithmetic skills was the most important predictor, and the only one to reach significance, accounting for 5.3% of the variance, followed by beliefs about math, accounting for 2.5% of the variance, and, lastly, mathematical self-concept, accounting for 0.1% of the variance. It is tempting to conclude from these results that mastery of arithmetic skills is the most important aspect of statistics performance; however, analysis of the reasons for loss of credit on the midterm examination showed computation errors to be rare, the most common errors being conceptual ones in which an inappropriate procedure was computed perfectly. Remediation of arithmetic skills would not be likely to correct these errors; thus it is likely that the relationship of arithmetic skills to statistics performance results from characteristics of the test situations which go beyond their specific content.

Insert Table 5 about here

A related finding concerned student responses to the arithmetic test. Though students were not required to stay beyond the normal class period, many became restless on reaching the arithmetic test, complained to the proctor that they were unable to stay to finish it, or skipped large numbers of items and handed in their materials early. Omissions accounted substantially for losses of credit on the arithmetic test for approximately one third of the sample. Of the 30 subjects who failed to complete the arithmetic test, 26 were either high in mathematics anxiety, low in mathematical self-concept, or both. Computation errors, however, were unrelated to level of math anxiety or self-concept. This suggests a tendency on the part of math-anxious students to give up easily when faced with a mathematical task rather than to try and make mistakes, or even to guess, which, given the multiple-choice format of the test, would have been fairly easy to do.

Considering the ambiguity of these relationships, it is important to note that the intercorrelations of the predictors probably suppressed some of their effects and obscured some important contributions to math anxiety and statistics performance. After the unique contributions of each predictor are considered, shared variance remains, accounting for as much or more variance than some of the predictors. In the case of math anxiety, this shared variance was 12.8%; for statistics performance, it was 5.2%. In the latter case in particular, the variance arithmetic skills share with attitudes contributes virtually as much as arithmetic skills alone; thus attitudes may be more strongly related to performance than first appears, particularly in light of subjects' responses to the arithmetic test.

Though the unique contribution of beliefs about math to performance was small, beliefs may have played an important part in statistics avoidance. The only measure on which the seven students who had withdrawn from the course differed from the main sample was in their acceptance of misconceptions about math, which was distinctly higher. Thus attitudes may be important determinants of students' ability to see a mathematical task through to completion.

In order to define the four possible anxiety-performance groups, low and high math anxiety levels were defined as the lower and upper 35% of scores on the MARS. High performance was likewise defined as the upper 35% of midterm scores, but because the midterm score distribution was severely negatively skewed, a lower cutoff was used to define low performance. This cutoff was ten points below the group mean, which was the same number of points away from the mean as the 65th percentile.

Table 6 presents the group means and standard deviations on the discriminating variables. The two high anxiety groups are slightly higher in beliefs about math and much lower in mathematical self-concept than are the low anxiety groups; in fact, the high anxiety, high performance group more closely resembles the other high anxiety group than the other high performance group.

Insert Table 6 about here

Tables 7 and 8 present the results of the discriminant analysis. One significant function was found, accounting for virtually all of the variance in the discriminating variables and correlating highly with the group variables anxiety and performance. The structure coefficients show mathematical self-concept to be the more important discriminating variable, correlating almost perfectly with the underlying dimension.

Insert Tables 7 & 8 about here

Several interesting findings emerged regarding the attitudes and performance of older students returning to school after several years' absence. These correlations are presented in Table 9. (A few students did not answer the demographic questions and had to be excluded from this part of the analysis.) Age and number of years since last math course are moderately correlated, as would be expected; yet the difficulties of older students with math are not simply a function of time. Though age and years since last math course were similarly related to beliefs and to self-concept, age was more strongly related to math anxiety, arithmetic skills, and, in particular, statistics performance.

Insert Table 9 about here

Older students also showed stronger relationships of attitudes to achievement than did younger students, as presented in Table 10. Thus older, returning students, who are often more poorly prepared than are younger students, may be the ones most severely affected by negative attitudes toward mathematics.

Insert Table 10 about here

Discussion

The results of this study show that, consistent with the assumptions underlying many math anxiety treatment programs, there is a relationship between math anxiety and misconceptions about math. It is possible that this relationship is stronger in actuality than was found in this study, as many misconceptions may elicit disagreement due to their social unacceptability (for example, statements that women have less ability than men) or because, once on paper, their absurdity is apparent; yet these beliefs may continue to operate on an emotional level. This has been noted elsewhere as well ([illegible]ife, 19[illegible]). Related to this finding is the relationship of misconceptions to the two performance measures, arithmetic skills and statistics performance, and the fact that all students who had withdrawn from the course had scored highly on misconceptions about math. These findings suggest that mistaken notions regarding the nature of mathematics and the abilities necessary to learn it do in fact play an important role in math difficulties.

This study also shows that a substantial part of math anxiety involves a low self-concept of mathematical ability; thus math anxiety involves not simply fears of hard work, of evaluation by others, of low grades, or dislike of the subject, but fears of personal failure or inadequacy. It is interesting in this connection that high anxiety, high performance students were closer in self-concept to other high anxiety students than to other high performance students. It seems that many math-anxious people are not convinced that they have the capability of doing well in math even when they are able to do so; their self-evaluation and anxiety level are not realistic assessments of their ability. It is a frequent observation that mathematically anxious people rarely allow themselves credit for their accomplishments, thus perpetuating a low self-concept despite evidence to the contrary (Donady & Tobias, 1977; Kogelman et al., 1978; Kogelman & Warren, 1979; Poffenberger & Norton, 1959).

The responses of students to the arithmetic test point to the difficulty of obtaining a pure measurement of students' mathematical skills, even when the test used is on a low mathematical level. The results show a tendency for people high in math anxiety and low in mathematical self-concept to give up easily when they find doing math uncomfortable. Computation errors, however, were unrelated to attitudes. This is consistent with Giangrasso's (1981) finding that, while mathematically anxious people did not make more computation errors than those low in anxiety, they were less willing to take the time needed to solve problems. It has been pointed out that such attitudes may be self-serving: Math-anxious people are often quick to tell themselves that they are unable to do math and so end the discomfort; if they were willing to persevere in working on a problem, they might find themselves able to solve it (Fogelman & Warren, 1979).

The overwhelming incidence of conceptual rather than computational errors on the statistics examination (most often, correct computation using an inappropriate formula) raises an important question regarding the ways in which attitudes may be related to one's approach to mathematics. It has been found that the mathematically anxious more frequently make conceptual errors than do the mathematically comfortable (Giangrasso, 1981). Perhaps people who do not appreciate the importance of conceptual understanding in mathematics, seeing it as a subject to be performed mechanistically and by rote, are more prone to conceptual difficulties with math, and possibly affective ones as well.

It is interesting to note that the math difficulties of older students were not simply a function of the passage of time.

older students also had the tendency to be less well prepared in math than younger students. It may be that for the older student, less advanced mathematical training, perhaps acquired when women received little encouragement toward achievement in mathematics, combined with many years away from school, produce a level of anxiety and lack of confidence which cannot be alleviated simply by taking a refresher course as many had done. These factors seem to have taken a toll on their course performance as well. Previous research has indicated older, returning students, particularly women, as the most frequent victims of math anxiety (Betz, 1978; Hendel & Davis, 1978); the present study indicates these students as the most debilitated by their attitudes as well.

It was noted that many of the variables in this study were intercorrelated. Particularly noteworthy are the correlations of cognitive and affective measures—beliefs about math with mathematical self-concept, arithmetic skills with attitudes. Much speculation has been made regarding the causal link between cognitive and affective variables in math learning (for example, see Aiken, 1970, 1976; Neale, 1969); however, it is important to question whether this conceptualization is not an oversimplification of the relationships between attitudes and performance. To ask which causes the other presupposes that attitudes and performance are distinct phenomena, when the reality is that they are complexly intertwined. It may be more valuable to ask instead what these difficulties now mean to the person experiencing them. Math anxiety may be thought of as a syndrome of attitudes, expectations and behaviors with regard to math learning and performance. This study suggests that the math-anxious individual is one who has a mechanistic, nonconceptual approach to math, a low level of confidence in his or her ability to do math, and a tendency to give up easily when answers are not immediately apparent. Perhaps, with this awareness in mind, educators may be better able to understand and alleviate their students' difficulties.

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Table 1

Factor Analysis of the Be About Math Scale

Factor Loading		Item
Factor I. Mathematics is precise and mechanical (20%)		
.76	2.	The most important thing in doing math is to use the right formulas.
.68	4.	It's always important to get the answer to a math problem exactly right.
.51	7.	Doing math means following instructions precisely.
.53	9.	Math deals exclusively with numbers.
.48	16.	Math is not a creative activity.
Factor II. Math is separate from and irrelevant to life (11.4%)		
.75	6.	Math is separate from other parts of life.
.73	11.	Math is not necessary for most people's lives.
.56	13.	There is one correct way to do a math problem.
Factor III. Mathematics represents the only real intelligence (9.6%)		
.69	3.	Mathematicians do problems quickly, in their heads.
.52	10.	If you can do math, then you're really intelligent.
.67	12.	A mathematician's mind is like a computer.
.51	17.	Some people have a mathematical mind and some don't.
Factor IV. Mathematics is a masculine activity (8.2%)		
.88	5.	Men are better at math than women.
.83	14.	Women don't have the ability in math that men have.
Factor V. Mathematics requires a good memory (7.6%)		
.35	15.	Math requires a good memory.
Factor VI. Mathematics requires a unique type of logical thinking (6%)		
-.81	1.	Mathematical thinking is different from the thinking required in other fields.
.67	8.	Math requires only logic, not intuition.

$\underline{n}$ = 92.

Table 2

Items on the Mathematical Self-concept Scale

1. It takes me much longer to understand mathematical concepts than the average person.
2. I have never felt myself incapable of learning math.
3. I have a mental block when it comes to math.
4. I have a good mind for math.
5. If I can understand a math problem, then it must be an easy one.
6. It has always seemed as if math required brain cells I didn't have.
7. I can understand math better than most people.
8. Whenever I am exposed to math, I feel that it is beyond me.
9. I don't ask questions in math classes because mine sound so stupid.
10. I have no more trouble understanding math than any other subject.
11. I just don't have a mathematical mind.
12. When I have difficulties with math, I know I can handle them if I try.
13. My mathematical ability is above average.
14. I have never been able to think mathematically.
15. I always feel like a dummy in my math classes.
16. I don't have a good enough memory to learn math.
17. I get very tense when I see a math problem because I know I will not be able to do it.
18. I never feel like a mathematical incompetent.

Table 2 (continued)

19. Whenever I do a math problem, I am sure that I have made a mistake.

20. I feel secure in my ability to do math.

21. If my eating depended on my ability to do math, I would undoubtedly starve to death.

22. I have no facility with numbers.

23. Whenever I have to take math, I worry about whether I can pass.

24. When I have to do math problems, I do not worry about whether I will be able to do them.

25. Whenever I do math problems, I end by giving up in despair.

26. I never worry about failing math.

27. When I do math, I feel confident that I have done it correctly.

Table 3

Intercorrelations of the Five Instruments

	Mathematical Self-concept	Mathematics Anxiety	Arithmetic Skills	Statistics Performance
SAM	-.39***	.32***	-.34***	-.27**
MSC		-.62***	.36***	.18*
MA			-.28**	-.12
AS				.32***

n = 92.

*$p < .05$.

**$p < .01$.

***$p < .001$.

Table 4

Regression of Mathematics Anxiety on Beliefs About Math, Mathematical Self-concept and Arithmetic Skills

Predictor	Regression Weight	R^2	Unique Contribution to R^2	df	F
BAM	.656 (.087)	.105	.006	2, 89	.898
MSC	-1.573 (-.575)	.396	.262	2, 89	38.156*
AS	- .440 (-.039)	.398	.002	2, 89	.187

Note. Numbers in parentheses are standardized regression weights.

$n = 92$.

*$p < .001$.

Table 5

Regression of Statistics Performance on Beliefs About Math, Mathematical Self-concept and Arithmetic Skills

Predictor	Regression Weight	R^2	Unique Contribution to R^2	df	F
BAM	-.249 (-.176)	.071	.025	2, 89	2.515
MSC	.009 (.017)	.078	.001	2, 89	.024
AS	.534 (.253)	.131	.053	2, 89	5.354*

Note. Numbers in parentheses are standardized regression weights.

n = 92.

*$p < .01$.

Table 6

Means and Standard Deviations of the Four

Anxiety-Performance Groups

		Beliefs About Math		Mathematical Self-concept	
Group	N	Mean	SD	Mean	SD
Low Anxiety, Low Performance	6	43.67	12.80	111.50	11.43
Low Anxiety, High Performance	23	40.74	7.55	108.78	14.28
High Anxiety, Low Performance	10	48.40	8.33	68.10	20.20
High Anxiety, High Performance	16	45.50	7.58	82.63	15.86

Table 7

Canonical Discriminant Functions for Discriminating Variables

Beliefs About Math and Mathematical Self-concept

Function	Eigenvalue	Percent of Variance	Canonical Correlation	Wilks' Lambda	df	Chi-square
1	1.24	98.67	.74	.438	6	42.06*
2	.02	1.33	.13	.984	2	.847

n = 56.

*$p < .001$.

Table 8

Structure Coefficients for the Discriminating Variables

Variable	Coefficient
Mathematical Self-concept	.99966
Beliefs About Math	-.30530

Table 9

Correlates of Age and Years Since Last Math Course

	Years	BAM	MSC	MA	AS	SP
Age	.59**	.19*	-.48**	.45**	-.35**	-.43**
Years		.22*	-.49**	.37**	-.12	-.17

n = 84.

*$p < .05$.

**$p < .001$.

Table 10

Correlates of Statistics Performance for

Different Age Groups

	BAM	MSC	MA
Under Age 27[a]	-.18	.12	.04
Over Age 35[b]	-.32	.22	-.27

[a] $\underline{n}$ = 44.

[b] $\underline{n}$ = 23.