THE IDENTIFICATION OF NUMBER ANXIETY IN A COLLEGE POPULATION

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Many persons report in clinical sessions and in academic classes that they are emotionally disturbed in the presence of mathematics. It has been the writers' experience that reactions of this nature to mathematical and arithmetical materials constitute a major field of emotionality in academic situations. And yet, although many studies have been conducted to determine optimum ways of presenting arithmetic materials (**7**), almost no controlled research has been attempted in the realm of emotional problems associated with arithmetic and mathematics. Schonell (**12**) observed that backwardness in arithmetic is due as much to emotional as to intellectual factors, and psychoanalytic writers (**6, 8, 11**) suggest that failure in arithmetic may be related to maternal overprotection.

Inasmuch as there has not been any attempt to determine if actually there is a set of reactions to numbers and mathematics on the scale that appeared evident to the writers, an inquiry was called for to investigate the extent and nature of such reactions. Consequently, the study reported here is an endeavor to detect the presence of a syndrome of emotional reactions to arithmetic and mathematics, tentatively designated "Number Anxiety." We speak of a syndrome, for anxiety is probably more accurately described as "anxieties" rather than "anxiety" (**2**). The existence of specific situational anxieties has been shown in several investigations (**3, 13**). Moreover, O'Connor's (**10**) finding of five distinct factors on the Taylor Scale of Manifest Anxiety shows that several dimensions of anxiety are measured by this popular scale. Number Anxiety, too, may turn out to be a complex variable.

Hypotheses

Three hypotheses were formulated on the basis of previous observation concerning the existence of Number Anxiety and its relations to concomitant human functioning:

1. Number Anxiety exists as a factor distinct from (although it may accompany) "general anxiety."
2. Number Anxiety is not related to intelligence as measured by the Wechsler-Bellevue or ACE scales, although it is probably negatively correlated with ACE Q scores.
3. Persons with high Number Anxiety will tend to make lower scores in mathematics than others, even though intelligence (as measured above) between these two groups is not significantly different.

Subjects

Seven hundred and four students in basic mathematics classes at Florida State University.

Procedure

The Taylor Manifest Anxiety Scale (**14**), omitting three items of relatively low validity and including three items (Table 1) specifically designed to measure feelings of anxiety concerning working with numbers, was administered to the 704 students at the close of class periods during which mathematics tests had been returned to them. The *Ss* were informed that the results of the Taylor Scale, called the "Confidential Data Sheet," would be used for scientific purposes and would have no influence on their grades or careers.

Scores on the three Number Anxiety items were correlated separately and together with the total score on the 47-item Taylor scale. In addition, intercorrelations were obtained among the three Number Anxiety items and the 14 items on the Taylor scale shown in two previous studies (**1, 5**) to be the most valid, making a 17 × 17 correlation matrix. This matrix was subjected to a Holzinger and Harman cluster analysis (**4**).

According to total scores on the three-item Number Anxiety items and the 47-item Taylor Scale, the 704 *Ss* were divided into four groups, those high in both "general anxiety" and Number Anxiety, those high in one and low on the other and vice versa, and those low in both. From each of these four groups ten *Ss* were chosen by a table of random numbers for further investigation. Inasmuch as males and females were not significantly different in scores on either scale, the sex variable was randomized. The 40 students in the subsample were not informed of the basis of

selection, and were presumably ignorant of the connection between the administration of the "Confidential Data Sheet" and the following procedures. The *Ss* in the subsample were given Form I of the Wechsler-Bellevue Intelligence Scale (**15**) by one examiner. At the same time as the administration of the verbal subtests, pre- and poststimulus readings were taken on a psychogalvanometer registering palmar skin resistance (**9**). Besides the recording of GSR deflections for each subtest item, the deflection was noted for the arithmetic subtest instructions, "I want to see how good you are in arithmetic."

The final Mathematics 105 grades for the 704 students and their American Council on Education Psychological Examination scores, Q, L, and Total, were obtained and correlated with Number Anxiety scores. Correlations were also found comparing grades, ACE, and Wechsler-Bellevue Verbal, Performance, and Full Scale IQ's with Number Anxiety scores for the 40 *Ss* investigated more intensively.

Results

Number Anxiety as defined by the three scale items (Table 1) proved to be present in approximately one-third of the 704 students; 239 or 35% responded positively to two or three of the key items.

With some minor differences, scores on the 47-item Taylor scale formed a distribution very similar to that of Taylor's original score distribution. Like the original distribution, the one obtained in this study is positively skewed; it was assumed, however, that it probably represents a normal distribution sufficiently well to allow correlations which employ a dichotomy of scores. Correla-

TABLE 1

BISERIAL CORRELATIONS BETWEEN THREE "NUMBER ANXIETY" ITEMS AND TOTAL SCORE ON TAYLOR SCALE SPLIT AT MEAN

Item	Correlation with Taylor Scale
3. I am often nervous when I have to do arithmetic.	.32
9. Many times when I see a math problem I just "freeze up."	.37
38. I was never as good in math as in other subjects.	.09
Total, items 3, 9, 38 combined	.33

TABLE 2
FACTOR LOADINGS IN "LITTLE FACTOR ANALYSIS" OF THREE "NUMBER ANXIETY" ITEMS

Item	Factors	
	A	B
3	−.002	.552
9	.266	.324
38	.518	.001

tions between the Taylor scale and the Number Anxiety items, individually and *in toto*, are presented in Table 1.

The relatively high correlations among the Number Anxiety items (Table 3) led the writers to suppose that they represent a cluster or syndrome; but the fact that they are not any more highly intercorrelated further suggested that the three items are not factorially pure. With the full recognition that a factor analysis of three items is purely an exploratory measure, a factor analysis, which was termed a "little factor analysis" to distinguish it from a serious one, was performed employing only the Number Anxiety items 3, 9, and 38, by means of Thurstone's centroid method. Two factors accounting for all of the common factor variance emerged. Orthogonal rotation allowed for no psychological meaningfulness, but oblique rotation to simple structure (as far as the latter can be obtained with three items) yielded greater significance (see Table 2). Factor A was identified very tentatively as "Negative math. reaction" and Factor B as "Nervousness in the presence of math."

A cluster analysis (**4**) of the correlation matrix (Table 3) of 14 Taylor Scale and three Number Anxiety items revealed three distinct clusters, tentatively labelled: I. Compulsive inattentiveness (composed of items 6 and 41 from the Taylor Scale); II. Covert, conscious strain (items 47, 45, 42, 48, 40, 44, 21, 5, 27, 29, 49, and 34); and III. Nervousness and difficulty in arithmetic (items 3, 9, and 38). The second cluster approaches "general anxiety" and the third clearly represents what is called here Number Anxiety.

Log conductance changes of the GSR (**9**) subjected to analysis of variance revealed that only on the arithmetic subtest and arithmetic instructions were there significant F ratios (at the .05

TABLE 3

TETRACHORIC CORRELATIONS AMONG 17 ITEMS FROM CONFIDENTIAL DATA SHEET

	5	6	9	21	27	29	34	38	40	41	42	44	45	47	48	49
3	.41	.10	.67	.37	.33	.24	.12	.50	.20	.03	.14	.28	.32	.35	.31	.10
5		.44	.37	.70	.59	.29	.37	.09	.52	.30	.42	.52	.67	.50	.54	.23
6			.14	.26	.28	.32	.31	.02	.40	.82	.40	.31	.50	.51	.38	.31
9				.33	.36	.16	.22	.64	.21	.18	.17	.06	.24	.19	.24	.12
21					.37	.29	.53	.27	.13	.31	.40	.50	.71	.34	.60	.27
27						.43	.38	.59	.45	.29	.56	.59	.62	.55	.55	.33
29							.16	.08	.30	.26	.32	.47	.47	.38	.28	.28
34								−.09	.46	.37	.36	.41	.31	.39	.29	.10
38									−.01	−.08	−.03	.01	−.02	.14	−.01	.07
40										.48	.47	.35	.48	.57	.68	.39
41											.48	.30	.48	.52	.47	.36
42												.47	.50	.58	.45	.38
44													.58	.37	.51	.13
45														.58	.52	.37
47															.55	.55
48																.49

level). That is, on Information, Comprehension, Digit Span, and Similarities there were no significant differences between Number Anxiety and "general anxiety" individuals or between high and low scorers on each anxiety scale. None of the interactions was significant, even on the two arithmetic comparisons. A breakdown of the arithmetic and arithmetic instructions GSR changes showed that all of the significant differences in each case lay between high and low scorers on Number Anxiety.

Correlations between Number Anxiety and final grades in Mathematics 105 for both the 40 subsample group and the 704

TABLE 4

BISERIAL CORRELATIONS BETWEEN "NUMBER ANXIETY" AND FINAL GRADES IN MATH, WECHSLER-BELLEVUE IQS, AND ACE SCORES

No. of Subjects	Grades	Wechsler-Bellevue			ACE		
		PS	VS	FS	Q	L	T
40	−.51	.20	−.015	.44	−.25	−.08	−.04
704	−.44						

original sample, together with the correlations of Wechsler-Bellevue and ACE tests with Number Anxiety, are presented in Table 4. The only correlations which are significant are those between grades and Number Anxiety.

Discussion

Several lines of evidence lead to the position that probably there is an overall dimension that may be termed Number Anxiety which differs from "general anxiety." The low correlations of the Taylor scale scores with the individual Number Anxiety items as well as with the total of the latter is the first piece of evidence. The second is the result of the cluster analysis which sharply separates Number Anxiety from the two "general anxiety" clusters. The third line of evidence is the highly significant changes which occurred in galvanic skin resistance for "number anxious" persons on the arithmetic instructions and arithmetic subtest of the Wechsler, changes which did not occur for the "general anxiety" group.

Although the identification of this overall dimension seems fairly secure, the actual unidimensionality of Number Anxiety is not assured by the study at hand. In fact, there is reason to believe that there are at least two subfactors in the surface factor isolated here, the two brought to light by the "little factor analysis" of Number Anxiety items. A further analysis of the three latter items in the matrix of 17 items is in progress. Also, an analysis of further items designed to ferret out Number Anxiety is being conducted with the 40 *Ss* who constituted the original subsample.

Nothing in the present study yields bases for determining the etiology of Number Anxiety. From previous thought and spontaneous remarks by *Ss* of the subsample, a number of hypotheses have been formulated as to the origin of this type of anxiety which *Ss* find very handicapping. And very tentatively in the continuing research we are putting some of these hypotheses to the test. However, more work is needed to identify just exactly what Number Anxiety is and what differentiates it from other kinds of anxiety before much exact research can be done in determining etiology. One hypothesis which is a partially etiological one, that Number Anxiety is merely the result of low intelligence, seems to be set aside by the research already done, in that neither the Wechsler nor ACE showed any significant relation to Number

Anxiety. That actual accomplishment in mathematics is associated with lack of Number Anxiety is demonstrated by the present research, though how much causation is involved is a question, for one may cause the other, vice versa, or both may be the resultant of other factors.

One caution must be voiced in connection with the changes in GSR and Number Anxiety. These variables are associated, but the GSR cannot be strictly considered to be a measure of Number Anxiety, for other conditions of stress have also been shown to have GSR correlates. Apparently the Wechsler Verbal Scale is not sufficiently stressful to generate significant GSR changes except in connection with "number anxious" persons and Arithmetic.

Conclusions

All three of the proposed hypotheses were substantially supported by the research described here.

1. Number Anxiety does appear to be a separate (composite) factor from "general anxiety," although the correlation of .33 between the Taylor Scale and the three Number Anxiety items indicates that some relation probably holds between these two gross syndromes.

2. Number Anxiety does not seem to be related to general intelligence as measured by either the Wechsler-Bellevue or ACE scales. The supposition that Q scores on the ACE are correlated negatively with Number Anxiety must wait further research, for the r of $-.25$ does not reach significance.

3. Persons with high Number Anxiety do tend to make lower mathematics grades, as indicated by the r's of $-.44$ for the 704 *Ss* and $-.51$ for the 40 subsample group between Number Anxiety and grades in Mathematics 105.

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