INFORMATION TO USERS

While the most advanced technology has been used to photograph and reproduce this manuscript, the quality of the reproduction is heavily dependent upon the quality of the material submitted. For example:

- Manuscript pages may have indistinct print. In such cases, the best available copy has been filmed.
- Manuscripts may not always be complete. In such cases, a note will indicate that it is not possible to obtain missing pages.
- Copyrighted material may have been removed from the manuscript. In such cases, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, and charts) are photographed by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each oversize page is also filmed as one exposure and is available, for an additional charge, as a standard 35mm slide or as a 17"x 23" black and white photographic print.

Most photographs reproduce acceptably on positive microfilm or microfiche but lack the clarity on xerographic copies made from the microfilm. For an additional charge, 35mm slides of 6"x 9" black and white photographic prints are available for any photographs or illustrations that cannot be reproduced satisfactorily by xerography.

Order Number 8713809

The relationship between anxiety, stress, and the retrieval of information from long term memory

Wendell, Anne-Sojourner, Ph.D.

City University of New York, 1987

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

THE RELATIONSHIP BETWEEN ANXIETY, STRESS, AND THE RETRIEVAL OF INFORMATION FROM LONG TERM MEMORY

ANNE-SOJOURNER WENDELL

A dissertation submitted to the Graduate Faculty in Educational Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1987

This manuscript has been read and accepted by the Graduate Faculty in Educational Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

May 1, 1987
Date

Barry J. Zimmerman
Chair of Examining Committee

May 1, 1987
Date

Carol Kehr Tittle
Executive Officer

Dr. Shirley Feldman

Dr. Alan Gross
Supervisory Committee

The City University of New York

The Relationship Between Anxiety, Stress, and the Retrieval of Information from Long Term Memory

Anne-Sojourner Wendell

Advisor: Professor Barry J. Zimmerman

The purpose of this study was to examine the relationship of anxiety, stress, and multiple retrieval trials to student performance on a free recall task. Subjects were 97 undergraduate students in introductory education and psychology courses at Hunter College. Students were identified as either high or low anxious on the basis of their scores on the Test Anxiety Questionnaire (Sarason, 1972). All subjects were trained to a criterion of three errorless repetitions of a list of 20 words, using a free recall paradigm. Number of trials and number of errors to criterion were compared for high and low anxious individuals.

One week later, half of the subjects in each anxiety group were stressed (by being told that the task was predictive of general intelligence and academic performance) and half were not. Subjects were required to list as many

of the 20 words as they could recall (in the absence of any feedback) on five successive trials. The number of words recalled at each trial was compared for four groups, which varied in anxiety level and the presence or absence of stress at retrieval.

It had been hypothesized that high anxious students would require more trials and make more errors before achieving the pre-set criterion. Empirical support was obtained for each hypothesis. In addition, it was expected that high anxious subjects who were stressed would experience greater retrieval deficits when compared to any of the other three anxiety groups. Main effects were expected for anxiety and stress, and, in addition, interactions were expected between anxiety, stress, and retrieval trials. Significant main effects were found for stress, along with significant interactions between anxiety level and trials, and between anxiety level, stress condition, and trials.

Explanations for the relationships are offered. Training all subjects to a preset criterion made it possible to actually examine differences in retrieval between the different anxiety groups. Results indicate that, when differences in acquisition are controlled for, differences in recall between high and low anxious individuals are a function of stress. Moreover, the use of multiple retrieval trials allows for closer inspection of the retrieval

process. Results indicate that differences in retrieval between high and low anxious individuals may also be influenced by the lesser ability of the high anxious individual to reconstruct the appropriate retrieval algorithms. In addition, suggestions for future research are made and educational implications are drawn.

Acknowledgement

I would like to thank Barry J. Zimmerman (committee chair), the members of my committee, and the outside readers--Shirley Feldman, Alan Gross, Dalton Miller-Jones, and Sue Rosenberg Zalk for all of their help and support.

My love and gratitude to my mother, Cynthia Ann Washington, and to my friend, Wesley Theodore Cobb, Jr. They have both made invaluable contributions to my academic career in general and to this research in particular.

To my father, Donald M. Wendell, and my stepfather, John H. Washington, thank you.

Finally, I would like to dedicate this work to my grandmother, Christina Regis, and to my cousin, Jacqueline Ellis--they always believed in me.

Contents

Abstract	iv
Acknowledgement	
I. Introduction	1
II. Overview of the Literature	2
. Study Skills Deficit Model	2
. Shallow Encoding Model	4
. Interference Model	5
. A More Powerful Model--Information Processing	7
. Retrieval Studies	8
III. Statement of the Problem	14
. Hypotheses	15
IV. Method	17
. Subjects	17
. Materials	17
. Procedure	18
V. Results	21
. Acquisition Data	21
. Retrieval Data--Aggregate Analyses	22
. Retrieval Data---Trial-by-Trial Analyses	24
VI. Discussion	31
. Suggestions for Further Research	38

Appendix A. Test Anxiety Scale 42

Appendix B. Worry-Emotionality Scale 44

Appendix C. Word List 45

References 46

List of Figures

Figure 1.	Number of Words Correct by Anxiety Level Across Trials	26
Figure 2.	Number of Words Correct by Anxiety Level and Stress Condition Across Trials	29

List of Tables

Table 1.	Mean Test Anxiety Scale Scores Median = 16.00	18
Table 2.	Acquisition Data	21
Table 3.	Recall of High and Low Anxious Subjects	27
Table 4.	Recall for High and Low Anxious Subjects by Stress Condition	30

I. Introduction

This study was carried out in order to clarify the effect of anxiety on the retrieval of information from long term memory. Both facilitating and debilitating effects of anxiety have been posited and supported by such authors as Alpert and Haber (1960) and Grant (1973). However, it is the debilitating effects of anxiety that are of primary concern in this research. Anxiety has been shown to adversely impact on students during the learning stages (acquisition and storage) and during performance (retrieval). While the debilitating effects of anxiety on learning have been frequently supported, questions as to how anxiety impacts upon performance remain unanswered.

Anxiety in this study is characterized as evaluative anxiety, as opposed to the generalized dread of Kierkegaard (1944). Evaluative or test anxiety has been shown to be associated with low levels of academic performance by many authors (Mueller, 1980; Tobias, Hedl, & Towle, 1974; Harper, 1971). Explanations for this relationship include a study skills deficit model, a shallow encoding model, and an interference model.

II. Overview of the Literature

Study Skills Deficit Model

The study skills deficit model holds that highly anxious students frequently have poorer study skills than low anxious students and that the effect of these study skills is reduced initial learning and test results (Wittmaier, 1972; Desiderato & Koskinen, 1969).

The study skills deficit model is based on research indicating that highly anxious students have poorer study skills than low anxious students. For example, Desiderato and Koskinen (1969) found that, while high anxiety was associated with low grades, highly anxious students had poorer study skills than low anxious students. In addition, quality of study habits and amount of studying time were positively related to academic performance. They concluded that defective study habits accounted for poor academic performance--not anxiety. Lin and McKeachie (1970) also found differences between high and low anxious students in ability and study habits.

Wittmaier (1972) examined the effects of both debilitating and facilitating anxiety on academic performance. He found that students with low levels of debilitating anxiety had better study habits than their high anxious counterparts and they avoided delaying academic tasks. He concluded that pre-exam test anxiety was

partially the cause of and partially the effect of ineffective study habits. Mitchell and Ng (1972) reached similar conclusions in their study.

Along with other authors whose research tends to support the study skills deficit model, Holroyd, Westbrook, Wolf, and Badhorn (1978) and Culler and Holahan (1980) have studied the role of intellectual ability and study habits for high and low anxious students. They concluded that high anxious students are right to be anxious because they have not learned the material well. Although they agree that high anxiety precedes and is related to poor performance, they assert that this situation occurs because poor ability leads to high anxiety.

The study skills deficit model is not problematic in and of itself, but the expressed tendency on the part of some authors, most notably Culler and Holahan (1980), to assume that this model sufficiently explains anxiety's role in affecting academic performance is lamentable. This model explains how learning deficits may result in high anxiety, but not the reverse. While poor study skills may negatively affect the performance of the highly anxious student, one is still left with the self-reports of students, actors, and others who assert that: "I knew it last night, but I've forgotten it now.". The model does not adequately address itself to the issue of retrieval problems occurring as a function of anxiety.

Shallow Encoding Model

The shallow encoding model holds that the decreased performance on the part of the highly anxious student is a function of the shallow encoding of information. Craik and Lockhart (1972) assert that forgetting is directly related to levels of processing. That is, deeper processing is likely to lead to relatively long-term retention, while shallow processing or shallow codes will most likely be quickly forgotten. For example, semantic processing of words (deep coding) is associated with higher recognition rates than a physical features analysis of the words (shallow coding) (Craik & Tulving, 1975).

Mueller (1978) found differences in levels of organizing information for high and low anxious students. As a result, he stated that deficits in free recall for high anxious students are a function of shallow encoding at acquisition. Later research by this author and others (Mueller, Carlomusto, & Marler, 1978; Mueller & Courtois, 1980) supports earlier findings in this area as well as indicating that one of the major differences between high and low anxious students is that low anxious students are more likely to use broad encodings appropriately but high anxious students do not do so and are likely to be inflexible in deploying memory strategies.

The depth of encoding explanation for anxiety's impact

upon academic learning is a useful one. Like the study skills deficit model however, depth of encoding is inadequate for explaining the phenomenon that is of concern here: academic performance. That is, because this model is concerned with encoding at acquisition, it does not provide a framework for examining anxiety's possible effects at the point of retrieval.

Interference Model

The interference model posits that anxiety produces task-irrelevant responses in the testing situation. These responses interfere with task-relevant responses and reduce the effectiveness with which prior learning is retrieved, hence a negative relationship is assumed to exist between anxiety and test performance (Sarason, 1972; Wine, 1971).

Sarason (1972) suggested that the debilitating effects of anxiety were a function of its interference with cognitive processes, i.e., high levels of anxiety lead to task-irrelevant responses which inhibit task-relevant responses. He also concluded that it is the manner in which the high anxious student attends to the events in her environment, as well as how she interprets and uses such information, which determines anxiety's effect on performance.

Wine (1971, 1980) has identified direction of attention as a major factor in anxiety's effect on test performance.

She contends that the attention of highly anxious individuals in an evaluative situation is divided between task-relevant (question answering) and task-irrelevant (worrying) responses. Those who experience high levels of anxiety give a significant portion of their attention to task-irrelevant responses. With only a small portion of their attention available for task-relevant responses, their performance is depressed. Work by Morris and Liebert (1970) provides evidence that supports Wine's analysis. In examining the emotional and cognitive (worry) aspects of anxiety, Morris and Liebert found a strong negative relationship between worry and academic performance.

While the interference model may prove useful in explaining how anxiety affects academic performance, there are two important points which must be noted. First, Wine has not provided an operational definition for task-irrelevant responses and we are therefore forced to rely on self-report measures of worrying to provide support for her contention. Second, this model describes a situation in which anxiety may be viewed as decreasing performance as a result of its interference with the acquisition of information which in turn leads to lower retrieval. According to this view, anxiety does not directly diminish retrieval, but rather interferes with acquisition, which in turn spills over into retrieval.

A More Powerful Model--Information Processing

The previous models all have contributed to the investigation of anxiety and its effect on academic performance. However, there is a model that can subsume each of the previous models in explaining the relationship between anxiety and academic performance. Tobias (1977,1979) proposed a model for research directed towards identifying the effects of anxiety on learning at each of three information-processing stages. Anxiety may interfere with: (a)the pre-processing or input of information; (b)the processing and storage of information; and/or (c) the post-processing or retrieval of information from long term memory. Not only does this model allow for anxiety affecting functioning at one of these information-processing stages, it allows for the possibility that some students may experience any or all of these effects in cumulative fashion. That is, the student may be anxious in the learning situation, not attend to the input as carefully as necessary, may then store it in an ineffective manner, and, may still be anxious at the testing situation and have trouble in retrieving the material.

This model can address the issues of concern to the previously discussed theories. The study skills deficit model, the shallow encoding model, and the interference model may all be conceived of as explanations of anxiety's

effect on functioning that focus on the pre-processing (input of information) and/or the processing (storage of information) stages.

In contrast to other formulations Tobias' model can also explain the impact of anxiety on the retrieval of information as well. Previous theoretical models have actually focussed on anxiety's impact on learning (input and storage) and have given little attention to anxiety's impact on performance (retrieval).

Retrieval Studies

Retrieval, lexically speaking, is ''to call to mind again''. In a psychological definition of and examination of retrieval, it is essential that it be determined whether information has been learned before the issue of retrieval can be addressed. That is, retrieval is a process by which stored or learned information is later recalled or used during performance. A retrieval deficit is identified by the discrepancy between what is known to have been stored and what can be recovered.

Only a few studies have directly investigated the relationship between anxiety and the retrieval of information from long term memory. Benjamin, McKeachie, Lin, and Holinger (1981) used an information processing model to study performance deficits of high test anxious students vis-a-vis problems in encoding, organization,

and/or retrieval of information in a testing situation. Although they found evidence of an encoding deficit for high anxious students, some evidence of a retrieval deficit was found as well.

In the research reported by Benjamin, et al., the test performance of undergraduate students enrolled in a second-level psychology course was examined. The final examination in the course consisted of several types of questions, including multiple choice and short answer items.

Storage and retrieval in this study were distinguished by comparing recall and recognition performance, based on the authors' belief that recall involves both adequate storage and retrieval whereas recognition involves less active retrieval. They used multiple choice questions (recognition) to evaluate storage, and short answer items (recall) to evaluate retrieval. The authors' evidence for a retrieval deficit was the lower performance of the high anxious students on the short answer questions when compared to medium anxious and low anxious students. These authors carried out an analysis of covariance using multiple choice scores as the covariate and short answer scores as the dependent variable. High anxious students did more poorly than other students on the short answer (recall) questions even when multiple choice performance was controlled. Such a difference was not found when short answer scores were used as the covariate and multiple choice scores served as

the dependent variable. The authors contended that these findings support a retrieval deficit.

Such an interpretation is questionable for several reasons. First, the high anxious students had, in general, lower performance than other students--which suggests that the groups were not comparable in terms of initial learning. The use of analysis of covariance assumes a linear relationship between acquisition and recall which was not empirically established. Second, the suitability of a multiple choice test as a measure of storage can be challenged. The tests were given at the end of the term and thus clearly required retrieval of information from long term storage. Therefore, one must ask how these researchers can be sure that inability to answer a multiple choice question is not a problem of retrieval? Furthermore, the comparison of multiple choice and short answer questions is based on the implicit assumption that the two types of questions are comparable, when in reality they required different types of responses, may be subject to different types of error, and are, in all likelihood, not exactly parallel in meaning.

These problems may be avoided by first, training anxious and non-anxious students to some preset criterion (which assures that their initial learning is comparable i.e., that the information has been adequately stored) and second, by using the same test at acquisition and at

retrieval.

Wendell and Tobias (1983) attempted to assess student learning at acquisition and then to determine whether the retrieval of previously mastered material was affected by test anxiety. The subjects were undergraduate students enrolled in an introductory educational psychology course. The students were given a pre-test, an immediate post-test, and a delayed post-test on course material that was presented on videotape. The pre-test and immediate post-test were given in as non-evaluative a setting as possible---students were told that the effectiveness of the tapes was being evaluated, not their performance. On the other hand, the students were stressed immediately before the delayed post-test by being told that performance on the test would be reflected in their final grades for the course.

The same form of a multiple choice test was used at all points and students were compared on the basis of two retrieval indices that were calculated. The authors attempted to assess the differential effects of evaluative anxiety by comparing the number of questions that were answered incorrectly on the delayed post-test (evaluative setting) that had been answered correctly on the pre-test and/or the immediate post-test (non-evaluative settings). No difference was found for questions that had been answered correctly on both the pre- and immediate post-tests. However, highly anxious students were more likely than were

low anxious students to have answered a question incorrectly on the delayed post-test if they had answered it correctly on the immediate post-test but not the pre-test. This finding was interpreted as supporting a retrieval deficit.

There were a number of problems with this study. First, the authors used multiple choice measures (which Benjamin et al. (1981) had argued were measures of storage rather than retrieval) instead of measures which could be more readily identified as recall items. Although the present writer has raised questions about this particular interpretation, it is nonetheless clear that multiple choice items are not ideal measures of retrieval because they provide built-in clues. Second, no unstressed control groups were included and thus the impact of stress-induced anxiety could not be assessed. Third, the authors' unusual procedure of analyzing results by individual test items across the three test phases is questionable. This procedure assumes perfect reliability for the items and it creates a situation where students are being compared on different subsets of items. Such conditions create significant interpretative problems.

In order to avoid these particular shortcomings, research on retrieval should involve a free recall task, with no cues provided by the researcher; training all students to a pre-set criterion to ensure equivalent acquisition; and stressing only half of the high anxious

students and half of the low anxious students so that the effects of stress on anxiety might be evaluated.

III. Statement of the Problem

The present research sought to address issues raised by the abovementioned authors as well as by others. In the present study, immediate indications of acquisition were carried out in order to control for the possibility that the acquisition indices used by Wendell and Tobias (1983) initially tapped intermediate or long term memory. Moreover, both high and low anxious students were trained to the same criterion on a free recall task, thus assuring acquisition. This training to criterion was carried out not only to ensure that the list was completely learned but also to ensure equivalent mastery between the two groups. Finally, this training also allowed for the elimination of alternate explanations based on inadequate storage.

If the hypothesized retrieval deficit were to be supported, the question of how it occurred would still remain. The design of this research included multiple retrieval opportunities. Brainerd, Howe, and Kingma (1984) have reviewed research indicating that patterns of responding exhibited in such multiple retrieval opportunities may indicate whether failure to recall occurs as a result of the trace being inaccessible or the loss of a retrieval algorithm. These authors assert that recovery of previously learned information over a number of trials without feedback indicates the subsequent recovery of a

retrieval algorithm for that information; while continued inability to recall this information implies the complete inability to reconstruct the retrieval algorithm. For example, the student who can recall no words on her first recall trial, three words on the second trial, and seven words on her fifth trial may be said to have reconstructed the missing retrieval algorithm for those words. On the other hand, the student who cannot remember any of the words on any of the trials may be viewed as one who could not reconstruct the missing retrieval algorithms.

In applying Brainerd et al.'s notion to high versus low anxious individuals, it was hypothesized that low anxious students would be more able to reconstruct lost retrieval algorithms than high anxious students, because anxiety was viewed as interfering with said reconstructive activities.

Hypotheses

The purpose of this study was to examine the effect of anxiety on the retrieval of information from long term memory. Additionally, differences between high and low anxious students in the rate of acquisition were examined. Several hypotheses were tested. It was expected that:

1. High anxious students would recall less learned material under stress conditions than would low anxious students under those same conditions.

This hypothesis deals with trait anxiety.

2. High anxious students would recall less learned

material under stress conditions than would high anxious students who had not been stressed. This hypothesis is concerned with state anxiety.

3. Low anxious students' performances would not differ significantly whether they were subject to stress conditions or not.

This hypothesis is concerned with the expected interaction between anxiety level and stress condition.

4. High anxious students would recall less of the material in the absence of stress conditions than would low anxious students who had not been stressed.

This hypothesis is concerned with both trait anxiety and the expected interaction.

5. High anxious students would need more trials to achieve the preset criterion on the free recall task than would low anxious students.

6. High anxious students would make more errors before achieving the criterion than would low anxious subjects.

Hypotheses 5 and 6 are included as a check of previous research findings on learning differences as a function of trait anxiety.

7. Low anxious students would show a greater increase in recall over retrieval trials than high anxious students.

8. High anxious students who were not stressed would show a greater increase in recall over retrieval trials than high anxious students who were stressed.

Hypotheses 7 and 8 are directed towards determining whether differences in reconstruction of retrieval algorithms are a function of state and/or trait anxiety. That is, an interaction between retrieval trials and state and/or trait anxiety is expected.

IV. Method

Subjects

Subjects were 97 undergraduate students enrolled in introductory education and psychology courses. There were 76 females and 21 males. Males were equally distributed across all treatment conditions. Subjects had a mean age of 27.55 years.

Materials

A recall task was developed based on a list of 20 words drawn from the Battig-Montague (1969) categorized word pool. The words were selected such that no two words represented the same category.

Two anxiety tests were selected for use during this study. The Test Anxiety Scale (Sarason, 1972) is a 37-item true-false test developed to measure trait anxiety and was used for that purpose in this research (see Appendix A). This scale is the most frequently used in anxiety research for the measurement of trait anxiety. Its validity and reliability have been widely documented. The Worry-Emotionality Scale (Morris & Liebert, 1970) is a state anxiety scale derived from Mandler and Sarason's Test Anxiety Questionnaire. (See Appendix B). It differs from that scale in several ways--most importantly, questions have been modified to assess test anxiety as a state rather than

as a trait. The measure consists of ten items, five worry and five emotionality, that are rated on a five-point Likert scale.

Procedure

The Test Anxiety Scale was completed by all students at least one month before training on the recall task began. Scores on this measure were interpreted as an index of trait anxiety. Subjects were identified as either high anxious or low anxious on the basis of a median split procedure. See Table 1.

	Mean	SD
High Anxious	24.63	6.09
Low Anxious	10.92	3.17

Table 1: Mean Test Anxiety Scale Scores.
Median = 16.00.

The recall task itself was carried out at two meetings separated by one week. During the first session, students studied the 20 words (see Appendix C) until a criterion of three errorless repetitions of the list was achieved. Subjects were given study times of 4 seconds per word per study cycle with a 15-second rest period between study cycles. Students were required to repeat as many words from the list as they could remember within each study cycle.

This procedure was repeated until the criterion was achieved. The students then completed the Worry-Emotionality Scale based on how they felt during the study-test cycles. This constituted the acquisition phase. High and low anxious students' number of trials to criterion as well as the total number of errors to criterion were recorded.

After one week, subjects returned for the second and final session. Before testing, one half of the high anxious students and one half of the low anxious students were told: ''Performance on this task has been found to be highly related to academic performance and reflective of general intelligence and it is therefore extremely important that you do well.'' The other half of the subjects were told: ''Try to relax and try to do as well as possible.'' Subjects were then asked to list as many of the words from the original list as they could remember. After a 15-second rest period, subjects were again asked to list as many of the 20 words as they could. This was repeated three more times, for a total of five testing occasions. Subjects were again asked to complete the Worry-Emotionality Scale, reflecting how anxious they felt during the post-testing experience. During this retention phase, the number of recalled words was recorded for each trial period.

Subjects were thoroughly debriefed at the end of the second session by being told that the task was not related

to intelligence or academic performance. The purposes and goals of this research were explained to all subjects.

V. Results

A number of analyses were performed on these data. The results of analyses for each of the hypotheses will be reported in the order of their processing, i.e., analyses of acquisition will be reported first, then the analyses of the retrieval data will be considered.

Acquisition Data

With regard to acquisition, two hypotheses were posed. Hypothesis 5 stated that high anxious subjects would require more trials than low anxious students to achieve the preset criterion. See Table 2.

	Trials to Criterion		Errors to Criterion	
	M	SD	M	SD
High Anxious	7.65	2.49	24.45	13.96
Low Anxious	5.71	1.90	13.06	9.99

Table 2: Acquisition Data.

This hypothesis was tested using a one-way analysis of variance (ANOVA), and was supported. It was found that high anxious subjects ($M = 7.65$) required more trials than low anxious subjects ($M = 5.71$), $F(1,93) = 18.65$, $p < .01$.

Hypothesis 6 stated that high anxious subjects would make more errors than low anxious subjects would make before

achieving the preset criterion. This hypothesis was tested in the same manner as hypothesis 5 and was supported as well. It was found that high anxious subjects (M = 24.45) made more errors than low anxious subjects (M = 13.06), $F(1,93) = 21.25$, $p < .01$.

Retrieval Data--Aggregate Analyses

Worry-Emotionality scores for the stressed versus non-stressed groups were compared in order to determine whether the experimental stressing had the expected effect. It was found that subjects exposed to experimental stress had higher worry scores at retrieval (M = 9.91) than those who were not exposed to said stress (M = 7.71), $t(95) = 2.71$, $p < .01$. Emotionality scores for these two groups were not significantly different. These findings are consonant with previous research, in which it was found that worry scores are highly negatively correlated with performance. These results confirm the effect of the experimental stressing.

The retrieval data were analyzed in two ways. Hypotheses 1-4 were analyzed using a priori *t*-tests. Hypothesis 2 stated that high anxious subjects who were not stressed would recall more of the learned material than would the high anxious subjects who had been stressed. A *t*-test was performed comparing the average number of words recalled by these two groups of high anxious subjects.

Subjects who were not stressed remembered more words (M = 15.65) than if they were stressed (M = 13.97), $t(47) = 2.09$, $p < .05$. This leads to the rejection of the null hypothesis of no difference between these two groups and provides support for the alternative hypothesis of superior performance on the part of high anxious subjects who were not stressed.

It was stated in hypothesis 3 that there would be no difference in the performance of the low anxious subjects who were stressed compared to the performance of the low anxious subjects who were not stressed. The resulting t value between the stressed versus non-stressed low anxious groups was non- significant, $t(46) = -0.66$, $p > .05$. This leads to the acceptance of the null hypothesis---which supports the lack of a differential effect of stressing on low anxious subjects. While no significant difference was found in this analysis, it is important to note that these results are based on an analysis of aggregated means, not trial-by-trial data. Those trial-by-trial analyses will be presented subsequently.

Hypothesis 1 stated that, when stressed, high anxious subjects would recall less learned material than low anxious subjects. A t-test was performed comparing the mean number of words recalled by low anxious subjects with the mean number of words recalled by high anxious subjects averaged across trials. The first hypothesis was not supported,

$t(43) = 0.94$, $p > .05$.

The expected difference between the high anxious and low anxious subjects who had not been stressed was addressed in hypothesis 4. This hypothesis stated that low anxious subjects who had not been stressed would recall more learned material than would the high anxious subjects who had not been stressed. The result was not significant, $t(50) = -0.13$, $p > .05$. No support was found for the alternative hypothesis of improved performance on the part of low anxious subjects who were not stressed as compared to high anxious subjects under the same conditions. Therefore the alternative hypothesis proposed was not accepted.

Retrieval Data---Trial-by-Trial Analyses

Analysis of student differences in retrieval across trials was performed using a 2 x 2 x 5 (anxiety level x stress condition x trials) ANOVA with repeated measures. Significant main effects were found for stress condition, $t(94) = 1.732$, $p < .04$, one-tailed test, and trials, $F(4,372) = 16.94$, $p < .01$. The trials x anxiety level interaction was found to be significant, $F(4,372) = 3.05$, $p < .02$; and, most importantly, the three-way interaction (anxiety level x stress condition x trials) was significant, $F(4,372) = 2.39$, $p < .05$. Hypotheses 7 and 8 were concerned with students' rates of recall across trials as a function of anxiety level and stress condition.

Hypothesis 7 indicated that low anxious individuals as a whole would show a greater increase in recall over the five trials than would the high anxious subjects. The finding of a significant trials x anxiety interaction, $F(4,372) = 3.05$, $p < .02$, was consistent with this hypothesis. The specific nature of this two-way interaction was analyzed using *t*-tests.

This interaction is presented visually in Figure 1. Hypothesis 7 was tested specifically by comparing the amount of improvement for low anxious subjects between Trial 1 and Trial 5 with the same data for high anxious subjects. In other words, *t*-tests were used to determine the significance of the differences in performance between trials 5 and 1 for high anxious and low anxious subjects. Low anxious subjects recalled more words at Trial 5 than at Trial 1, $t(47) = 1.73$, $p < .02$. High anxious subjects however, did not recall more words at Trial 5 than at Trial 1, $t(48) = 1.03$, $p > .05$. This lends further support to the hypothesis that low anxious individuals would show a greater increase in recall across trials than high anxious individuals. It is possible, however, that the significant two-way interaction was in part due to the flip-flop of groups between trials 1 and 2.

In addition, a series of *t*-tests was performed comparing the mean number of words recalled by low anxious subjects with the mean number of words recalled by high

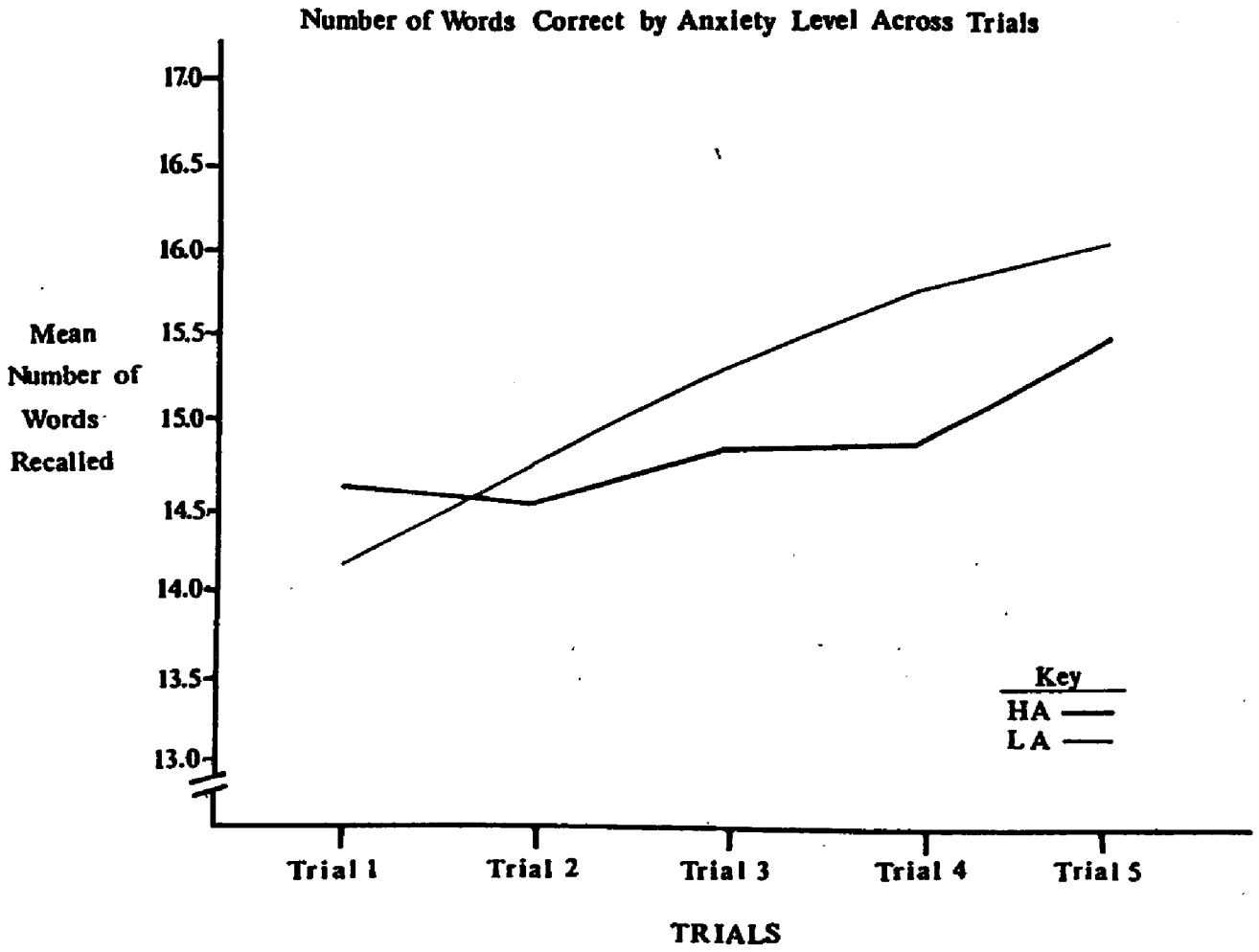
Number of Words Correct by Anxiety Level Across Trials
17.0
16.5
16.0
15.5
15.0
14.5
14.0
13.5
13.0
Mean Number of Words Recalled
Key
HA
LA
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
TRIALS

Figure 1

anxious subjects for each trial. Although the high anxious and low anxious subjects did not differ significantly from each other at Trial 1 nor at Trial 5, however, the difference at trials 4 and 5 approached significance, smallest $p < .12$. See Table 3.

		High Anxious	Low Anxious
Trial 1	M	14.60	14.17
	SD	3.26	3.98
Trial 2	M	14.53	14.75
	SD	2.96	3.72
Trial 3	M	14.81	15.29
	SD	3.21	4.06
Trial 4	M	14.86	15.77
	SD	3.07	3.42
Trial 5	M	15.53	16.04
	SD	2.76	3.54

Table 3: Recall of High and Low Anxious Subjects

Hypothesis 8 indicated that high anxious individuals who were not stressed would show a greater increase in recall across the five trials than would those high anxious individuals who had been stressed. Support for this hypothesis would be expressed in a significant three-way interaction between trials, stress condition, and anxiety level--and indeed, such an interaction was found. However,

trial by trial analyses of this interaction (See Figure 2.) revealed a pattern of results that did not conform with that expressed in hypothesis 8.

In order to determine the significance of the differences in performance between trials 5 and 1 for high anxious subjects who had been stressed and high anxious subjects who had not been stressed, *t*-tests were used. Neither was significant, disconfirming differential rates of increase of recall. However, trial by trial *t*-tests indicated that the stressed subjects showed inferior recall to non-stressed subjects at all points: Trial 1, $t(47) = 1.68$, $p < .05$; Trial 2, $t(47) = 1.28$, $p < .10$; Trial 3, $t(47) = 1.67$, $p < .05$; Trial 4, $t(47) = 2.35$, $p < .05$; and, Trial 5, $t(47) = 2.05$, $p < .05$. These data indicate that stressed and unstressed subjects evidenced differential rates of recall. See Table 4.

In conclusion, the three-way interaction between anxiety, stressing, and trials was created primarily by the improved recall of the low anxious students who were stressed. On the other hand, the recall of students in the other experimental groups was relatively stable across trials.

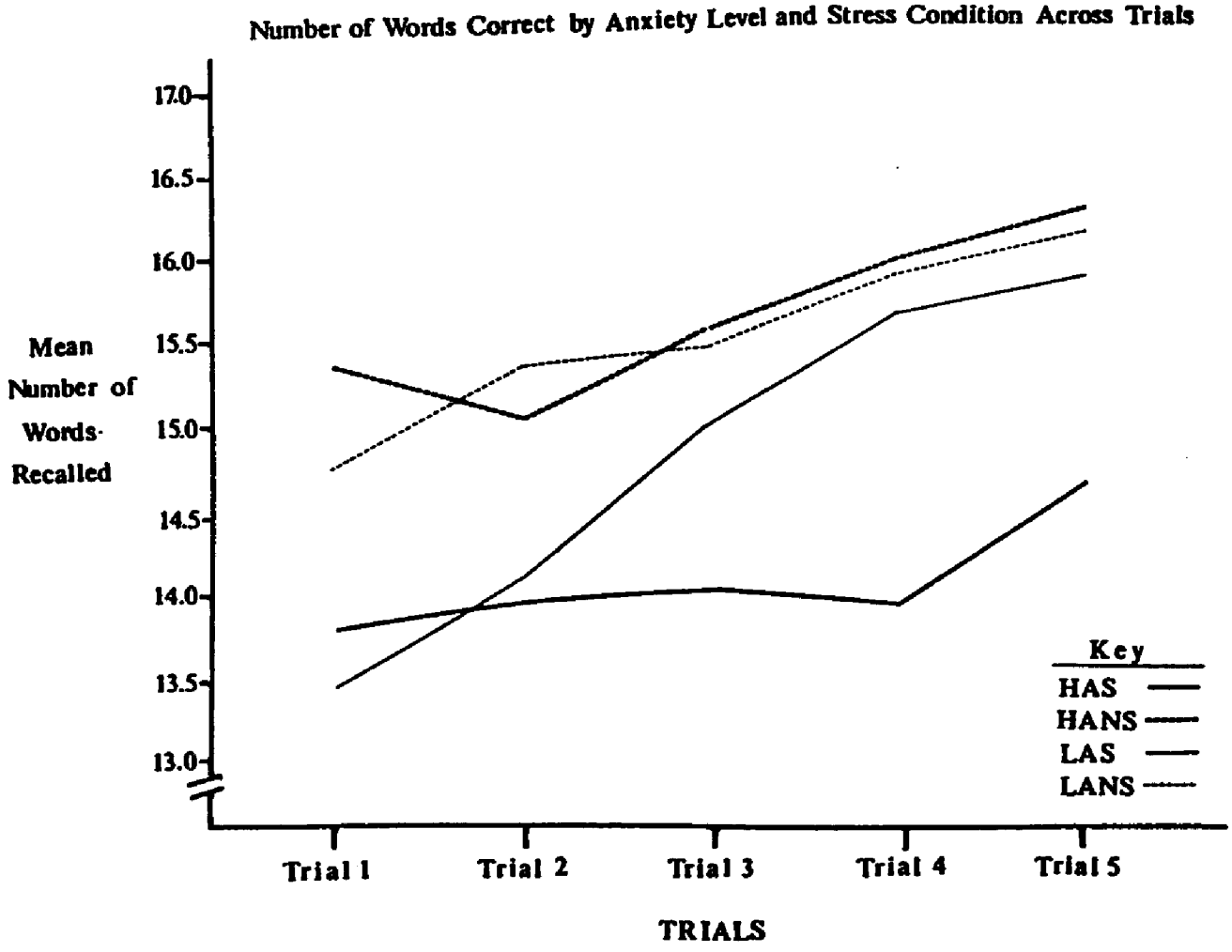
Number of Words Correct by Anxiety Level and Stress Condition Across Trials
Mean Number of Words Recalled
17.0
16.5
16.0
15.5
15.0
14.5
14.0
13.5
13.0
Key
HAS
HANS
LAS
LANS
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
TRIALS

Figure 2

		High Anxious, Stress	High Anxious, No Stress	Low Anxious, Stress	Low Anxious, No Stress
Trial 1	M	13.78	15.35	13.45	14.77
	SD	3.01	3.49	4.02	3.95
Trial 2	M	13.96	15.04	14.09	15.35
	SD	3.01	2.89	3.88	3.59
Trial 3	M	14.00	15.54	15.05	15.58
	SD	3.18	3.25	4.20	3.90
Trial 4	M	13.91	16.00	15.68	15.85
	SD	2.92	3.25	3.33	3.74
Trial 5	M	14.65	16.31	15.91	16.15
	SD	2.50	3.08	3.54	3.55

Table 4: Recall for High and Low Anxious Subjects by Stress Condition.

VI. Discussion

The findings of this research are of considerable importance for understanding how anxiety is related to both student learning and performance. Although the negative effects of anxiety on learning and performance have been demonstrated before, it has not been possible to separate the impact of anxiety on acquisition and retrieval. The present study was the first effort to clearly distinguish these informational subprocesses through the use of a trials-to-criterion design. Anxiety was found to be negatively related to both of these subprocesses.

The effects of anxiety during acquisition conformed to the stated hypotheses. As expected, students' trait anxiety was related to the number of trials they needed to reach the preset criterion and to the number of errors they made before that criterion was reached. High anxious individuals needed more trials and made more errors than low anxious individuals in order to achieve the same level of expertise.

The retrieval data were more complex than expected. It was found that, although anxiety alone did not depress recall during retrieval trials, being stressed negatively influenced initial retrieval for both low and high anxious subjects. That is, receiving stress depressed the scores of both high and low anxious subjects at Trial 1. However, on subsequent trials, the low anxious subjects who were

stressed were able to recover sufficient stored information such that, by the fifth trial, they performed at the same level as the unstressed groups. On the other hand, the performance of high anxious subjects remained depressed on Trials 2-4. It is important to reemphasize at this point that no feedback was given---therefore the observed differences reflected the low anxious students' ability to recover information from memory. On the basis of the theoretical analyses of Brainerd et al. (1984) for multiple trial retrieval data, it appears that stress-induced anxiety interfered with the recovery or reconstruction of retrieval algorithms necessary for the accessing of the previously learned material. Thus, the data revealed an interaction between anxiety level and stress condition that was responsible for the differences in performance betweeen these groups over the five trials. The high and low anxious subjects who were not stressed evinced equivalent levels of performance across all five trials. There was no significant recovery of learned information for either of these two groups. However, since initial levels of recall were relatively high, this lack of recovery may simply be a function of those original high rates of recall.

The significant three-way interaction between anxiety level, stress condition, and retrieval trials indicated that the interrelationship of all three variables is important. This particular analysis provided the most thorough and

revealing examination of these factors. At Trial 1, recall performance appeared to be primarily a function of stressing, i.e., the performance of high anxious subjects who were not stressed mirrors that of the low anxious subjects who were not stressed although the performance of low anxious subjects who were stressed is just as depressed as that of high anxious subjects under the same condition. In fact then, stress does similarly affect both high and low anxious individuals at the outset of evaluation. However, the differential effect of being stressed becomes increasingly evident over subsequent trials for the two groups of subjects. The negative effects of stress do not continue for low anxious subjects. Interestingly, this effect would not have been evident without the inclusion of multiple retrieval trials in the design. By Trial 5, the low anxious subjects who were stressed had recovered to such a degree that their recall scores were equivalent to those of the low anxious subjects who had not been stressed. Whether this recovery of the retrieval algorithm is a function of time, a cognitive searching strategy, and/or an anxiety diminution strategy is not clear at this point. It is however clear that differences in covert processes exist among students who were stressed that is related to their anxiety level.

The substantial but non-significant increase in recall between Trials 4 and 5 for the high anxious subjects who

were stressed, suggests the need for more trials in future research. This would permit determination of whether high anxious subjects who were stressed could continue to recover. It is possible that high anxious students were simply slower to recover from the stressing, rather than being fundamentally different in their use of retrieval strategies.

Post-hoc *t*-tests of the retrieval trials data indicated that low anxious individuals showed a greater increase in recall over trials than the high anxious subjects. Further information about this trend can be derived from Figure 2. This figure shows that the increase in recall was due to the marked improvement of the low anxious subjects who had been stressed. On the other hand, the initial differences in recall between high anxious subjects who had been stressed and those high anxious subjects who had not been stressed was maintained across trials, with no significant increase in recall for either group across trials. The differential rates of recall would seem then to be a function of the stressing. High anxious subjects differed from the low anxious subjects in their inability to recover from the stressing within the same time frame as the low anxious subjects.

Several of the obtained results could not be predicted on the basis of previous research. It was found that high anxious subjects did not have diminished average or initial

recall scores compared to low anxious subjects under the same stress conditions. Previous research had indicated that high anxious individuals display poorer performance than low anxious individuals. Prior researchers have attributed this deficit to problems in retrieval. However, after being trained to the same criterion as their low anxious counterparts, in the present study, high anxious individuals did not exhibit performance deficits unless they were stressed. Furthermore, after receiving stress, the low anxious subjects exhibited the same deficit levels on the initial trial as the high anxious subjects. This finding suggests that previous researchers may have attributed performance deficits erroneously to anxiety during retrieval when, in fact, anxiety at acquisition was the determining factor. The present findings indicate that training all individuals to the same standard of performance (in contrast to merely providing an equal number of trials or the same amount of study time) eliminates much of the disparity between these two anxiety groups. When additional time was provided at acquisition and the explicit stress was eliminated from the retrieval situation, high anxious subjects did not experience the pernicious effects of anxiety.

It would seem then, that the theoretical and empirical bases for the original hypotheses that guided this research were inadequate due to a confounding of acquisition and

performance measures in previous studies. Clearly, the use of a trials-to-criterion design and multiple retrieval trials are needed in future research to prevent this situation from re-occurring. It seems that a failure to experimentally control for acquisition and retrieval in previous research led to some imprecision in four of the hypotheses that were proposed.

For example, since multiple retrieval trial designs had not been used in prior anxiety research on retrieval, the first four hypotheses were formulated and evaluated on the basis of average trial performance. In so doing, some of the obtained results were misleading. Hypothesis 1, which was not supported by the *t*-test used, is in fact supported by ANOVA tests that were directed at hypotheses 7 and 8. When averaging scores across all five trials, the differences between the high and low anxious subjects are not discernible. However, when we look at performance trial-by-trial and refer to other post hoc analyses, it is clear that, at Trial 5, there was a significant difference between the performance of the high versus low anxious subjects who were stressed.

The second hypothesis, dealing with the expectation of differential rates of recall for high anxious subjects vis-a-vis stress condition was supported both by the initial *t*-test and the more complete analysis using ANOVA.

The third hypothesis, concerning the lack of a

differential effect of stressing on low anxious subjects, was supported by a *t*-test of the trial averages. Here again, we have an instance in which (even though the author's original assertions are supported) the initial analysis was misleading. However, from the results of the ANOVA, it is clear that there was in fact a difference in performance between low anxious subjects who were stressed and those who were not. Although the low anxious subjects demonstrated an initial performance deficit due to stress akin to that of high anxious individuals, substantial differences existed between these two groups by Trial 5.

The fourth hypothesis, that the performance of high anxious subjects who had not been stressed would be greater than that of high anxious subjects who had been stressed, was not supported in any of the analyses. It appears that the use of a training-to-criterion procedure in the present study was responsible for the lack of replication of previous results which found differences between these two anxiety populations.

When considering all of the analyses and hypotheses as a whole, it is possible to draw several conclusions about the nature of anxiety and its impact on learning and performance. First, anxiety has been shown to be negatively related to both learning and performance. Both subprocesses are adversely affected in the high anxious individual. Second, the debilitating effects of anxiety on acquisition

may be mitigated by providing extra time or study opportunities for the high anxious individual. Third, reducing or eliminating stress in the evaluative situation may reduce the debilitating effects of anxiety on the retrieval of information from long term memory.

Suggestions for Further Research

This research has demonstrated that anxiety was negatively related to retrieval of information from long term memory. However, the mechanism through which this occurs remains unclear. Whether Wine's assertion that direction of attention is the crucial factor, or Sarason's assertion that anxiety leads to task-irrelevant responses, or some other explanation should be considered is at this point unclear.

Kuhl (1983) has suggested that motivational and volitional factors need to be considered when examining discrepancies between ability and performance. He suggests that attentional control may be a major factor in the appearance of such discrepancies. Kuhl contends that a person may have the cognitive abilities and may be sufficiently motivated to solve a task, and still fail to perform the necessary cognitive activities because of an inability to shield the task-oriented intention against competing action tendencies, such as, thinking about the self-evaluative implications of past failures at some other

task. In his research, Kuhl found a significant correlation between test anxiety and high-ruminating ''state'' orientations. It is possible then that one of the major functional differences between high and low anxious individuals is in their ability to redirect ruminative tendencies away from dysfunctional cognitions and back to the task at hand.

Suggestions have been made in this investigation for minimizing the negative or debilitating effects of anxiety. It is likely that as knowledge of the underlying cognitions related to anxiety is gained, our efficiency in counteracting it will increase as well. The present research has helped to determine where, when, and under what circumstances anxiety may be negatively related to performance--not the cognitive nature of this dysfunction.

Other questions of importance include how to organize evaluation activities in non-threatening or supportive ways. In the present research, subjects were told that this investigation was concerned with how people remember, not how much. Additionally, subjects in the no-stress condition were told simply to relax and do the best that they could. It is possible that these simple instructions reassured the high anxious subjects so that they performed at a level more reflective of their actual capacity. This information can be used by practitioners to eliminate stress from testing situations. This information provides some limited insight

concerning how low anxious subjects can counteract the debilitating effects of stress for themselves. How the low anxious student goes about such a task is a research issue in need of further investigation. It may be possible that techniques used by low anxious individuals can be taught to the high anxious so that the latter can self-control when threatening evaluation situations cannot be avoided.

The findings in this research are of importance to educators for several reasons. First and foremost, these findings clearly indicate that anxiety does in fact affect the retrieval of information from long term memory. Support is provided for Tobias' view that anxiety may negatively affect both acquisition and retrieval for some subjects--those identified as high anxious--and that these subjects are even more likely to experience greater debilitating effects of stress than low anxious subjects. This investigation provides more detailed information delineating the relationships between anxiety, initial learning or acquisition, retrieval or free recall, and stressing within an evaluative situation.

This research also provides information about instructional tactics for reducing the debilitating effects of anxiety both at acquisition and retrieval. Clearly, there are at least two concrete things that can be done to eliminate the debilitating effects of anxiety on student performance--short of changing the affective constitution of

the individual--train all students to a mastery criterion (Bloom, 1968) for the particular task and eliminate or reduce stress in the evaluative situation (Houston, 1982). Additionally, the present results demonstrate that allowing for multiple retrieval opportunities will help students' recall regardless of their anxiety level or exposure to stress. These three procedures have direct classroom applications and should influence how teachers help students to prepare for tests as well as the manner in which teachers conduct that testing. Extensive reviews to help ensure mastery, diminished evaluative threat,and providing ample time for recall will combine to enhance student test performance.

Appendix B. Worry-Emotionality Scale

Name:

Class:

HOW DO YOU FEEL?

EACH SENTENCE SHOWS HOW PEOPLE FEEL. EVERY PERSON FEELS DIFFERENTLY.

PLEASE ANSWER THE WAY YOU FEEL RIGHT NOW.

	NOT AT ALL	BARELY SO	MODERATELY SO	STRONGLY SO	VERY STRONGLY SO
I FEEL MY HEART BEATING FAST.					
I FEEL REGRETFUL.					
I AM SO TENSE THAT MY STOMACH IS UPSET.					
I AM AFRAID THAT I SHOULD HAVE STUDIED FOR THIS LESSON.					
I HAVE AN UNEASY, UPSET FEELING.					
I FEEL THAT OTHERS WILL BE DISAPPOINTED IN ME.					
I AM NERVOUS.					
I FEEL I MAY NOT DO AS WELL ON THIS LESSON AS I COULD.					
I FEEL PANICKY.					
I DO NOT FEEL VERY CONFIDENT ABOUT MY PERFORMANCE ON THIS LESSON.					

Appendix C. Word List

ID #

TRIALS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
apple																												
cancer																												
dog																												
football																												
hurricane																												
iron																												
jazz																												
knife																												
legs																												
lieutenant																												
magazine																												
milk																												
mountain																												
oil																												
rattler																												
robin																												
salt																												
shirt																												
waltz																												
window																												

References

Alpert, R., & Haber, R.M. Anxiety in academic achievement situations. Journal of Abnormal and Social Psychology, 1960, 61, 207-215.

Battig, W.F., & Montague, W.E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticutt category norms. Journal of Experimental Psychology Monograph, 80, (No.3, Pt.2).

Benjamin, M., McKeachie, W., Lin, Y. & Holinger, D. Test anxiety: Deficits in information processing. Journal of Educational Psychology, 1981, 73, 816-824.

Bloom,B.S. Learning for mastery. Evaluation Comment, Vol. 1, No. 2, Los Angeles: Center for the Study of the Evaluation of Instructional Programs, University of California, 1968.

Brainerd, C.J., & Howe, M.L. (1982). Stages-of-learning analysis of developmental interactions in memory, with illustrations from developmental interactions in picture-word effects. Developmental Review, 2, 251-273.

Brainerd, C.J., Howe, M.L., Kingma, J., & Brainerd, S.H. Explaining category interference effects in associative memory. Canadian Journal of Psychology, 1984, 38(3), 454-477.

Craik, F.I.M., & Lockhart, R.S. Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 671-684.

Craik, F.I.M., & Tulving, E. Depth of processing and the retention of words in episodic memory. Journal of Experimental Psychology: General, 1975, 104, 268-294.

Culler, R.E., & Holahan, C. Test-taking and academic performance: The effects of study-related behaviors. Journal of Educational Psychology, 1980, 72, 16-20.

Desiderato, O., & Koskinen, P. Anxiety, study habits, and academic achievement. Journal of Counseling Psychology, 1969, 16(2), 162-165.

Grant, R.D., Jr. Validation of an automated test anxiety

reduction program. Unpublished doctoral dissertation, The University of Texas at Austin, 1973.

Harper, F.B. Specific anxiety theory and the Mandler-Sarason Test Anxiety Questionnaire, Educational & Psychological Measurement, 1971, Win, 31(4), 1011-1014.

Holroyd, A., Westbrook, T., Wolf, M., & Badhorn, E. Performance, cognition, and physiological responding in test anxiety. Journal of Abnormal Psychology, 1978, 87(4), 442-451.

Houston, B.K. Trait anxiety and cognitive coping behavior. Series in Clinical & Community Psychology: Achievement, Stress, & Anxiety, 1982, 195-206.

Kierkegaard, S. The Concept of Dread. (W. Lowrie, trans.). Princeton, N.J.: Princeton University Press, 1944. (Originally published, 1844).

Kuhl,J. Motivational aspects of achievement motivation and learned helplessness: Toward a comprehensive theory of action control. In B.A. Maher & W.B. Maher (eds.), Progress in Experimental Personality Research, (Vol. 13). Orlando: Academic Press, 1984.

Lin, Y., & McKeachie, W. Aptitude, anxiety, study habits, and academic performance. Journal of Counseling Psychology, 1970, 17(4), 306-309.

Mitchell, K., & Ng, K. Effects of group counseling and behavior therapy on the academic achievement of test anxious students. Journal of Counseling Psychology, 1972, 19(6), 491-497.

Morris, L.W., & Liebert, R.M. Relationship of cognitive and emotional components of test anxiety to physiological arousal and academic performance. Journal of Consulting and Clinical Psychology, 35(3), 332-337.

Mueller, J. The effects of individual differences on test anxiety and type of orienting task on level of organization in free recall. Journal of Research in Personality, 1978, 12(1), 100-116.

Mueller, J.H., Carlomusto, M., & Marler, M. Recall and organization in memory as a function of rate of presentation and individual differences in test anxiety. Bulletin of the Psychonomic Society, 1978, 12(2), 133-136.

Sarason, I.G. Experimental Approaches to test anxiety: Attention and the uses of information. In C.D. Spielberger (ed.), Anxiety: Current trends in theory and research, (Vol. 2). New York: Academic Press, 1972.

Tobias, S. A model for research on the effect of anxiety on instruction. In J.E. Sieber, H.F. O'Neill, Jr., & S. Tobias, Anxiety, learning, and instruction. Hillside, N.J.: Erlbaum, 1977.

Tobias, S. Anxiety research in educational psychology. Journal of Educational Psychology, 1979, 71(5), 573-582.

Tobias, S., Hedl, J.J., & Towle, N.J. Response time and test anxiety. Psychological Reports, 1974, 34(2), 479-485.

Wendell, A.S., & Tobias, S. Anxiety and the retrieval of information from long term memory. Paper presented at the 14th Convocation of NERA, Ellenville, N.Y., October 26-28, 1983.

Wine, J. Test anxiety and direction of attention. Psychological Bulletin, 1971, 76(2), 92-104.

Wine, J. Cognitive-attentional theory of test anxiety. In I.G. Sarason (Ed.), Test anxiety: Theory, research, applications. Hillside, N.J.: Erlbaum, 1980.

Wittmaier, B. Test anxiety and study habits. Journal of Educational Research, 1972, 352-354.