THE EFFECT OF BIOFEEDBACK INDUCED PHYSIOLOGICAL AROUSAL
AND THERAPEUTIC INSTRUCTIONS ON INDICES OF
TEST ANXIETY AND TEST PERFORMANCE

DISSERTATION

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Ronald L. Davis, B.S., M.S.
Denton, Texas
August, 1978
Davis, Ronald L., The Effect of Biofeedback Induced Physiological Arousal and Therapeutic Instructions on Indices of Test Anxiety and Test Performance, Doctor of Philosophy (College Teaching), August, 1978, 118 pp., 4 tables, bibliography, 67 titles.

This study was concerned with determining the effect of two levels of electromyogram (EMG) induced physiological arousal and therapeutic instructions on self-reported test anxiety, test performance, and on-task behavior. The rationale for such a study is the fact that treatments of test anxiety have presented inconsistent results. Little research has been undertaken with regard to the effect of EMG biofeedback as a treatment for test anxiety or non-specific effects associated with such a treatment.

Four hypotheses were tested using a Two Factor Analysis of Variance with Repeating Measures on one Factor. These hypotheses were that, under an EMG-induced low physiological arousal condition as opposed to an EMG-induced high physiological arousal condition, 1. Cognitive-intellectual test performance would be significantly higher; 2. self-reported test anxiety would be significantly lower; 3. self-reported on-task behavior would be significantly higher, and 4. therapeutic instructions would have no effect upon any of the dependent variables under study. Subjects were twenty undergraduate student volunteers who reported suffering from test anxiety.
The study consisted of five phases. The first phase was screening. Subjects accepted were randomly assigned to a positive or negative therapeutic instruction group. Phase two consisted of either high or low physiological arousal training via auditory EMG biofeedback. Phase three consisted of performance testing under either high or low physiological arousal conditions. Subjects were administered positive or negative therapeutic instructions before each performance testing, depending upon the group to which they were assigned. Phase four was the reversal of phase two and phase five was the reversal of phase three. All subjects received training and testing under both high and low physiological arousal treatment conditions in counter-balanced order.

Results indicated that self-reported test anxiety was significantly higher (p < .05) under the high physiological arousal condition than under the low physiological arousal condition and that self-reported on-task behavior was significantly greater (p < .05) for the positive therapeutic instruction group. Physiological arousal levels did not have any significant effect upon test performance or self-reported on-task behavior. Also, therapeutic instructions did not have a significant effect on self-reported test anxiety or test performance.

The results indicated a cognitive change with regard to test anxiety which was not reflected in test performance. Also, on-task behavior did not enhance test performance.
Recommendations included replicating the present study using more biofeedback training sessions with a lower EMG $\mu$V criterion required during testing; using physiological measures of autonomic functioning; inducing physiological arousal through other kinds of biofeedback; studying the effect of instructions conveying expectations for certain kinds of behavior on the actual occurrence of the expected behavior; and studying the effect of magnitude of change from the subject's baseline EMG level upon test anxiety, test performance and on-task behavior.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td></td>
</tr>
<tr>
<td>Purposes of the Study</td>
<td></td>
</tr>
<tr>
<td>Hypotheses</td>
<td></td>
</tr>
<tr>
<td>Significance of the Study</td>
<td></td>
</tr>
<tr>
<td>Definition of Terms</td>
<td></td>
</tr>
<tr>
<td>Limitations</td>
<td></td>
</tr>
<tr>
<td>II. REVIEW OF RELATED LITERATURE</td>
<td>10</td>
</tr>
<tr>
<td>Test Anxiety</td>
<td></td>
</tr>
<tr>
<td>Effects of Anxiety on Test Performance</td>
<td></td>
</tr>
<tr>
<td>Treatment of Test Anxiety</td>
<td></td>
</tr>
<tr>
<td>Cognitive Variables Related to Test Anxiety</td>
<td></td>
</tr>
<tr>
<td>Biofeedback Training</td>
<td></td>
</tr>
<tr>
<td>Therapeutic Instructions (Non-Specific Effects)</td>
<td></td>
</tr>
<tr>
<td>Summary of Related Literature</td>
<td></td>
</tr>
<tr>
<td>III. METHODS AND PROCEDURES</td>
<td>36</td>
</tr>
<tr>
<td>Procedures for Administration of Treatment</td>
<td></td>
</tr>
<tr>
<td>EMG Biofeedback-Induced Physiological Arousal Condition (Training Phase)</td>
<td></td>
</tr>
<tr>
<td>Therapeutic Instruction Conditions</td>
<td></td>
</tr>
<tr>
<td>Testing Conditions</td>
<td></td>
</tr>
<tr>
<td>Instruments</td>
<td></td>
</tr>
<tr>
<td>Procedure for Analysis of Data</td>
<td></td>
</tr>
<tr>
<td>IV. RESULTS AND DISCUSSION</td>
<td>53</td>
</tr>
<tr>
<td>Physiological Arousal</td>
<td></td>
</tr>
<tr>
<td>Therapeutic Instructions</td>
<td></td>
</tr>
</tbody>
</table>
# Chapter V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary</td>
<td>73</td>
</tr>
<tr>
<td>Summary of Findings</td>
<td></td>
</tr>
<tr>
<td>Conclusions</td>
<td></td>
</tr>
<tr>
<td>Implications</td>
<td></td>
</tr>
<tr>
<td>Recommendations for Further Study</td>
<td></td>
</tr>
</tbody>
</table>

## APPENDIX A

- Page 84

## APPENDIX B

- Page 94

## APPENDIX C

- Page 99

## BIBLIOGRAPHY

- Page 103
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Two-Way Analysis of Variance Testing the Effect of EMG-Induced Physiological Arousal and Therapeutic Instructions on Otis Quick Score Mental Abilities Test Scores of All Subjects (N=20).</td>
<td>56</td>
</tr>
<tr>
<td>II.</td>
<td>Two-Way Analysis of Variance Testing the Effect of EMG-Induced Physiological Arousal and Therapeutic Instructions on Anxiety Thermometer Scores of All Subjects (N=20).</td>
<td>59</td>
</tr>
<tr>
<td>III.</td>
<td>Two-Way Analysis of Variance Testing the Effect of EMG-Induced Physiological Arousal and Therapeutic Instructions on On-Task Behavior Scale Scores of All Subjects (N=20).</td>
<td>62</td>
</tr>
<tr>
<td>IV.</td>
<td>Two-Way Analysis of Variance Testing the Effect of EMG-Induced Physiological Arousal and Therapeutic Instructions on Rate (Number of Otis Test Questions Answered Per Minute) for All Subjects (N=20).</td>
<td>65</td>
</tr>
<tr>
<td>V.</td>
<td>Three-Way Analysis of Variance Testing the Effects of EMG-Induced Physiological Arousal, Therapeutic Instructions and Order of Treatment Presentations on Otis Quick Score Mental Abilities Test Scores of all Subjects (N=20).</td>
<td>95</td>
</tr>
<tr>
<td>VI.</td>
<td>Three-Way Analysis of Variance Testing the Effects of EMG-Induced Physiological Arousal, Therapeutic Instructions and Order of Treatment Presentations on Anxiety Thermometer Scores of all Subjects (N=20).</td>
<td>96</td>
</tr>
<tr>
<td>Table</td>
<td>Three-Way Analysis of Variance Testing</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------</td>
<td></td>
</tr>
<tr>
<td>VII.</td>
<td>the Effects of EMG-Induced Physiological Arousal, Therapeutic Instructions and Order of Treatment Presentations on On-Task Behavior Scale Scores of all Subjects (N=20)</td>
<td>97</td>
</tr>
<tr>
<td>VIII.</td>
<td>Three-Way Analysis of Variance Testing of EMG-Induced Physiological Arousal, Therapeutic Instructions and Order of Treatment Presentations on Rate of all Subjects (N=20)</td>
<td>98</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

A variable of interest to both educators and psychologists is the effect of anxiety in situations where tests are administered (9, 16). The reason for such interest is due to the detrimental effect that anxiety can have on performance outcome measures, i.e., achievement tests, final exams, aptitude tests, etc. and the personal misery it causes the test-taker.

As a consequence of such interest, many treatments designed to ameliorate test anxiety have been investigated. Most such studies address one or both of two components assumed to comprise test anxiety; a cognitive (verbal and imaginal) component and an emotional (physiological arousal) component (3, 16).

The physiological arousal component of test anxiety has been investigated largely through determining the effects of systematic desensitization or relaxation training on a self-report measure of degree of test anxiety and test performance (4, 5, 7). The inconsistent results with regard to such approaches both decreasing test anxiety and increasing test performance (14, 17) have led investigators to delegate physiological arousal to secondary status as a significant variable.
implicated in test anxiety, especially the debilitating effects upon test performance.

However, such investigations have not studied physiological arousal apart from other variables with regard to effect upon experienced test anxiety and test performance. If physiological arousal of subjects could be systematically varied while taking a test and simultaneously controlling for variables such as expectations for success, then its contribution with regard to effect could be more thoroughly and individually assessed. If such variations in physiological arousal were found to have little or no differential effect on various indices of test anxiety and performance, then it could be stated with more assurance that physiological arousal is, indeed, of secondary importance to other variables in causing the debilitating effects of test anxiety. Such results would serve to free psychologists and educators to pursue techniques to treat variables other than physiological arousal, i.e., cognitive and environmental variables.

One method of investigating the effect of levels of physiological arousal on experienced test anxiety and test performance is electromyographic biofeedback (EMG) training. EMG training offers an efficient and quick method of teaching subjects to vary muscular tension indicative of various levels of physiological arousal while also offering an investigator the ability to objectively monitor the test-taker's level of physiological arousal during a test administration (2).
Statement of the Problem

The problem of this study was to determine the effect of two levels of biofeedback-induced physiological arousal and therapeutic instructions on three dependent variables. These dependent variables are cognitive-intellectual test performance, self-reported test anxiety and self-reported ability to stay on task during the test administration.

Purposes of the Study

The purposes of the study were to determine the effect upon

1. The cognitive-intellectual test performance of each subject placed under both high and low physiological arousal conditions and therapeutic instruction conditions communicating either an expectancy for positive treatment outcome or an expectancy for negative treatment outcome;

2. The self-reported test anxiety of each subject placed under both low and high physiological arousal conditions and therapeutic instruction conditions communicating either an expectancy for positive treatment outcome or an expectancy for negative treatment outcome;

3. The report by each subject of the ability to remain on task during test administrations when placed under both low and high physiological arousal conditions and therapeutic instruction conditions communicating either an expectancy for positive treatment outcome or an expectancy for negative treatment outcome.
Hypotheses

The following hypotheses were formulated in order to accomplish the purposes of the study.

1. Cognitive-intellectual test performance scores as measured by the Otis Quick Score Mental Abilities Test (11) will be significantly higher for high test anxious subjects under the low physiological arousal condition than under the high physiological arousal condition.

2. Self-reported test anxiety scores as measured by the Anxiety Thermometer will be significantly less for high test anxious subjects under the low physiological arousal condition than under the high physiological arousal condition.

3. Self-reported on-task behavior as measured by scores on the On-Task Behavior Scale will be significantly greater for high test anxious subjects under the low physiological arousal condition than under the high physiological arousal condition.

4. Therapeutic instructions will have no significant effect on any of the dependent measures of high test anxious subjects.

Significance of the Study

The majority of studies to date have investigated both the effect of test anxiety on performance and the effect of various treatment methods in the alleviation of both self-reported test anxiety and decreased test performance (12, 15, 17). However, no research to date has attempted to
assess the effect of varying a hypothesized component of test anxiety, such as physiological arousal, on test performance and self-reported test anxiety. The studies that have attempted to induce relaxation as a treatment method or as a component of another treatment method, i.e., systematic desensitization (1, 4, 5, 6), have given little attention to monitoring the actual physiological arousal level during a test administration which would constitute an additional measure of anxiety to the subject's self-report of experienced anxiety.

Electromyographic (EMG) biofeedback training offers a recently originated approach to the treatment of test anxiety which may be of benefit to both educators and psychologists. A critical factor in establishing a new treatment procedure is to separate the non-specific therapeutic effects (instructions, demand characteristics of the treatment, etc.) from the effects of the treatment itself. Such investigations have been undertaken in relation to systematic desensitization (8, 10, 14), but little attention has been given to biofeedback training. Controlling for such non-specific effects would seem to add credence to the assumption that physiological arousal induced through biofeedback procedures is a major contributor to changes in test performance and other indices of test anxiety.
Definition of Terms

The following terms will have restricted meaning.

Physiological arousal is muscle activity level recording taken from electrodes placed over the frontalis muscle.

Therapeutic instructions are instructions to the subject which communicate that the treatment he is undergoing will either have the effect of decreasing his anxiety and increasing his test performance or will have the effect of increasing his anxiety and impairing his test performance.

Test anxiety components are physiological arousal and task-irrelevant attentional responses.

On-task behavior is behavior that involves responses of the subject which are oriented toward the goal of completing the task at hand.

Frontalis are the muscles of the forehead, the relaxation of which has been related to general bodily relaxation (13).

Limitations

1. The effects of physiological arousal on test performance, self-reported test anxiety, and on-task behavior will not generalize beyond college students scoring at or above the 75th percentile on the Suinn Test Anxiety Behavior Scale (18) and having a resting EMG $\mu V_r$ (Root Mean Square microvolts) baseline mean of six or higher.

2. The effects of induced physiological arousal levels will not generalize beyond testing situations where the subject
is able to monitor his level of physiological arousal while taking a test.

3. The amount of time on-task as measured by the On-Task Behavior Scale is a self-observation and estimate of each subject.

4. The level of anxiety as measured by the Anxiety Thermometer is a self-observation and estimate of each subject.
CHAPTER BIBLIOGRAPHY


CHAPTER II

REVIEW OF RELATED LITERATURE

Test Anxiety

Effects of Anxiety on Test Performance

Anxiety experienced during test situations has been the most widely studied of the specific anxieties (social anxiety, speech anxiety, etc.) (46). Several studies within this area have investigated level of test anxiety as related to cognitive-intellectual test performance and academic achievement.

Phillips (41), in his review of the test anxiety literature, indicates that correlational investigations have shown that high, when compared to low, scorers on measures of test anxiety tend to perform more poorly on various types of abilities tests. However, evidence seems to indicate that such a fact does not indicate intellectual deficiency on the part of high test anxious individuals (46, 48). Rather, impaired test performance seems to be partly a function of external factors such as instructions stressing the test-like, evaluative nature of the task at hand, instructions as to level of difficulty, time pressure and presence of an audience (46).

Sarason and Minard (48) investigated test anxiety as related to test performance on sub-scales of the Weschler Adult Intelligence Scale of 96 high and low test-anxious college
students. They found low test-anxious subjects superior in performance to high test-anxious subjects on Vocabulary, Block Design and Comprehension sub-scales.

Sarason (47) investigated the relationship between test anxiety and achievement tests (SAT, MAT) among 305 Yale University liberal arts undergraduate students and found a significant negative correlation between the two variables.

Pederson (40) investigated level of test anxiety (high, medium and low) of 96 male subjects as related to two performance tasks, vowel cancellation and multiplication problems and a paired-associate learning task. Subjects were assigned either to co-acting groups or alone. Performance on all tasks was impaired for medium and high test-anxious subjects in co-acting groups.

Osterhouse (38) investigated the effect of levels of test anxiety on examination performance in two different classrooms. Subjects were undergraduate psychology students at the University of Maryland. Levels of test anxiety were significantly different for the two classrooms with low test-anxious subjects having higher examination grades regardless of the classroom in which they were enrolled.

In studying the effects of test anxiety on academic and cognitive-intellectual test performance, Paul and Ericksen (39) investigated the relationship between performance on an examination designed to maximize anxiety reduction and test anxiety as measured by the Test Anxiety Questionnaire (48) among 118
female introductory psychology students. They found a significant negative correlation between the Test Anxiety Questionnaire scores and examination performance.

Speilberger (50) investigated the relationship between anxiety level and academic performance for college students when the student's ability, as measured by scholastic ability and academic standing, was taken into account. He found that for those students in the middle range of abilities, high anxious students made poorer school grades than low anxious students. Also, a larger percentage of high anxious students were academic failures at all ability levels except the highest.

**Treatment of Test Anxiety**

A second area of the literature which has burgeoned as a consequence of research demonstrating test performance deficits as a result of test anxiety is that of treatment methods.

Systematic desensitization, one of the most frequently encountered strategies for the treatment of test anxiety, has as a major component the decreasing of physiological arousal through muscle relaxation. The technique usually involves the pairing of deep muscle relaxation with imagined scenes depicting situations that the client has indicated cause him/her to feel anxious. Wolpe (56) indicates that systematic desensitization follows the principle of counter-conditioning which means the use of learning procedures to substitute one type of response (relaxation) for another (anxiety, tension).
Several investigators have found systematic desensitization to increase measures of performance as well as decrease self-reported anxiety.

Garlington and Cotler (14) found a greater reduction in test anxiety among 16 female undergraduate students treated with ten sessions of systematic desensitization than control subjects. They also found improved grade point average or final grade was reflected concomitant with decreases in anxiety scale scores.

Donner and Guerney (13) found a significant improvement in grade point average and decreases in test anxiety following both therapist-administered and tape recorder-administered systematic desensitization among 42 test-anxious junior and senior college females. No such improvement was found in a control group.

Horne and Matson (18), in comparing the effects of desensitization, modeling, flooding, and study skills training on self-reported test anxiety and academic standing, found that among all the treatments, desensitization had the most dramatic effect on grade point average. All treatment groups demonstrated significant decreases in self-reported test anxiety over that of a no-treatment control group.

Systematic desensitization in combination with other treatment strategies has also been associated with significant reduction in self-reported test anxiety with concomitant
increases in measures of cognitive-intellectual test performance and academic achievement.

Mitchell and Ng (31) compared the effects of desensitization only to desensitization together with counseling involving study skills and practice in attention focusing. They found that desensitization alone demonstrated a decrease in self-reported test anxiety but only the desensitization plus counseling demonstrated both a decrease in test anxiety and improved academic achievement.

Katahn, Strenger and Cherry (20) compared a combination of counseling involving group discussion of anxiety evoking situations and systematic desensitization to a control group in decreasing test anxiety and increasing academic achievement among a group of test-anxious subjects. Following treatment, the desensitization plus counseling group demonstrated both an increase in grade point average and a decrease in self-reported test anxiety.

McManus (29) found that a combination of desensitization and study skills counseling significantly improved grade point average and decreased self-reported test anxiety among test-anxious college students.

Cohen (10) applied interaction, non-interaction and progressive and non-progressive hierarchies to various systematic desensitization groups consisting of high anxious college students. He found that subjects completing a short-term program of systematic desensitization in groups tend to report
significantly more test anxiety reduction and achieve a greater grade point average increase than control subjects.

Although systematic desensitization has been found to sometimes be effective in both increasing grade point average or measures of test performance, while also decreasing self-reported test anxiety, the data with regard to the effects of systematic desensitization upon such variables are inconsistent.

Several studies using systematic desensitization, while finding decreases in self-reported anxiety, have found no parallel increases in cognitive-intellectual test performance or grade point average (3, 4, 10, 11, 49).

Also, methods of inducing decreased physiological arousal (a component of systematic desensitization) as a treatment for test anxiety and decreased performance on tests demonstrate further inconsistent results.

Allen (2) investigated the effects of relaxation or relaxation and study counseling in small groups or via self-instructional manuals on test anxiety and academic performance. He found that only study skills training significantly decreased test anxiety and increased academic performance.

Chang and Denny (11), however, found that applied relaxation, a procedure aimed at imparting a general coping skill with which the client may reduce anxiety whenever it is encountered, was significantly more effective than systematic desensitization in enhancing cognitive-intellectual test performance.

Also, Russell and Sipich (45), in a case study, used cue
controlled relaxation, which is a procedure whereby a phrase is paired with a relaxed state and is later repeated to oneself in an anxiety-evoking situation. He found that the procedure both decreased self-reported test anxiety and increased several measures of performance.

However, Marchetti (26), in testing the effects of cue-controlled relaxation against a placebo and no-treatment control group on test anxiety and two physiological indices, heart rate and skin conductance, found cue-controlled relaxation had no effect on self-reported test anxiety or any physiological measures.

Other treatment strategies which have demonstrated some success in either decreasing test anxiety and increasing academic performance are implosion therapy (42), cognitive modification (30), negative practice (34), and covert positive reinforcement (19). Both implosion therapy and negative practice significantly improved academic performance, and covert positive reinforcement significantly improved post-test anagram solutions. The cognitive modification improved subject's performance on a test of cognitive-intellectual ability, but not to a significant degree.

**Cognitive Variables Related to Test Anxiety**

Some recent investigations have indicated the importance of cognitive variables associated with test anxiety.
Wine (55) has indicated that highly test-anxious subjects are internally focused on self-evaluative, self-deprecating thinking and perception of autonomic responses. Such attentional splitting increases off-task behavior, thereby facilitating poor test performance.

As a consequence of her analysis, she has espoused a treatment approach which is designed to redirect the subject's attending to task-relevant stimuli. In an unpublished manuscript (54), Wine tested the effects of attentional training on improving test performance and decreasing self-reported test anxiety. She found significant decreases in self-reported test anxiety and significant increases in scores on the Wonderlic Personnel Test and the digit symbol test of the Wechsler Adult Intelligence Scale.

Morris and Liebert (32) investigated the relationship of physiological and cognitive components of test anxiety (labeled emotionality and worry, respectively) to pulse rate, performance expectancy, and actual examination grades in samples of high school and college students. They measured worry and emotionality by a self-report questionnaire that they constructed from questions of the Test Anxiety Questionnaire (48). They found a negative correlation between grades on the examination and the cognitive component, but not for the physiological component. They found pulse rate no more highly related to emotionality than to worry components.

Doctor and Altman (12) investigated the differential effects
of worry and emotionality, measured by the Liebert and Morris (24) scale, on test performance. Subjects were 159 undergraduate psychology students. Those subjects high in worry had significantly lower scores on the final exam regardless of emotionality scores or expectancy of success.

According to Sarason (46) and Wine (55), the worry component espoused by Liebert and Morris is an attentionally demanding cognitive activity and, consequently, may be primarily responsible for impaired test performance. Given such evidence, it would seem important to investigate the contribution of the ratio of on-task to off-task behavior to cognitive-intellectual test performance or make an attempt to control for such a variable.

**Biofeedback Training**

Some evidence exists which indicates a close association between somatic and autonomic nervous system activity.

Obrist, Webb, Sutterer and Howard (35) indicate that alterations in cardiac output alter the amount of blood available to the muscles. Also, the blood needed by the muscles affects cardiac output (heart rate) which affects other systems associated with the autonomic nervous system, i.e., the vascular system.

Malmo (25) indicates that progressively increasing muscle tension, as measured by electromyograph recordings from the forearm extensor and frontalis muscles, is associated with both increased blood pressure and heart rate.
Budzynski and Stoyva (8) indicate that decreased frontalis muscle tension is associated with decreased heart rate (often of over seven beats per minute) and phenomena associated with autonomic changes such as warmth and increased salivation.

Given that changes in muscle tension are associated with alteration in responses associated with the autonomic nervous system, i.e., heart rate, blood pressure (implicated in the physiology of anxiety), it would seem possible to investigate autonomic nervous system arousal levels via inducing various tension levels in the voluntary musculature.

Electromyogram (EMG) biofeedback training is a process for facilitating various levels of muscle activity or arousal. According to Budzynski and Stoyva (8), the EMG is an apparatus which permits measurement of muscle action potential levels of the subject on a trial-by-trial basis and feeds these measurements back to the subject by means of an auditory signal or some form of visual array. In this way, the subject can more easily learn to control the level of muscle activity.

Such a biofeedback loop directly incorporates major characteristics of operant conditioning (49). First, the biofeedback apparatus increases the intensity of a discriminative stimulus, the feedback signal, which comes to control the operant of altering that signal. Such an operant is initiated by a second discriminative stimulus, the rule which states, "when the feedback signal is present, if you (the subject or client) alter it in the desired direction you will feel relaxed and also win the approval of the experimenter or clinician."
Given the above analysis, it can then be stated that the discriminative stimulus of the feedback signal becomes the occasion for a second discriminative stimulus, the conveying of a rule to oneself which, in turn, initiates the operant response of altering the feedback signal in the predesignated desired direction. The initial reinforcement for such a response comes from the anticipated relaxed state, acceptance and approval of the experimenter and other positive consequences that have occurred in the past, contingent upon the individual following various rules. However, at this point the operant of altering the feedback signal is maintained through contingent reinforcement. That is, the response of altering the feedback signal in the desired direction produces a relaxed, quiescent state which, for most people, is a pleasing state of affairs. Such a consequence contingently reinforces the operant of altering the feedback signal in the desired direction.

A second characteristic of operant conditioning associated with biofeedback is the principle of successive approximations or "shaping." The usual target behavior in biofeedback training is a low arousal state which may be approximated by demanding progressively greater decreases in muscle tension in order to change the frequency of the feedback signal.

Electromyogram (EMG) biofeedback training has been found to significantly decrease tension in several muscle groups. Haynes, Mosely and McGowan (17) found that EMG decreased frontalis muscle tension more than a passive relaxation procedure and proved, also, to be quicker than the passive relaxation.
Budzynski and Stoyva (9) compared three groups of five subjects with respect to depth of relaxation achieved through EMG frontalis biofeedback, irrelevant feedback and no feedback. They found that the EMG biofeedback lowered the frontalis EMG by fifty percent as compared to twenty-four percent for the silent group and as compared to twenty-eight percent for the irrelevant feedback group. In view of their study, Budzynski and Stoyva indicate that only frontalis biofeedback subjects decreased tension in both the frontalis and forearm extensor muscles, whereas the reverse relationship did not hold.

Alexander, French and Goodman (1) compared the effectiveness of auditory and visual feedback in EMG biofeedback assisted relaxation of the frontalis muscles on twenty-eight subjects matched on baseline frontalis EMG levels. They found that the groups receiving auditory feedback with eyes closed manifested significant lowering of EMG over seven sessions as compared to no significant lowering of EMG for auditory feedback with eyes open, visual feedback and no feedback—eyes closed groups.

Kinsman, O'Banion, Robinson and Staudenmayer (21) compared continuous biofeedback to discrete verbal feedback during training to relax the frontalis muscle using the EMG. It was found that while verbal feedback alone facilitated muscle relaxation, EMG biofeedback was clearly more effective in facilitating consistent decreases in EMG activity both across trials and days.
of training. Also, biofeedback-induced lowered frontalis tension levels transferred to non-feedback trials while verbal feedback did not affect performance on non-feedback trials.

In that EMG biofeedback has proven effective in inducing arousal levels incompatible with tension and anxiety, it has been utilized in treatment of both anxiety-associated tension and tension-mediated problems such as headaches.

With regard to the treatment of headaches, Budzynski, Adler and Mullaney (6) treated eighteen subjects suffering from tension headaches with EMG biofeedback to the frontalis. Subjects were randomly assigned to an experimental (EMG feedback) group, a pseudo-feedback or a control group. EMG level was significantly lower for the experimental group than for the other two groups during the last two weeks of training (of eight weeks of training) and at a three month follow-up. The average headache rating scores for both the EMG feedback and pseudo-feedback group declined over time with four out of six subjects in the EMG feedback group having a significant decline in headaches, whereas one of six in the pseudo-feedback group had a significant decline. None of the control subjects showed a significant decline below baseline levels.

Budzynski and Stoyva (7) reported that tension headaches were successfully treated in clinical patients with four weeks to two months of biofeedback training. During this time the feedback signal was progressively faded out of the training.
It was found upon a three month follow-up that headache activity remained at a low level for those patients who relaxed for a brief period each day.

Haynes, Griffin, Mooney and Parise (16) investigated the comparative effectiveness of EMG biofeedback and relaxation on twenty-one university students suffering from muscle contraction headaches over six thirty-minute sessions. They found EMG biofeedback and relaxation instructions to both be significantly more effective than control procedures in reducing reports of headache frequency. However, the two procedures were not significantly different from one another in effectiveness.

Mulhall and Todd (33), in a case study, successfully treated a thirty-two year old male suffering from headaches caused by neuro-muscular tension by EMG biofeedback from the temporalis muscle.

Results of EMG biofeedback training in the treatment of anxiety and anxiety-mediated symptoms have been less consistent than research results dealing with tension headaches.

Raskin, Johnson and Rondestvedt (43) investigated the use of EMG biofeedback induced muscle relaxation for states of chronic anxiety in ten chronically anxious subjects. Biofeedback training was initiated for an average of six weeks of daily practice. Subjects were able to decrease EMG levels to 2.5 microvolts per minute and when doing so, reported their state at the end of the session as "one of tranquility." Some decrease in insomnia and headache activity benefited four of
the ten subjects, but subjects reported being unable to generalize relaxation to situations outside the training lab in which they felt anxious.

In contrast to the above study, Townsend, House and Addario (51) found with thirty chronically anxious patients selected from the Inpatient Psychiatric Service of the Naval Regional Medical Center in San Diego, California, that EMG assisted relaxation training with two weeks of self-practice demonstrated significant decreases in EMG levels, mood disturbance and trait anxiety measures over that of a control group.

Le Boeuf (22), in a case study, significantly decreased tension-mediated tremors of the right hand and forearm in a subject in five thirty-minute sessions over an eight day period in which EMG activity of the right forearm extensor was monitored. The decrease in tremors was found to have been maintained at a three and six month follow-up.

Garrett and Silver (15) combined decreasing muscle tension via EMG biofeedback training and increasing Alpha rhythms via electroencephalogram biofeedback training as a treatment of test anxiety. The treatment significantly decreased self-reported test anxiety. There was some improvement on test scores between first and final examinations, but the difference fell short of significance.

Wickramesekera (52) combined EMG biofeedback training with desensitization in a case study involving the treatment
of test anxiety. The subject reported a decrease in test anxiety and was able to take and pass an examination she had previously avoided taking.

Romano and Cabianca (44) compared EMG biofeedback-assisted desensitization and EMG relaxation to an automated systematic desensitization procedure and a no-treatment control group as treatments for test anxiety. Three measures of test anxiety were utilized: the Suinn Test Anxiety Behavior Scale, the Test Anxiety Scale and anagrams administered under a threat condition. They found that all three experimental procedures were more effective than a no-treatment control in decreasing self-reported test anxiety. However, they found no significant differences with regard to anagram solutions. Also, when the biofeedback procedures were grouped together and compared to the automated desensitization, the biofeedback proved to be more effective in decreasing self-reported anxiety.

**Therapeutic Instructions (Non-Specific Effects)**

Borkovec indicates that expectancy manipulations communicated through therapeutic instructions are viewed as discriminative stimuli or demand characteristics influencing post-test fear behavior. He states further,

\[ ... \text{implicit or explicit communication is made to the subject in the therapeutic conditions that the post-test is an assessment of the successfulness of the therapy sessions in changing their fear behavior (high demand for improved overt behavior) while subjects in the non-therapeutic condition are given no suggestions that they are to display post-test behavior different from pre-test behavior (low demand for improved behavior) (5, p. 296).} \]
In reviewing studies on therapeutic instructions, Borkovec found that instructional effects were most powerful for subjects with a mild rather than a great amount of fear. He reviewed ten studies which demonstrated systematic desensitization is equally effective with or without therapeutic instructions while nine other studies found the effect of therapeutic instructions superior to non-therapeutic instructions within therapy conditions.

Wilkins (53), in his review, reported four of eleven studies reviewed could be interpreted as reflecting differential effects due to therapeutic instructions. He laments the grouping of uncontrolled variables under the rubric of "expectancy" and then attributing causality to it. He indicates the need to explore more directly the variables implicated in behavior change.

Several studies reviewed for the present study also demonstrate inconsistent results.

Leitenberg, Agras, Barlow and Oliveau (23), and Oliveau, Agras, Leitenberg, Moor and Wright (36) found significant contributions of therapeutically oriented instructions to the outcome of systematic desensitization in the treatment of snake phobic subjects. However, McGlynn (27), and McGlynn, Gaynor and Puhr (28) found no significant contributions of therapeutic instructions to a systematic desensitization treatment of phobias.
In that the effect of therapeutic instructions on treatment outcome sometimes proves to be significant, it would seem efficacious to attempt to control for such a potentially powerful extraneous variable. Orne (37) underlines the importance of controlling for such a variable in stating that the extent to which the subject's behavior is related to demand characteristics rather than the experimental variable will determine in large measure the extent to which generalizations can be drawn about the effects of experimental variables in nonexperimental contexts.

Summary of Related Literature

The literature reviewed indicates that test anxiety is often responsible for impaired test performance and decreased grade point average. Test anxiety is often operative in certain situations; namely, testing situations where time is limited, an audience is present, the evaluative nature of the test is emphasized and the test is of considerable importance to the person being evaluated.

Such anxiety is considered to be comprised of a physiological and a cognitive component, the physiological component being sympathetic nervous system arousal, and the cognitive component being negative self-statements and a tendency to be distracted by such statements and other internal and external stimuli. Although the two components interact to cause impaired test performance, some investigators believe treatment of the cognitive component to be most effective in alleviating
both test anxiety and impaired test performance, whereas others believe the physiological component to be of more importance in this regard.

Several treatment strategies have been used in an attempt to alleviate test anxiety, the most frequently encountered being systematic desensitization. While systematic desensitization has sometimes demonstrated significant effects in both decreasing self-reported test anxiety and increasing academic or test performance, other studies have found no significant effects of such a procedure. Such inconsistent results have also been reported with other techniques designed to reduce physiological arousal such as progressive relaxation and cue-controlled relaxation. Such inconsistent results would seem to warrant further research into the effects of the physiological arousal component of test anxiety on test performance.

A method of inducing different levels of physiological arousal is the electromyograph (EMG) biofeedback. In that muscle tension is often related to autonomic nervous system arousal and vice versa, an apparatus such as the EMG, which may be used to operantly condition different muscle tension levels, may be used to both measure and induce different physiological arousal levels in order to study the effect of such a variable on test performance and self-reported test anxiety.

EMG biofeedback has been shown to be effective in treating tension headaches, insomnia and other tension-related problems. Its effectiveness with regard to test anxiety and performance, however, is yet to be proven.
Finally, in studying the effects of levels of physiological arousal on test anxiety and performance, a major variable to be controlled is instructional or expectancy effects. Therapeutic instructions inducing the anticipation of success or failure with regard to the experimental variable under study have often contributed significantly to results in systematic desensitization studies. In that biofeedback induced decreased arousal is similar to the relaxation component within desensitization, such an extraneous variable as "expectancy" effects could be operative in the biofeedback procedure.


33. Mulhall, D. J. and Todd, R. W., "Deconditioning by the Use of EMG Signals," Behavior Therapy, 6, 1975, 125-127.


CHAPTER III

METHODS AND PROCEDURES

Procedures for Administration of Treatment

Announcements were made in Psychology, Business Administration and Education classes at both North Texas State University and Texas Women's University during the Spring and Summer terms of 1977. The announcements involved asking for volunteers to take part in an experiment investigating the relationship of biofeedback training to test anxiety. Only those students believing themselves to be anxious and nervous during examinations were asked to volunteer. Also stated was that the experiment would not take over two and one-half hours of the student's time and such time would be broken into thirty minute daily sessions once or twice a week as could be scheduled for the convenience of the student. Slips of paper were then passed to every student in the class and they were asked to write their name and phone number and the word "yes" on the paper to indicate interest in participating. If not interested, they were instructed to write "no" on the paper. All slips of paper were then handed in to the person making the announcements. Students who wrote their phone numbers and the words "yes" or "maybe" were later contacted by phone for purposes of scheduling.

When recruited, each subject was screened on two measures
of anxiety: the Suinn Test Anxiety Behavior Scale (STABS) (18) and level of muscle tension during a resting baseline as measured by electromyographic recordings taken from electrodes placed over the frontalis muscle of the subject.

In order to be included in the study, each potential subject was required to score at or above the 75th percentile on the STABS (16), signifying high self-reported test anxiety (14) and have an average muscle action potential of six microvolts or more over a four minute baseline period while sitting in an upright position at a desk, signifying high muscle tension level. The necessity of EMG screening was to select subjects with frontalis muscle tension levels elevated to a point where EMG biofeedback training could be considered feasible in inducing significantly decreased muscle tension response.

Twenty selected subjects (n=20) were randomly assigned to either a positive therapeutic instruction group or a negative therapeutic instruction group. Each subject received both high and low physiological arousal training. The order of presentation of the training was counter-balanced to control for any effects due to sequence of training presentation. Subjects were randomly assigned to the initial training condition (either high or low physiological arousal induced by EMG biofeedback training).

A Biofeedback Technology EMG 401 system (Bio-Feed-Back Technology, Inc., Garden Grove, California) was used to promote effective training of control over muscle tension levels. The
BFT EMG 401 system provides instrumentation for muscle tension detection, information feedback, and data collection. The system consists of two instruments, the feedback myograph (BFT EMG 401), and the Time-Period Integrator (BFT TPI 215). The feedback myograph senses muscle-produced electrical activity through three silver/silver chloride electrodes (6.5 m.m. in diameter) placed one inch above the eyebrows and spaced three inches apart on the subject's forehead. The EMG 401 amplifies the detected signal and provides both audio information feedback to the subject and an electrical signal which is processed by the Time-Period Integrator. Auditory feedback is provided to the subject via headphones such that a tone varies in pitch in direct proportion to the degree of forehead muscle tension present. The higher the pitch of the tone, the higher the EMG level of the muscle tension present. The feedback myograph is powered by low voltage rechargeable batteries and is electrically shielded for effective research use in the normal office setting.

The BFT Time-Period Integrator 215 receives the amplified EMG 401 signal, averages it over a selected time period (10-120 seconds) and provides a visual digital readout in microvolts (μV). The 215 Integrator also has a noise threshold feature which allows both the detection of internal equipment noise and the cancellation of the effect of that noise on the EMG uv readings. It is 125 volts (AC) powered and, for the subject's safety, is electrically isolated by optical isolation circuitry.
Before every session, the EMG batteries were checked for proper voltage level and the noise calibration was made. The subject's forehead was prepared for electrode contact by scrubbing the skin with an abrasive and swabbing it with a solution of alcohol and water. Three electrodes held in place by a rubber headband and treated with electrode cream were placed one inch above the subject's eyebrows. The two active electrodes were placed approximately three inches apart above each eye, the ground electrode between them centered above the nose. The subject was then seated at a desk situated away from electrical and ground sources as a general safety precaution, and was asked to touch a ground screw on the EMG unit to remove static electricity. Electrode resistance was checked to insure that both electrodes were below 20,000 ohms and approximately similar in resistance. The subject's muscle tension level was then monitored and recorded for four 60 second periods while he remained inactive.

**EMG Biofeedback Induced Physiological Arousal**

**Condition (Training Phase)**

Following the recording of the pre-treatment baseline, each subject meeting the screening criteria was given the following instructions depending upon the condition to which the subject was assigned, high or low physiological arousal:

In order to (increase/decrease) your muscle tension level we are utilizing electromyograph biofeedback which records tension in your forehead and facial muscles and feeds it back to you in the form of a tone by way of
earphones. As your forehead and facial muscles become (more/less) tense the tone goes (up/down) in frequency. During this session I want you to make the tone go (up/down) and keep it as (high/low) as possible until otherwise instructed.

Following the above instructions, the experimenter instructed the subject to begin. The training phase continued until the subject reached a pre-set criteria level of muscular tension. For the low arousal condition, the criterion was a mean of 3 μV or below recorded at 30 second intervals during the last 10 minutes of the training session. For the high arousal condition, the criterion was a mean of 9 μV or higher recorded during a 10 minute interval of the training session.

Training was conducted in 30 minute sessions up to a maximum of five sessions.

**Therapeutic Instruction Conditions**

Each subject was randomly assigned to either a negative or positive therapeutic instruction group. Subjects in the negative therapeutic instruction group received negative therapeutic instructions immediately prior to testing under both high and low physiological arousal inductions. Subjects in the positive therapeutic instruction group received positive therapeutic instructions immediately prior to testing under both high and low physiological arousal inductions.

For each subject assigned to the positive therapeutic instruction group, the following instructions were given during both high and low physiological arousal inductions:
Research has shown that being able to control physiological arousal level, that is, alter it at will while taking a test, often decreases felt anxiety. Such control over arousal level enhances the ability to cope with the test situation thereby decreasing thoughts of failure which usually impair test performance.

For each subject assigned to the negative therapeutic instruction group, the following instructions were given during both high and low physiological arousal inductions:

Research has shown that there is a midpoint between high and low physiological arousal levels which is optimal. Also, moving away from this midpoint to either high or low arousal extremes while taking a test often increases felt anxiety. Such alteration in arousal impairs the ability to cope with a test situation thereby increasing thoughts of failure which usually impair performance.

Testing Conditions

After each subject met the pre-set criterion of arousal level, he was administered a four minute resting baseline which consisted of the subject sitting quietly at a desk without EMG biofeedback while the experimenter took 30 second interval readings.

Following the baseline period the following instructions were given:

During the next thirty minutes you will be administered a timed intelligence test. While taking the test I want you to (raise/lower) your tension level and keep it as (high/low) as you can until you finish the test. I will be monitoring your tension level and if it is not (high/low) enough for a one minute period the feedback tone will be turned on to signal you to make the tone (lower/higher).

After the instructions were given, the subject was presented with an Anxiety Thermometer and an On-Task Behavior...
Scale (both designed for the present study). After presentation the following instructions were given:

The Anxiety Thermometer is a scale in the shape of a thermometer which ranges from 1 to 10. You will be presented the thermometer once before you begin the intelligence test, twice during the test, and once immediately following the test. You are to make a mark on the thermometer corresponding to the amount of anxiety that you are experiencing at that moment, 0 for absolutely no anxiety and 10 for almost overwhelming anxiety—a panic condition. It is imperative that you mark the thermometer immediately when it is handed to you.

The On-Task Behavior Scale is to be filled out immediately after completing the intelligence test. It is a measure of how much of the time you believe that you were either answering a test question or thinking about the answer to a test question. Each number, from 1 to 30, stands for minutes. If you believe, for example, that you were either answering a question or thinking about the answer to a question for 10 of the 30 minutes while taking the test you would circle the 10 and so on.

Following the above instructions, the Anxiety Thermometer and On-Task Behavior Scale were placed aside and a set of written instructions regarding completing the On-Task Behavior Scale (see Appendix A) was presented to the subject.

A copy of the Otis Quick Score Mental Abilities Test (9) was then placed on the desk before the subject along with two sharpened pencils. The directions for the administration of the test were read (from the Otis Test Manual, 9).

Following the directions for administration, the subject was presented with either positive or negative therapeutic instructions and was asked to complete the first Anxiety Thermometer. After completing the thermometer, the subject was given instructions to either increase or decrease arousal level and begin the test.
EMG µV readings were recorded at one minute intervals throughout the test administration. If, during the test administration, the averaged microvolts decreased below 9 µV or increased above 3 µV, depending upon the experimental condition, the experimenter turned the auditory tone switch to the "on" position as a cue for the subject to either further increase or decrease the tone frequency. The number of cues given to the subject during the testing sessions was recorded.

Subjects being tested under the low physiological arousal condition were asked by the experimenter, intermittently, to stop answering test questions and close their eyes for a one minute period. Such directions were necessary to inhibit EMG µV increments due to the subject's attending to written material (7). The test timer was stopped during rest periods so as not to shorten time allowed to complete the intelligence test. Subjects were informed that the timer would be stopped during such rest periods.

Additional Anxiety Thermometers were presented at the conclusion of the tenth, twentieth and thirtieth EMG scoring intervals. Following the completion of the final Anxiety Thermometer at the conclusion of the test, the subject was presented the On-Task Behavior Scale and instructed to complete it.

Each subject received both training and testing conditions (high and low physiological arousal) in counter-balanced order. One of two parallel forms of the Otis Quick Score Mental Abilities Test (Am or Fm) was administered under each testing condition.
Debriefing for subjects in the negative therapeutic instruction group followed the final test administration for each subject.

Debriefing instructions were as follows:

Although it is true that test performance often deteriorates as one moves away from the midpoint of physiological arousal to either high or low arousal extremes, one is seldom at the midpoint. For example, if you have high physiological arousal during a test, then begin to become relaxed, you will be decreasing physiological arousal which will bring you back closer to the midpoint and thus enhance test performance.

All subjects received 10 minutes of EMG biofeedback-assisted relaxation following the test administration under induced high physiological arousal unless they requested not to have such relaxation.

A minimum of two subjects, one in each of the two therapeutic instruction conditions, simultaneously received the complete sequence of experimental phases immediately after being selected for the study by the screening procedure outlined above.

The experimental phases included: training in either increasing or decreasing physiological arousal level; testing under either increased or decreased physiological arousal level; training in decreasing or increasing physiological arousal level (the opposite of phase 1); and testing under either decreased or increased physiological arousal level (the opposite of phase 2). The testing phases under either high or low physiological arousal conditions were separated by a minimum of 24 hours.
Instruments

The Suinn Test Anxiety Behavior Scale (STABS, 16) has been used recently in research to both select high anxious subjects (14) and for pre- and post-test measures to determine the effectiveness of a particular treatment method (5, 19).

The STABS is a 50 item scale composed of behavioral situations which may arouse different levels of test anxiety in subjects. The subject rates himself on the amount of anxiety aroused by each item by making a checkmark on a five point Likert scale ranging from "Not at All" to "Very Much" anxiety. A sampling of diverse behavior and situations is included so as to permit its application to a large variety of subjects.

Normative data (16) were collected on two samples: 75 students enrolled in a large State University in Hawaii and one hundred fifty-eight students enrolled in a State University in Colorado. Reliability data were obtained by readministration of the STABS to the Hawaii sample six weeks after the first administration and to the Colorado sample four weeks after the first administration. Test-retest reliability for the Hawaii sample was 0.74 and for the Colorado sample, 0.78, which is comparable to the Test Anxiety Scale (12) reliability of 0.76 and the Taylor Manifest Anxiety Scale reliability of 0.72.

Suinn (16) obtained validity data by comparison of the STABS to the Test Anxiety Scale (12) which yielded a correlation of 0.59 (p < 0.001 level) for the Hawaii sample and 0.60
(p < 0.001 level) for the Colorado sample. Suinn also obtained data indicating performance on the STABS to be significantly correlated with number of errors in course examinations 
(r = 0.24, p = < 0.05 for the Hawaii sample) and final course grades (r = 0.26, p = < 0.05 for the Hawaii sample and r = 0.28, p < 0.02 for the Colorado sample). Percentile ranks are included in the normative data (16).

The Otis Quick Scoring Mental Abilities Test, Gamma Series (9) for high school and college is an 80 item, timed, multiple choice group intelligence test. It consists of six alternate forms, two for hand scoring and four for both hand and machine scoring. The test takes 30 minutes to complete and is self-administering.

Norms are reported for ages eleven through eighteen and over. The norms (Am and Bm forms) were obtained in part by equating experiments in which 777 students took the Gamma and the Otis Higher Examination and 742 students who were administered the Gamma form Am and Bm and the Pinter Advanced General Abilities Test. Split-half reliability for the Am form is 0.90, 0.91 and 0.85 for grades ten through twelve and .88 on Form Bm based on a sample of 489 college freshmen at the College of the Holy Cross.

Validity of each item of the Otis Quick Score Mental Abilities Test was investigated by finding the biserial coefficient of correlation between the item and the total score on the test on scores of 100 adults of each sex. The median correlation was .61.
The Anxiety Thermometer is similar to the Fear Thermometer developed by Walk (17). It is a self-report inventory of subjective anxiety. The scale is in the form of a thermometer with the zero point indicating no anxiety at the bottom and ten indicating extremely high anxiety at the top. The subject places a mark across the point between the two extreme points. The distance from the base of the thermometer to the mark made by the subject yields a numerical index representing the amount of anxiety experienced by the subject.

Walk (17) tested the Fear Thermometer on a group of parachute trainees making mock tower jumps of 34 feet. Self-ratings of fear began relatively high and fell rapidly with further jumps. Correlations between the number of errors made by trainees on each jump and fear ratings were significant with the exception of the first jump. The correlation coefficients ranged from 0.28 to 0.45.

The Fear Thermometer has been frequently used in investigations of behavioral treatments of fear and anxiety (2, 3, 4, 6, 10, 13, 15). In one study (4), the mean Fear Thermometer change scores of low avoidance subjects differed significantly from mean change scores of high avoidance subjects demonstrating a relationship of self-rated fear to other indices of fear and anxiety, i.e., avoidance behavior.

Further evidence of validity of self-rating scales of anxiety comes from Robbins (11), who found subject's self-rated reactions to taped selections of anxiety-evoking material
correlated significantly with duration of exposure to the material.

In another study, Desroches, Kaiman and Ballard (1) reported self-ratings of "nervousness" to correlate 0.69 with the Zuckerman Adjective Checklist measure of anxiety and 0.58 with the Bendig short form of the Taylor Manifest Anxiety Scale.

McReynolds (8) found a self-rating of anxiety to correlate 0.75 with the Taylor Manifest Anxiety Scale for a group of psychiatric patients.

The On-Task Behavior Scale (see Appendix A) was designed for the present investigation. It is a graphic rating scale with two end-points "On-Task" and "Off-Task." The continuum between the two end-points is marked off in 30 segments indicating number of minutes on task (either answering a question or thinking about the answer to a question) while engaged in work on the Otis Quick Score Mental Abilities Test. For example, if a subject, at the conclusion of the 30 minute timed test, believed that he was either answering a question or thinking about the answer to a question 20 of the 30 minutes that he was engaged in taking the Otis, he would mark the "20" segment of the scale.

Examples of "Off-Task" and "On-Task" behavior were included in the instructions for use of the scale by the subject (see Appendix A).
Procedure for Analysis of Data

The design of the present investigation was an A x B with repeating measures on A. There were two levels of Factor B, positive and negative therapeutic instructions. There were also two levels of Factor A, high and low physiological arousal, as measured by electromyograph recording from the frontalis area. The level of significance for acceptance of the experimental hypotheses was p=.05.

The statistical design is represented by the following diagram (18).

```
THERAPEUTIC INSTRUCTIONS

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

Four two-factor Analyses of Variance were computed on the following dependent measures: raw scores of the Otis Quick Score Mental Abilities Test; mean scores of the Anxiety Thermometer; percentage scores of the On-Task Behavior Scale; and percentage of Otis Quick Score Mental Abilities Test questions answered per minute (e.g., rate).
The Hartley procedure ($F_{max}$) was used to test homogeneity of variance.

A three-way Analysis of Variance (EMG-induced physiological arousal levels $\times$ therapeutic instructions $\times$ order of presentation of treatments) was used to test for any interaction effects between the independent variables and effect of order of presentation of treatments. The level of rejection of the null hypothesis was $p = .05$.

The present chapter outlined specific procedures and description of apparatus utilized for the purpose of testing the hypotheses under study. Also included was a description of the testing instruments employed and procedures for analysis of collected data.


CHAPTER IV
RESULTS AND DISCUSSION

The purpose of this chapter is to present the results of a comparison of intelligence test performance, self-reported anxiety and self-reported on-task behavior of high test-anxious subjects between two physiological arousal conditions (high and low) and two therapeutic instruction conditions (positive and negative). In addition, it includes a discussion of these results. The results are presented in the order in which the four hypotheses are stated in Chapter I.

The experimental design consists of a Two Factor Analysis of Variance (A x B) with Repeated Measures on Factor A for all hypotheses. The Hartley (F max.) procedure, (Winer, 5) was used to test for homogeneity of variance. Also, a Three Factor Analysis of Variance was used to test for any interaction effects between the independent variables and order of treatment presentations.

Twenty subjects, students at either North Texas State University or Texas Women's University (Denton, Texas) during the Spring and Summer semesters of 1977 were included in and completed the investigation. Seventy-four subjects initially volunteered for the study. Of these subjects, fifteen did not meet the screening criteria, and seventeen met the screening criteria but were unable to meet the criterion level for
successful completion of EMG training in either increasing or decreasing physiological arousal levels. Twenty-two subjects indicated that they did not wish to complete the study for personal reasons. Data for these subjects were discarded (see Appendix C for screening data).

Prior to computing the Two Factor Analysis of Variance (ANOVA), a Three Factor ANOVA with Repeated Measures on one Factor was computed in order to test for interaction effects between the levels of the independent variables (positive and negative therapeutic instructions; high and low physiological arousal), and the order of treatment presentations. The Three Factor ANOVA's were computed for four dependent measures: the test performance scores on the Otis Quick Score Mental Abilities Test (OQSMAT); Anxiety Thermometer (AT) scores; On-Task Behavior Scale (OTBS) scores; and number of questions answered per minute on the OQSMA (rate). The level of significance for rejecting the null hypothesis was $p=.05$. No significant interaction effects at the $p=.05$ level of significance were found (see Appendix B for Three Factor ANOVA summary tables). The findings indicate that the order of presentation did not significantly affect any of the dependent measures under any of the levels of the independent variables.

The results of the Two Factor ANOVA's are presented in the order of the hypotheses stated in Chapter I. Hypothesis IV relates to expectation for success or failure with regard to treatment as conveyed through therapeutic instructions.
Hypothesis IV was part of all Two Factor ANOVA's (Factor B) used to test Hypotheses I, II and III. Significance levels computed for F ratios involving main effects of treatment are for a one-tail test, whereas F ratios involving main effects for groups are for a two—tail test. All hypotheses were stated in the null form for purposes of testing.

Null Hypothesis I: There will be no significant differences on cognitive-intellectual test performance scores as measured by the OQSMAT for high anxious subjects administered under the low and high physiological arousal treatment conditions.

Null Hypothesis IV: Therapeutic instructions will have no effect on cognitive-intellectual test performance scores as measured by the OQSMAT for high test anxious subjects under either high or low physiological arousal conditions.

Related to the Hypotheses I and IV above, Table I presents the Two Factor ANOVA summary table. It is a two-way analysis of Factors A and B with repeated measures on Factor A (EMG-induced physiological arousal conditions). Factor B (therapeutic instructions) has two levels, the negative and positive group. Factor A has two levels, the high and low treatments. Prior to any statistical tests on Factors A and B, a test on the homogeneity of variance was computed. For the SS subjects within groups ($F_{.95}=8.87$) and the $SS_B \times$ subjects within groups ($F_{.95}=.117$) the region of rejection at the $p=.05$ level of significance was 9.45 ($df=9,9$). Thus, the null
TABLE I

TWO-WAY ANALYSIS OF VARIANCE TESTING THE EFFECT OF EMG-INDUCED PHYSIOLOGICAL AROUSAL AND THERAPEUTIC INSTRUCTIONS ON OTIS QUICK SCORE MENTAL ABILITIES TEST SCORES OF ALL SUBJECTS (N=20)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS*</th>
<th>DF**</th>
<th>MS***</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>3588.47</td>
<td>19</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>B (positive-negative therapeutic instructions)</td>
<td>265.22</td>
<td>1</td>
<td>265.22</td>
<td>1.43</td>
<td>0.246</td>
</tr>
<tr>
<td>Subjects Within Groups</td>
<td>3323.35</td>
<td>18</td>
<td>184.62</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Within Subjects</td>
<td>469.50</td>
<td>20</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>A (high-low physiological arousal)</td>
<td>34.22</td>
<td>1</td>
<td>34.22</td>
<td>1.53</td>
<td>0.231</td>
</tr>
<tr>
<td>A x B</td>
<td>60.02</td>
<td>1</td>
<td>60.02</td>
<td>2.68</td>
<td>0.118</td>
</tr>
<tr>
<td>B x Subjects Within Groups</td>
<td>402.25</td>
<td>18</td>
<td>22.35</td>
<td>......</td>
<td>......</td>
</tr>
</tbody>
</table>

* Sum of Squares ** Degrees of Freedom *** Mean Square

hypothesis could not be rejected indicating no difference in variances between groups. Therefore, the homogeneity of variance requirement was met.

The first statistical test in the A x B ANOVA involved analyzing the OQSMAT scores for any interaction of Factor A— the two levels of EMG-induced physiological arousal with Factor B-- the two levels of therapeutic instructions. With one degree
of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p = .05 level is 4.41. Comparison of the F value for the A x B interaction in Table I with tabled values for significance at the p = .05 level reveals that the F value of 2.69 is not significant. Therefore, the main effects for Factors A and B were analyzed.

The second statistical test in the A x B ANOVA involved the main effects of Factor A— the two levels of EMG-induced physiological arousal. This test analyzed each subject's scores on the OQSMAT between high and low EMG-induced physiological arousal level treatment conditions. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p = .05 level is 4.41. Comparison of the F value for EMG-induced physiological arousal treatment conditions in Table I with the tabled values for significance at the p = .05 level reveals the F value of 1.53 is not significant.

The third statistical test in the A x B ANOVA involved the main effects of Factor B— the two levels of therapeutic instructions. This test analyzed the mean of the OQSMAT scores of the positive and negative therapeutic instruction groups. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p = .05 level is 4.41. Comparison of the F value for therapeutic instruction groups in Table I with tabled values for
significance at the $p=.05$ level revealed the F value of 1.44 is not significant.

The results of the second statistical test suggested that null hypothesis I could not be rejected. Such acceptance led to rejection of the working hypothesis stated in Chapter I which predicted that cognitive-intellectual test performance scores, as measured by the OQSMAT would be significantly higher for high test-anxious subjects under the low physiological arousal condition than under the high physiological arousal condition.

The results of the third statistical test suggested that null hypothesis IV could not be rejected. Hypothesis IV predicted that therapeutic instructions would have no effect on cognitive-intellectual test performance scores, as measured by the OQSMAT for high test-anxious subjects.

Null Hypothesis II: There will be no significant differences between high test-anxious subject's self-reported test anxiety scores, as measured by the AT, ascertained under high and low physiological arousal treatment conditions.

Null Hypothesis IV: Therapeutic instructions will have no effect on high test-anxious subject's self-reported test anxiety scores as measured by the AT ascertained under high and low physiological arousal treatment conditions.

Table II presents the Two Factor ANOVA summary table associated with hypotheses II and IV above. The levels of Factors A and B are identical with those presented in Table I.
TABLE II

TWO-WAY ANALYSIS OF VARIANCE TESTING THE EFFECT OF EMG-INDUCED PHYSIOLOGICAL AROUSAL AND THERAPEUTIC INSTRUCTIONS ON ANXIETY THERMOMETER SCORES OF ALL SUBJECTS (N=20)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS*</th>
<th>DF**</th>
<th>MS***</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>6329.38</td>
<td>19</td>
<td>......</td>
<td>......</td>
<td></td>
</tr>
<tr>
<td>B (positive-negative therapeutic instructions)</td>
<td>756.90</td>
<td>1</td>
<td>756.90</td>
<td>2.44</td>
<td>0.135</td>
</tr>
<tr>
<td>Subjects Within Groups</td>
<td>5572.48</td>
<td>18</td>
<td>309.58</td>
<td>......</td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>2753.60</td>
<td>20</td>
<td>......</td>
<td>......</td>
<td></td>
</tr>
<tr>
<td>A (high-low physiological arousal)</td>
<td>688.90</td>
<td>1</td>
<td>688.90</td>
<td>6.24</td>
<td>0.022</td>
</tr>
<tr>
<td>A x B</td>
<td>76.18</td>
<td>1</td>
<td>76.18</td>
<td>0.689</td>
<td>0.417</td>
</tr>
<tr>
<td>B x Subjects Within Groups</td>
<td>1988.52</td>
<td>18</td>
<td>110.47</td>
<td>......</td>
<td></td>
</tr>
</tbody>
</table>

* Sum of Squares  ** Degrees of Freedom  *** Mean Square  **** F is significant at .05 probability level.

Prior to any statistical tests on Factors A and B, a test on the homogeneity of variance was computed. For the SS subjects within groups (F.95=0.624) and SS_B x subjects within groups (F.95=1.47) the region of rejection at the p=.05 level of significance was 9.45 (df=9.9). Thus, the null hypothesis was not rejected indicating no difference in variances between groups. Therefore, the homogeneity of variance requirement was met.
The first statistical test in the A x B ANOVA involved analyzing the Anxiety Thermometer (AT) scores of all subjects (N=20) for any interaction of Factor A— the two levels of EMG-induced physiological arousal with Factor B— the two levels of therapeutic instructions. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p=.05 level was 4.41. Comparison of the F value for the A x B interaction in Table II for tabled values for significance at the p=.05 level revealed that the F value of 0.689 was not significant. Therefore, the main effects for Factors A and B were analyzed.

The second statistical test in the A x B ANOVA involved the main effects of Factor A— the two levels of EMG-induced physiological arousal. This test analyzed each subject's scores on the AT between high and low EMG-induced physiological arousal level treatment conditions. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p=.05 level was 4.41. Comparison of the F value for EMG-induced physiological arousal treatment conditions in Table II with tabled values for significance at the p=.05 level revealed the F value of 6.24 was significant. The means for AT scores under the high and low physiological arousal treatment conditions were 4.30 and 3.47, respectively, indicating significantly higher AT scores under the high physiological arousal treatment condition.
The third statistical test in the A x B ANOVA involved the main effects of Factor B-- the two levels of therapeutic instructions. This test analyzed the score means on the AT of the positive and negative therapeutic instruction groups. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p=.05 level was 4.41. Comparison of the F value for therapeutic instruction groups in Table II with tabled values for significance at the p=.05 level revealed the F value of 2.44 was not significant.

The results of the second statistical test presented in Table II necessitated the rejection of null hypothesis II. Such rejection led to the retaining of the working hypothesis which predicted that self-reported test anxiety scores as measured by the AT would be significantly less for high test-anxious subjects under the low physiological arousal treatment condition than under the high physiological arousal treatment condition.

The results of the third statistical test of Table II suggested that null hypothesis IV could not be rejected. Hypothesis IV predicted that therapeutic instruction would have no effect on high test-anxious subject's self-reported test anxiety scores as measured by the AT.

Null Hypothesis III: There will be no significant differences between high test-anxious subject's self-reported on-task behavior, as measured by the On-Task Behavior Scale (OTBS) ascertained under high and low physiological arousal treatment conditions.
Null Hypothesis IV: Therapeutic instructions will have no effect on high test-anxious subject's self-reported on-task behavior scores as measured by the OTBS ascertained under high and low physiological arousal treatment conditions.

Table III presents the Two Factor ANOVA summary table associated with hypotheses III and IV above.

### Table III

<table>
<thead>
<tr>
<th>Source</th>
<th>SS*</th>
<th>DF**</th>
<th>MS***</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>5621.40</td>
<td>19</td>
<td></td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>B (positive-negative therapeutic instructions)</td>
<td>1123.60</td>
<td>1</td>
<td>1123.60</td>
<td>4.50</td>
<td>0.0481</td>
</tr>
<tr>
<td>Subjects Within Groups</td>
<td>4497.80</td>
<td>18</td>
<td>249.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>1769.00</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A (high-low physiological arousal)</td>
<td>324.90</td>
<td>1</td>
<td>324.90</td>
<td>4.18</td>
<td>0.028</td>
</tr>
<tr>
<td>A x B</td>
<td>44.10</td>
<td>1</td>
<td>44.10</td>
<td>0.567</td>
<td>0.461</td>
</tr>
<tr>
<td>B x Subjects Within Groups</td>
<td>7390.00</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Sum of Squares ** Degrees of Freedom *** Mean Square **** F is significant at .05 probability level.

The levels of Factors A and B are identical to those presented in both Tables I and II.
Prior to any statistical tests on Factors A and B, a test of the homogeneity of variance was computed. For the SS subjects within groups (F\textsubscript{.05} = 0.89) and SS\textsubscript{B x subjects within groups} (F\textsubscript{.05} = 1.28) the region of rejection at the p=.05 level of significance was 9.45 (df=9,9). Thus, the null hypothesis was not rejected, indicating no difference in variance between groups. Therefore, the homogeneity of variance requirement was met.

The first statistical test in the A x B ANOVA involved analyzing the OTBS scores of all subjects (N=20) for any interaction of Factor A— the two levels of EMG-induced physiological arousal with Factor B— the two levels of therapeutic instructions. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p=.05 level is 4.41. Comparison of the F value for the A x B interaction in Table III with tabled values for significance at the p=.05 level revealed that the F value of .567 was not significant. Therefore, the main effects for Factors A and B were analyzed.

The second statistical test in the A x B ANOVA involved the main effects of Factor A— the two levels of EMG-induced physiological arousal. This test analyzed each subject's scores on the OTBS between high and low EMG-induced physiological arousal treatment conditions. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p=.05 level is 4.41. Comparison of the F value for EMG-induced physiological arousal
treatment conditions in Table III with tabled values for significance at the $p=.05$ level revealed the $F$ value of 4.18 was not significant.

The third statistical test in the A x B ANOVA involved the main effects of Factor B— the two levels of therapeutic instructions. This test analyzed the scores of the OTBS of the positive and negative therapeutic instruction groups. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the $F$ ratio significant at the $p=.05$ level is 4.41. Comparison of the $F$ value for therapeutic instruction groups in Table III with tabled values for significance at the $p=.05$ level revealed the $F$ value of 4.50 was significant. The OTBS score means of the positive and negative therapeutic instruction groups were 85.00 and 74.40, respectively, indicating significantly higher OTBS scores for the positive therapeutic instruction group.

The results of the second statistical test of Table III suggested that null hypothesis III could not be rejected. Such a conclusion leads to rejection of the working hypothesis stated in Chapter I which predicted that percent of time on-task as measured by the OTBS would be significantly greater for high test-anxious subjects under the low physiological arousal condition than under the high physiological arousal condition.

The results of the third statistical test suggested the rejection of null hypothesis IV which predicted that therapeutic instructions would have no effect on percent of time high
test-anxious subject's reported staying on-task as measured by the OTBS.

An additional ANOVA with repeated measures on one factor was computed on the rate (number of questions answered per minute) at which high test-anxious subjects answered test questions on the OQSMAT. The additional ANOVA was undertaken as a reliability check of the self-reported on-task behavior indicated by scores on the OTBS.

Table IV presents the Two Factor ANOVA summary table associated with the analysis of rate.

**TABLE IV**

TWO-WAY ANALYSIS OF VARIANCE TESTING THE EFFECT OF EMG-INDUCED PHYSIOLOGICAL AROUSAL AND THERAPEUTIC INSTRUCTIONS ON RATE (NUMBER OF OTIS TEST QUESTIONS ANSWERED PER MINUTE) FOR ALL SUBJECTS (N=20)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF**</th>
<th>MS***</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>6.57</td>
<td>19</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>B (positive-negative therapeutic instructions)</td>
<td>1.29</td>
<td>1</td>
<td>1.29</td>
<td>4.41</td>
<td>0.05</td>
</tr>
<tr>
<td>Subjects Within Groups</td>
<td>5.28</td>
<td>18</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Within Subjects</td>
<td>0.819</td>
<td>20</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>A (High-low physiological arousal)</td>
<td>0.107</td>
<td>1</td>
<td>0.107</td>
<td>2.72</td>
<td>0.117</td>
</tr>
<tr>
<td>A x B</td>
<td>0.003</td>
<td>1</td>
<td>0.003</td>
<td>0.077</td>
<td>0.784</td>
</tr>
<tr>
<td>B x Subjects Within Groups</td>
<td>0.710</td>
<td>18</td>
<td>0.039</td>
<td>......</td>
<td>......</td>
</tr>
</tbody>
</table>

* Sum of Squares ** Degrees of Freedom *** Mean Square **** P is significant at the .05 probability level.
The levels of Factors A and B are identical with those presented in previous tables (I, II, and III).

Prior to any statistical tests on Factors A and B, a test of the homogeneity of variance was computed. For the SS subjects within groups \(F_{.05}=0.76\) and \(SS_B\) x subjects within groups \(F_{.05}=1.38\) the region of rejection at the \(p=.05\) level of significance is 9.45 (df=9,9). Thus, the null hypothesis could not be rejected, which indicated no difference in variance between groups. Therefore, the homogeneity of variance requirement was met.

The first statistical test in the A x B ANOVA involved analyzing the rate scores of all subjects (\(N=20\)) for any interaction of Factor A——the two levels of EMG-induced physiological arousal with Factor B——the two levels of therapeutic instructions. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the \(F\) ratio significant at the \(p=.05\) level is 4.41. Comparison of the \(F\) value for the A x B interaction in Table IV for tabled values for significance at the \(p=.05\) level revealed that the \(F\) value of .077 was not significant. Therefore, the main effects for Factors A and B were analyzed.

The second statistical test in the A x B ANOVA involved the main effects of Factor A——the two levels of EMG-induced physiological arousal. This test analyzed each subject's rate (number of test questions answered per minute) between high and low EMG-induced physiological arousal treatment conditions.
With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p=.05 level is 4.41. Comparison of the F value for EMG-induced physiological arousal treatment conditions in Table IV with tabled values for significance at the p=.05 level revealed the F value of 2.72 was not significant.

The third statistical test in the A x B ANOVA involved the main effects of Factor B—the two levels of therapeutic instructions. This test analyzed subject's rates of answering OQSMAT questions between positive and negative therapeutic instruction groups. With one degree of freedom in the numerator and eighteen degrees of freedom in the denominator the F ratio significant at the p=.05 level is 4.41. Comparison of the F value for therapeutic instruction groups in Table IV with tabled values for significance at the p=.05 level revealed the F value of 4.41 was significant. The mean rates for the positive and negative therapeutic instruction groups are 2.71 and 2.35, respectively, indicating significantly higher rates for the positive therapeutic instruction group.

**Physiological Arousal**

The results seem to indicate that EMG-induced physiological arousal had no significant effect upon cognitive-intellectual test performance. However, mean OQSMAT scores under the EMG-induced low physiological arousal condition were higher than under the EMG-induced high physiological arousal condition. This is similar to that of Garrett and Silver (2) who found
non-significant increases on subject's test performance following biofeedback (EMG and EEG) training. Similarly, EMG-induced physiological arousal did not have a significant effect upon self-reported on-task behavior or rate of answering test questions. But, just as in the findings related to OQSMAT performance, both means related to self-reported on-task behavior and rate of answering test questions were found to be in the hypothesized direction. (see Appendix C).

With regard to subject's self-reported anxiety during the OQSMAT administration, the results indicate that self-reported anxiety was significantly lower under the EMG-induced low physiological arousal treatment condition. Such a finding indicates a cognitive change taking place which is not reflected in the subject's performance. Similar results have been reported in other investigations employing relaxation therapy techniques (1, 3, 4, 5).

**Therapeutic Instructions**

The results seem to indicate that therapeutic instructions had no significant effect upon cognitive-intellectual test performance or self-reported anxiety while being administered an intelligence test. Although this finding was hypothesized, the positive therapeutic instruction group reported spending significantly more time on task than the negative therapeutic instruction group. A second measure of on-task
behavior, rate of answering test questions, yielded significantly higher scores for the positive therapeutic instruction group than for the negative therapeutic instruction group. Such results could lead to the conclusion that instructions communicating an expectation for positive performance outcome on a test of cognitive-intellectual ability may result in increased on-task behavior regardless of physiological arousal level (as related to physiological arousal measures taken from the sample within the present investigation). However, such an increase in on-task behavior did not seem to significantly affect intellectual test performance scores. Though such was the case, the mean of the OQSMAT scores for the positive therapeutic instruction group was 5.15 points higher than that of the negative therapeutic instruction group.

The processes underlying the significant results related to the effects of induced low physiological arousal and positive therapeutic instructions upon self-reported test anxiety and on-task behavior may be attributed to several factors. First, each subject probably came to the experiment wishing to be cooperative; a "good" experimental subject. Such behavior within similar situations has been reinforced repeatedly during the lifetime of most people that come to college and volunteer for such experiments. Second, during the experiment each person received training in controlling levels of tension which, in the popular literature and press, is treated as being instrumental in combatting stress, tension and anxiety. Third,
during the EMG biofeedback training each subject received auditory feedback indicating that he was actually controlling such tension levels which increased the plausability of the procedure as a device for controlling stress and anxiety.

The positive effects of the biofeedback combined with the experimenter telling the subject that he could move from the training to the testing phase of the study communicated that the experimenter considered him to have mastered the procedure and could then use it to combat his test anxiety. Also, immediately before testing, the subject was instructed via therapeutic instructions that the procedure would decrease his anxiety and thoughts of failure. Having a history of reinforcement for cooperation, knowing that he was successful in mastering the biofeedback training procedure and was expected to engage in the behavior communicated via the pre-test instructions, he reduced his thoughts of failure during testing sessions under both physiological arousal conditions and "felt" more relaxed during the low physiological arousal testing session. Reducing thoughts of failure, in effect, decreased responses incompatible with on-task behavior which led to a self-report of a greater amount of time on task as well as a higher rate of answering test questions under the positive therapeutic instruction condition.

A puzzling result was the fact that the self-reported test anxiety was significantly lower under the low physiological arousal condition than under the high physiological arousal
condition, although the pre-test instructions suggested decreased anxiety without regard to physiological arousal. A possible explanation is that the physiological and auditory biofeedback suggested a high tension level which, in the history of most people, has been associated with the concept of anxiety. Such feedback cues provided a more plausible explanation of the subject's current physiological state than the pre-test instructions. Therefore, the subject rated himself as being more anxious under such a condition.

Presented in this chapter were the results of the statistical analyses designed to test the hypotheses under study. Also, a brief discussion of the results was presented in an attempt to offer a summary and an integration with other recent related studies. In addition, a brief analysis of the processes underlying the conclusions of the present study was presented.
CHAPTER BIBLIOGRAPHY


CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study was concerned with an investigation of the effects of biofeedback-induced physiological arousal and instructions conveying the expectation of success or failure regarding performance on an intelligence test upon cognitive-intellectual test performance, self-reported anxiety and on-task behavior.

The problem was to determine the effects of levels of biofeedback-induced physiological arousal and therapeutic instructions on cognitive-intellectual test performance, subjective (self-reported) test anxiety and self-reported ability to stay on-task during a test administration. The purposes were: (1) to determine the relationship between the cognitive-intellectual test performance of each subject under low and high physiological arousal conditions and under therapeutic instruction conditions communicating either an expectancy for positive treatment outcome with a consequent successful test performance or an expectancy for negative treatment outcome with a consequent impaired test performance; (2) to determine the relationship between the self-reported test anxiety of each subject under low and high physiological arousal conditions and under therapeutic instruction conditions communicating
either an expectancy for positive treatment outcome and successful test performance or an expectancy for negative treatment outcome and impaired test performance; and (3) to determine the relationship between the report by each subject of the ability to remain on-task during test administrations under low and high physiological arousal conditions and under therapeutic instruction conditions communicating either an expectancy for positive treatment outcome and successful test performance or an expectancy for negative treatment outcome and impaired test performance. The hypotheses formulated were (1) Cognitive-intellectual test performance scores as measured by the Otis Quick Score Mental Abilities Test (1) will be significantly higher for high test-anxious subjects under the low physiological arousal condition than under the high physiological arousal condition; (2) Self-reported test anxiety scores as measured by the Anxiety Thermometer will be significantly less for high test-anxious subjects under the low physiological arousal condition than under the high physiological arousal condition; (3) Self-reported on-task behavior as measured by scores on the On-Task Behavior Scale will be significantly greater for high test-anxious subjects under the low physiological arousal condition than under the high physiological arousal condition; (4) Therapeutic instructions will have no significant effect on any of the dependent measures of high test-anxious subjects.

The investigation was conducted in five phases. During
the first phase volunteers were screened on both the Suinn Test Anxiety Behavior Scale (2) and the electromyograph. Such screening was necessary in order to be assured of having subjects that were both highly test-anxious and able to benefit from electromyograph (EMG) biofeedback training.

During the second phase, subjects were trained via EMG biofeedback to either decrease or increase frontalis muscle tension levels. Such training was conducted in 30 minute sessions until each subject met a criterion of either 10 minutes of being in a low physiological arousal state (3 microvolts or lower) or 10 minutes of being in a high physiological arousal state (9 microvolts or higher). All subjects were randomly assigned to either initial, high or low physiological arousal training conditions.

During the third phase, each subject was administered an intelligence test (Otis Quick Score Mental Abilities Test (1)) after being instructed to either increase or decrease physiological arousal level, depending upon the treatment group to which he/she was assigned. Before beginning work on the intelligence test, each subject was given either positive or negative therapeutic instructions (which were groups into which each subject was randomly assigned). Positive therapeutic instructions conveyed the expectation of the treatment condition having the effect of enhancing the subject's performance on the intelligence test. Negative therapeutic instructions conveyed the opposite expectation, that the subject's
performance on the intelligence test would be impaired by the treatment condition. While completing the intelligence test, each subject was administered the Anxiety Thermometer (a self-report of experienced anxiety) at the beginning of the test administration, twice during the testing and once immediately following completion of the testing session. The testing session was 30 minutes in length. Each subject was attached to the EMG during testing, but only given feedback (via an auditory tone) if frontalis muscle tension decreased below 9 microvolts for the high physiological testing condition and above three microvolts for the low physiological testing condition. At the conclusion of the test administration, each subject completed the On-Task Behavior Scale, a self-report of how many minutes during the test administration he/she believed himself/herself to be on task (i.e., engaging in behavior that would facilitate completion of the intelligence test).

The fourth phase consisted of biofeedback training in either decreasing or increasing physiological arousal identical to phase two training. In phase four, each subject was trained in the physiological arousal condition opposite to that which he/she had been trained during phase two.

The fifth phase consisted of a second administration of the Otis Quick Score Mental Abilities Test (1) identical to phase three testing. In phase five, each subject was tested under the physiological arousal condition opposite to that under which he had been tested during phase three. Parallel
forms of the *Otis Quick Score Mental Abilities Test* (1) were used for purposes of intelligence testing under the two physiological arousal treatment conditions.

Subjects' scores on the *Otis Quick Score Mental Abilities Test* (1), *Anxiety Thermometer* and *On-Task Behavior Scale* were analyzed with a Two Factor Analysis of Variance with Repeated Measures on one Factor (physiological arousal treatment conditions) to determine if there were significant differences on the test scores between low and high physiological arousal treatments and positive and negative therapeutic instruction groups.

**Summary of Findings**

1. Subjects tested under the EMG-induced low physiological arousal condition did not make significantly higher scores on the *Otis Quick Score Mental Abilities Test* than subjects tested under the EMG-induced high physiological arousal treatment condition.

2. Subjects reported significantly less experienced anxiety, as measured by the *Anxiety Thermometer*, under the EMG-induced low physiological treatment condition.

3. Subjects did not report being on task, as measured by the *On-Task Behavior Scale*, significantly more under the EMG-induced low physiological arousal treatment condition than under the EMG-induced high physiological treatment condition.
4. Subjects in the positive therapeutic instruction group did not score significantly different on the Otis Quick Score Mental Abilities Test from subjects in the negative therapeutic instruction group.

5. Subjects in the positive therapeutic instruction group did not report anxiety levels significantly different from subjects in the negative therapeutic instruction group.

6. Subjects in the positive therapeutic instruction group reported spending significantly more time on-task than subjects in the negative therapeutic instruction group.

7. The rate at which subjects in the positive therapeutic instruction group answered test questions on the Otis Quick Score Mental Abilities Test was significantly higher than for subjects in the negative therapeutic instruction group.

Conclusions

The findings of this study appear to support the following conclusions.

1. With regard to the sample under study, high and low muscle tension states, denoting high and low physiological arousal levels, have no significant effect upon cognitive-intellectual test performance. However, mean differences appear to be in the hypothesized direction.

2. With regard to the sample under study, high and low muscle tension states, denoting high and low physiological
arousal levels, have a differential effect upon self-reported anxiety of subjects while being administered an intelligence test. Self-reported anxiety is less under the low physiological arousal condition. However, in the present investigation such physiological arousal effects were not reflected in changes in cognitive-intellectual test performance.

3. With regard to the sample under study, high and low muscle tension states, denoting high and low physiological arousal levels, do not have a differential effect upon experienced on-task behavior or rate at which questions on an intelligence test are answered.

4. With regard to the sample under study, instructions delivered to subjects prior to cognitive-intellectual test administration, conveying either expectation of success or failure with regard to the effect of the experimental treatment upon test-taking behavior, have no significant differential effects upon intelligence test performance or subjectively experienced anxiety while taking an intelligence test.

5. With regard to the sample under study, instructions conveying the expectation of the experimental treatment having an enhancing effect upon intelligence test performance both significantly increased subjectively experienced (self-reported) on-task behavior and rate at which test questions are answered.

Implications

Implications for education derived from the research findings and conclusions of the present study are as follows.
1. Students complaining of test anxiety should be encouraged to seek training in relaxation skills that might be used during testing sessions. Such procedures might reduce experienced test anxiety.

2. No matter what procedure the highly test-anxious student might use to relax while taking tests, the positive effects with regard to the procedure decreasing test anxiety and thoughts of failure should be emphasized.

3. Teachers should avoid telling students that their anxiety will impair test performance and/or increase thoughts related to failure.

4. Although relaxation skills used while taking tests may decrease felt anxiety, not much increase in test performance should be expected as a result.

Recommendations for Further Study

Based upon the research findings and conclusions the following recommendations are made.

1. The present investigation could be replicated with certain changes being made which might lead to more definitive results:

   a. A larger number of biofeedback training sessions could be used so as to increase the probability of generalization of biofeedback effects to testing sessions resulting in lower tension levels during testing.

   b. A lower criterion for muscle tension while being administered the testing instrument under the low physiological
arousal condition could be used. Such a decreased criterion would lead to greater separation of high and low induced physiological arousal which might increase the probability of obtaining significant findings on dependent measures.

c. Additional physiological measures could be used such as skin temperature and heart rate to ascertain the effects of EMG-induced physiological arousal levels upon the autonomic nervous system and also investigate the relationship between such autonomic nervous system changes and the dependent variables of test performance, self-reported test anxiety and on-task behavior.

d. Subjects could be matched with regard to degree of self-reported test anxiety (high-moderate-low) in order to study possible differential effects of the independent variables upon such subject characteristics.

2. Further research is needed to determine the effect of physiological arousal induced through other kinds of biofeedback (skin temperature, heart rate, etc.) upon test performance, test anxiety and on-task behavior.

3. Further research is needed to determine the effect of instructions conveying expectations for certain behavior such as increased on-task behavior, decreased anxiety, etc., upon the correlation between self-report and objective measures of such expected behavior.

4. Further research is needed to determine the effect upon test performance, self-reported test anxiety and on-task
behavior of initial EMG baseline and magnitude of change in muscle tension from that baseline as a result of EMG training.

5. Further research is needed to determine the effects of different levels of biofeedback-induced physiological arousal upon performance on tests requiring various kinds of skills (e.g., comprehension versus perceptual-motor, etc.).
CHAPTER BIBLIOGRAPHY


APPENDIX A

TESTING INSTRUMENTS AND DATA SHEETS
ON-TASK BEHAVIOR SCALE

Instructions: Please mark on the scale below the number that corresponds with the number of minutes that you believe that you were either thinking about the answer to a question or answering a question on the Intelligence Test that you just finished.

<table>
<thead>
<tr>
<th>ON-TASK</th>
<th>OFF-TASK</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1</td>
<td></td>
</tr>
</tbody>
</table>
Instructions for On-Task Questionnaire

1. Anything that competes or takes the place of answering questions on the Intelligence Test is considered to be OFF-TASK.

Examples of OFF-TASK are:
   a. Thinking about passing or failing the test;
   b. Mind becoming blank;
   c. Thinking about what you will do once the test administration is finished;
   d. Thinking about other tests that you have taken in the past.

2. ON-TASK behavior is:
   a. Thinking about the answer to a test question;
   b. Thinking about the definition of a word in a question;
   c. Thinking about material that you have learned previously that might be associated with a question on the test;
   d. Writing the answer to a test question;
   e. Reading a test question.
DATA SHEET

Name ____________________________  Sex ______

SS# ______________________________ Age ______

Phone ____________________________  

Training Session # ______  High/Low Physiological Arousal Training (Circle one)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | X |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|---|

Training Session # ______

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | X |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|---|

TESTING

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | X |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|---|

Cumulative time tone on ______ ______ (min. and sec.)
SUINN TEST ANXIETY SCALE

The items in the questionnaire refer to experiences that may cause fear or apprehension. For each item, place a check (✓) in the box under the column that describes how much you are frightened by it nowadays. Work quickly but be sure to consider each item individually.

1. Going into a regularly scheduled class period in which the professor asks the students to participate.

2. Re-reading answers I gave on the test before turning it in.

3. Sitting down to study before a regularly scheduled class.

4. Turning my completed test paper in.

5. Hearing the announcement of a coming test.

6. Having a test returned.

7. Reading the first question on a final exam.

8. Studying for a class in which I am scared of the professor.

9. Being in class waiting for my corrected test to be returned.

10. Seeing a test question and not being sure of the answer.

11. Studying for a test the night before.

12. Waiting to enter the room where a test is to be given.

13. Waiting for a test to be handed out.

14. Being called on to answer a question in class by a professor who scares me.

15. Waiting for the day my corrected test will be returned.

16. Discussing with the instructor an answer I believed to be right but which was marked wrong.

17. Seeing my standing on the exam relative to other people's standing.

18. Waiting to see my letter grade on the test.
19. Studying for a quiz.
20. Studying for a midterm.
22. Discussing my approaching test with a friend a few weeks before the test is due.
23. After the test, listening to the answers which my friends selected.
24. Looking at the clock to see how much time remains during an exam.
25. Seeing the number of questions that need to be answered in the test.
26. On an essay exam, seeing a question I cannot answer.
27. On a multiple choice test, seeing a question I cannot answer.
29. Being the first one to finish an exam and turn it in.
30. Being asked by a friend concerning my standing in a class.
31. Being asked by a friend concerning results of a test on which I did poorly.
32. Discovering I need an A or B on the next exam in order to pass the course.
33. Discovering I need an A or B on the final exam to maintain the grade point average necessary to remain in school.
34. Thinking about "warning slips" from the Dean's office.
35. Reading a "warning slip" from the Dean's office.
36. Remembering my past reactions while preparing for another test.
37. Seeking out the teaching assistant or instructor for advice or help.
38. Being told to see the instructor concerning some aspect of my class work.
39. Asking for a make-up exam after missing the scheduled exam.

40. Discussing the course content with fellow students just before entering the classroom the day of the exam.

41. Being the last one to finish an exam and turn it in.

42. Reviewing study materials the night before an exam.

43. On the first day of the course, hearing the instructor announce the dates of the midterm and final examination.

44. Having the instructor ask a question of the class which deals with the course material, and then look in my direction.

45. Making an appointment to see the instructor regarding some course problem.

46. Thinking about a coming exam 3 weeks before its scheduled date.

47. Thinking about a coming exam 1 week before its scheduled date.

48. Thinking about a coming exam the weekend before its scheduled date.

49. Thinking about a coming exam the night before its scheduled date.

50. Thinking about a coming exam the hour before its scheduled time.
ANSWER SHEET

<table>
<thead>
<tr>
<th>Not at all</th>
<th>a little</th>
<th>a fair amount</th>
<th>much</th>
<th>very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>2.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>3.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>4.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>5.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>6.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>7.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>8.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>9.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>10.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>11.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>12.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>13.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>14.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>15.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>16.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>17.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>18.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>19.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>20.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>21.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>22.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>23.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>24.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>25.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>26.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>27.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>28.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>29.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>30.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>31.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>32.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>33.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>34.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>35.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>36.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>37.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>38.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>39.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>40.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>41.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>42.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>43.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>44.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td>45.</td>
<td>()</td>
<td>()</td>
<td>()</td>
<td>()</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
<td>a little</td>
<td>a fair amount</td>
<td>much</td>
</tr>
<tr>
<td>-----</td>
<td>------------</td>
<td>----------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td>46.</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>47.</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>48.</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>49.</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>50.</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
</tbody>
</table>
APPENDIX B

THREE-WAY ANALYSIS OF VARIANCE SUMMARY TABLES
TABLE V

THREE-WAY ANALYSIS OF VARIANCE TESTING THE EFFECTS OF 
EMG-INDUCED PHYSIOLOGICAL AROUSAL, THERAPEUTIC 
INSTRUCTIONS AND ORDER OF TREATMENT 
PRESENTATIONS ON OTIS QUICK 
SCORE MENTAL ABILITIES 
TEST SCORES OF ALL 
SUBJECTS (N=20)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>3588.46</td>
<td>19</td>
<td>......</td>
<td>......</td>
<td>.....</td>
</tr>
<tr>
<td>Rows (order of Treatment presentations)</td>
<td>46.23</td>
<td>1</td>
<td>46.23</td>
<td>0.24</td>
<td>0.631</td>
</tr>
<tr>
<td>Columns (positive-negative therapeutic instructions)</td>
<td>265.23</td>
<td>1</td>
<td>265.23</td>
<td>1.37</td>
<td>0.268</td>
</tr>
<tr>
<td>Rows x Columns</td>
<td>180.63</td>
<td>1</td>
<td>180.63</td>
<td>0.93</td>
<td>0.348</td>
</tr>
<tr>
<td>Error (Between Groups)</td>
<td>3096.40</td>
<td>1</td>
<td>193.53</td>
<td>......</td>
<td>.....</td>
</tr>
<tr>
<td>Within Subjects</td>
<td>496.50</td>
<td>26</td>
<td>......</td>
<td>......</td>
<td>.....</td>
</tr>
<tr>
<td>Blocks (high-low physiological arousal)</td>
<td>34.23</td>
<td>1</td>
<td>34.23</td>
<td>1.66</td>
<td>0.216</td>
</tr>
<tr>
<td>Rows x Blocks</td>
<td>30.63</td>
<td>1</td>
<td>30.63</td>
<td>1.49</td>
<td>0.240</td>
</tr>
<tr>
<td>Columns x Blocks</td>
<td>60.03</td>
<td>1</td>
<td>60.03</td>
<td>2.91</td>
<td>0.107</td>
</tr>
<tr>
<td>Rows x Columns x Blocks</td>
<td>42.03</td>
<td>1</td>
<td>42.03</td>
<td>2.04</td>
<td>0.172</td>
</tr>
<tr>
<td>Error (Within Groups)</td>
<td>329.60</td>
<td>16</td>
<td>20.60</td>
<td>......</td>
<td>.....</td>
</tr>
</tbody>
</table>
### TABLE VI

THREE-WAY ANALYSIS OF VARIANCE TESTING THE EFFECTS OF EMG-INDUCED PHYSIOLOGICAL AROUSAL, THERAPEUTIC INSTRUCTIONS AND ORDER OF TREATMENT PRESENTATIONS ON ANXIETY THERMOMETER SCORES OF ALL SUBJECTS (N=20)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>6329.38</td>
<td>19</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Rows (order of Treatment presentations)</td>
<td>5.18</td>
<td>1</td>
<td>5.18</td>
<td>0.015</td>
<td>0.903</td>
</tr>
<tr>
<td>Columns (positive-negative therapeutic instructions)</td>
<td>756.90</td>
<td>1</td>
<td>756.90</td>
<td>2.220</td>
<td>0.156</td>
</tr>
<tr>
<td>Rows x Columns</td>
<td>102.40</td>
<td>1</td>
<td>102.40</td>
<td>0.300</td>
<td>0.592</td>
</tr>
<tr>
<td>Error (Between Groups)</td>
<td>5464.90</td>
<td>16</td>
<td>341.56</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Within Subjects</td>
<td>2753.60</td>
<td>20</td>
<td>......</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Blocks (high-low physiological arousal)</td>
<td>688.90</td>
<td>1</td>
<td>688.90</td>
<td>5.980</td>
<td>0.026</td>
</tr>
<tr>
<td>Rows x Blocks</td>
<td>144.40</td>
<td>1</td>
<td>144.40</td>
<td>1.250</td>
<td>0.279</td>
</tr>
<tr>
<td>Columns x Blocks</td>
<td>76.18</td>
<td>1</td>
<td>76.18</td>
<td>0.661</td>
<td>0.428</td>
</tr>
<tr>
<td>Rows x Columns x Blocks</td>
<td>2.30</td>
<td>1</td>
<td>2.30</td>
<td>0.020</td>
<td>0.889</td>
</tr>
<tr>
<td>Error (Within Groups)</td>
<td>1841.82</td>
<td>16</td>
<td>115.11</td>
<td>......</td>
<td>......</td>
</tr>
</tbody>
</table>
TABLE VII

THREE-WAY ANALYSIS OF VARIANCE TESTING THE EFFECTS OF EMG-INDUCED PHYSIOLOGICAL AROUSAL, THERAPEUTIC INSTRUCTIONS AND ORDER OF TREATMENT PRESENTATIONS ON ON-TASK BEHAVIOR SCALE SCORES OF ALL SUBJECTS (N=20)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rows (order of Treatment presentations)</td>
<td>12.10</td>
<td>1</td>
<td>12.10</td>
<td>0.047</td>
<td>0.831</td>
</tr>
<tr>
<td>Columns (positive-negative therapeutic instructions)</td>
<td>1123.60</td>
<td>1</td>
<td>1123.60</td>
<td>4.370</td>
<td>0.053</td>
</tr>
<tr>
<td>Rows x Columns</td>
<td>372.10</td>
<td>1</td>
<td>372.10</td>
<td>1.450</td>
<td>0.246</td>
</tr>
<tr>
<td>Error (Between Groups)</td>
<td>4113.60</td>
<td>16</td>
<td>257.10</td>
<td>......</td>
<td>......</td>
</tr>
<tr>
<td>Within Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocks (high-low physiological arousal)</td>
<td>324.90</td>
<td>1</td>
<td>324.90</td>
<td>3.700</td>
<td>0.070</td>
</tr>
<tr>
<td>Rows x Blocks</td>
<td>0.00</td>
<td>1</td>
<td>0.00</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Columns x Blocks</td>
<td>44.10</td>
<td>1</td>
<td>44.10</td>
<td>0.511</td>
<td>0.485</td>
</tr>
<tr>
<td>Rows x Columns x Blocks</td>
<td>19.60</td>
<td>1</td>
<td>19.60</td>
<td>0.227</td>
<td>0.640</td>
</tr>
<tr>
<td>Error (Within Groups)</td>
<td>1380.40</td>
<td>16</td>
<td>86.28</td>
<td>......</td>
<td>......</td>
</tr>
</tbody>
</table>
### TABLE VIII

**THREE-WAY ANALYSIS OF VARIANCE TESTING THE EFFECTS OF EMG-INDUCED PHYSIOLOGICAL AROUSAL, THERAPEUTIC INSTRUCTIONS AND ORDER OF TREATMENT PRESENTATIONS ON RATE OF ALL SUBJECTS (N=20)**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between Subjects</strong></td>
<td>6.57</td>
<td>19</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
</tr>
<tr>
<td>Rows (order or Treatment presentations)</td>
<td>0.013</td>
<td>1</td>
<td>0.013</td>
<td>0.041</td>
<td>0.842</td>
</tr>
<tr>
<td>Columns (positive-negative therapeutic instructions)</td>
<td>1.29</td>
<td>1</td>
<td>1.29</td>
<td>4.0</td>
<td>0.063</td>
</tr>
<tr>
<td>Rows x Columns</td>
<td>0.091</td>
<td>1</td>
<td>0.091</td>
<td>0.282</td>
<td>0.603</td>
</tr>
<tr>
<td>Error (Between Groups)</td>
<td>5.16</td>
<td>16</td>
<td>0.323</td>
<td>.....</td>
<td>.....</td>
</tr>
<tr>
<td><strong>Within Subjects</strong></td>
<td>0.820</td>
<td>20</td>
<td>.....</td>
<td>.....</td>
<td>.....</td>
</tr>
<tr>
<td>Blocks (high-low physiological arousal)</td>
<td>0.107</td>
<td>1</td>
<td>0.107</td>
<td>2.85</td>
<td>0.111</td>
</tr>
<tr>
<td>Rows x Blocks</td>
<td>0.027</td>
<td>1</td>
<td>0.027</td>
<td>0.706</td>
<td>0.413</td>
</tr>
<tr>
<td>Columns x Blocks</td>
<td>0.003</td>
<td>1</td>
<td>0.003</td>
<td>0.092</td>
<td>0.789</td>
</tr>
<tr>
<td>Rows x Columns x Blocks</td>
<td>0.082</td>
<td>1</td>
<td>0.082</td>
<td>2.18</td>
<td>0.159</td>
</tr>
<tr>
<td>Error (Within Groups)</td>
<td>0.601</td>
<td>16</td>
<td>0.038</td>
<td>.....</td>
<td>.....</td>
</tr>
</tbody>
</table>
APPENDIX C

RAW SCORES AND SCREENING DATA
MEAN EMG μV READINGS RECORDED DURING QGSMAT TEST ADMINISTRATIONS FOR ALL SUBJECTS (N=20)

<table>
<thead>
<tr>
<th>High Physiological Arousal Testing Condition</th>
<th>Low Physiological Arousal Testing Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.25</td>
<td>5.78</td>
</tr>
<tr>
<td>23.73</td>
<td>5.34</td>
</tr>
<tr>
<td>12.14</td>
<td>3.81</td>
</tr>
<tr>
<td>21.91</td>
<td>4.46</td>
</tr>
<tr>
<td>11.88</td>
<td>4.35</td>
</tr>
<tr>
<td>13.99</td>
<td>5.33</td>
</tr>
<tr>
<td>18.84</td>
<td>2.52</td>
</tr>
<tr>
<td>21.68</td>
<td>3.24</td>
</tr>
<tr>
<td>27.23</td>
<td>3.24</td>
</tr>
<tr>
<td>12.63</td>
<td>2.65</td>
</tr>
<tr>
<td>17.82</td>
<td>5.25</td>
</tr>
<tr>
<td>9.54</td>
<td>5.54</td>
</tr>
<tr>
<td>10.64</td>
<td>5.52</td>
</tr>
<tr>
<td>16.35</td>
<td>5.80</td>
</tr>
<tr>
<td>16.19</td>
<td>3.94</td>
</tr>
<tr>
<td>17.13</td>
<td>3.89</td>
</tr>
<tr>
<td>14.13</td>
<td>4.84</td>
</tr>
<tr>
<td>44.61</td>
<td>4.65</td>
</tr>
<tr>
<td>15.32</td>
<td>2.60</td>
</tr>
<tr>
<td>14.99</td>
<td>4.09</td>
</tr>
</tbody>
</table>
MEAN EMG µV* DURING SCREENING FOR ALL SUBJECTS (N=20)

<table>
<thead>
<tr>
<th>Subjects in Positive Therapeutic Instruction Group</th>
<th>Subjects in Negative Therapeutic Instruction Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.40</td>
<td>7.38</td>
</tr>
<tr>
<td>21.70</td>
<td>7.55</td>
</tr>
<tr>
<td>9.68</td>
<td>7.05</td>
</tr>
<tr>
<td>6.67</td>
<td>6.73</td>
</tr>
<tr>
<td>7.55</td>
<td>9.13</td>
</tr>
<tr>
<td>10.05</td>
<td>12.13</td>
</tr>
<tr>
<td>13.15</td>
<td>11.40</td>
</tr>
<tr>
<td>11.35</td>
<td>17.05</td>
</tr>
<tr>
<td>12.60</td>
<td>11.13</td>
</tr>
<tr>
<td>8.56</td>
<td>9.13</td>
</tr>
</tbody>
</table>

* No subjects were accepted for the study who scored below a mean of 6 µV during screening session.
<table>
<thead>
<tr>
<th>Subjects in Positive Therapeutic Instruction Group</th>
<th>Subjects in Negative Therapeutic Instruction Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>151</td>
<td>162</td>
</tr>
<tr>
<td>145</td>
<td>149</td>
</tr>
<tr>
<td>159</td>
<td>147</td>
</tr>
<tr>
<td>199</td>
<td>186</td>
</tr>
<tr>
<td>172</td>
<td>142</td>
</tr>
<tr>
<td>161</td>
<td>178</td>
</tr>
<tr>
<td>142</td>
<td>173</td>
</tr>
<tr>
<td>174</td>
<td>142</td>
</tr>
<tr>
<td>173</td>
<td>152</td>
</tr>
<tr>
<td>166</td>
<td>143</td>
</tr>
</tbody>
</table>

*All raw scores are above the 75 percentile when compared to STABS norms.*
FRONTALIS EMG $\mu V$ RECORDED AT ONE MINUTE INTERVALS UNDER LOW PHYSIOLOGICAL AROUSAL TEST CONDITION

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>SUBJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4.5</td>
<td>5.8</td>
</tr>
<tr>
<td>4.1</td>
<td>5.6</td>
</tr>
<tr>
<td>5.8</td>
<td>5.2</td>
</tr>
<tr>
<td>4.2</td>
<td>5.4</td>
</tr>
<tr>
<td>4.7</td>
<td>5.6</td>
</tr>
<tr>
<td>5.7</td>
<td>5.7</td>
</tr>
<tr>
<td>5.2</td>
<td>5.7</td>
</tr>
<tr>
<td>6.3</td>
<td>5.0</td>
</tr>
<tr>
<td>5.2</td>
<td>5.1</td>
</tr>
<tr>
<td>5.5</td>
<td>5.4</td>
</tr>
<tr>
<td>5.9</td>
<td>5.3</td>
</tr>
<tr>
<td>5.5</td>
<td>6.3</td>
</tr>
<tr>
<td>5.9</td>
<td>5.2</td>
</tr>
<tr>
<td>6.2</td>
<td>5.3</td>
</tr>
<tr>
<td>5.8</td>
<td>5.1</td>
</tr>
<tr>
<td>5.6</td>
<td>5.2</td>
</tr>
<tr>
<td>5.4</td>
<td>6.1</td>
</tr>
<tr>
<td>5.0</td>
<td>4.5</td>
</tr>
<tr>
<td>6.5</td>
<td>5.1</td>
</tr>
<tr>
<td>6.8</td>
<td>5.1</td>
</tr>
<tr>
<td>8.8</td>
<td>5.8</td>
</tr>
<tr>
<td>5.8</td>
<td>5.3</td>
</tr>
<tr>
<td>6.1</td>
<td>4.9</td>
</tr>
<tr>
<td>7.0</td>
<td>4.5</td>
</tr>
<tr>
<td>7.2</td>
<td>3.9</td>
</tr>
<tr>
<td>3.2</td>
<td>2.9</td>
</tr>
<tr>
<td>4.4</td>
<td>3.4</td>
</tr>
<tr>
<td>3.5</td>
<td>3.1</td>
</tr>
<tr>
<td>3.4</td>
<td>3.1</td>
</tr>
<tr>
<td>3.7</td>
<td>3.0</td>
</tr>
</tbody>
</table>
FRONTALIS EMG RECORDED AT ONE MINUTE INTERVALS UNDER LOW PHYSIOLOGICAL AROUSAL TEST CONDITION (Continued)

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3</td>
<td>4.2</td>
<td>2.5</td>
<td>2.9</td>
<td>5.6</td>
<td>5.6</td>
<td>8.1</td>
<td>5.4</td>
<td>4.3</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>4.2</td>
<td>2.5</td>
<td>3.5</td>
<td>6.7</td>
<td>5.9</td>
<td>8.4</td>
<td>5.6</td>
<td>4.0</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td>3.5</td>
<td>2.7</td>
<td>2.8</td>
<td>6.8</td>
<td>5.7</td>
<td>8.1</td>
<td>5.6</td>
<td>4.2</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>3.7</td>
<td>2.9</td>
<td>2.9</td>
<td>6.7</td>
<td>5.9</td>
<td>6.4</td>
<td>5.6</td>
<td>5.0</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>3.4</td>
<td>3.1</td>
<td>3.1</td>
<td>5.0</td>
<td>4.8</td>
<td>6.8</td>
<td>5.7</td>
<td>4.6</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>4.8</td>
<td>3.4</td>
<td>3.1</td>
<td>2.9</td>
<td>6.0</td>
<td>5.5</td>
<td>5.6</td>
<td>5.6</td>
<td>4.5</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>4.8</td>
<td>3.5</td>
<td>3.7</td>
<td>3.0</td>
<td>5.8</td>
<td>5.2</td>
<td>5.6</td>
<td>5.8</td>
<td>5.2</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>3.7</td>
<td>4.0</td>
<td>3.2</td>
<td>5.9</td>
<td>5.3</td>
<td>4.8</td>
<td>5.9</td>
<td>5.2</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>3.8</td>
<td>3.7</td>
<td>3.1</td>
<td>5.7</td>
<td>5.6</td>
<td>5.1</td>
<td>5.9</td>
<td>5.1</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>3.8</td>
<td>3.4</td>
<td>3.0</td>
<td>6.4</td>
<td>6.1</td>
<td>5.0</td>
<td>6.2</td>
<td>5.1</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>5.0</td>
<td>3.1</td>
<td>3.1</td>
<td>5.0</td>
<td>5.7</td>
<td>5.1</td>
<td>5.4</td>
<td>5.9</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>4.2</td>
<td>4.1</td>
<td>3.0</td>
<td>4.8</td>
<td>5.8</td>
<td>5.0</td>
<td>5.6</td>
<td>5.6</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>3.9</td>
<td>4.1</td>
<td>3.7</td>
<td>2.6</td>
<td>5.3</td>
<td>5.8</td>
<td>5.1</td>
<td>5.5</td>
<td>5.5</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>3.9</td>
<td>6.8</td>
<td>3.6</td>
<td>2.9</td>
<td>4.5</td>
<td>5.5</td>
<td>4.6</td>
<td>5.7</td>
<td>4.6</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td>2.9</td>
<td>3.7</td>
<td>3.0</td>
<td>5.5</td>
<td>5.6</td>
<td>5.1</td>
<td>5.5</td>
<td>5.5</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>4.9</td>
<td>3.2</td>
<td>3.8</td>
<td>3.3</td>
<td>5.1</td>
<td>5.6</td>
<td>5.4</td>
<td>6.0</td>
<td>5.6</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>4.2</td>
<td>3.6</td>
<td>3.6</td>
<td>4.3</td>
<td>5.1</td>
<td>5.4</td>
<td>5.4</td>
<td>5.7</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>3.8</td>
<td>3.1</td>
<td>4.1</td>
<td>4.9</td>
<td>5.1</td>
<td>5.4</td>
<td>5.5</td>
<td>5.7</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>4.8</td>
<td>3.3</td>
<td>3.3</td>
<td>3.0</td>
<td>4.6</td>
<td>5.8</td>
<td>5.6</td>
<td>5.6</td>
<td>5.7</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>3.5</td>
<td>3.1</td>
<td>3.1</td>
<td>4.9</td>
<td>5.4</td>
<td>4.6</td>
<td>5.3</td>
<td>5.6</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>4.8</td>
<td>2.6</td>
<td>3.0</td>
<td>2.7</td>
<td>5.0</td>
<td>5.7</td>
<td>5.8</td>
<td>5.5</td>
<td>4.9</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>5.0</td>
<td>5.9</td>
<td>5.5</td>
<td>5.4</td>
<td>4.1</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>3.2</td>
<td>3.1</td>
<td>3.2</td>
<td>5.4</td>
<td>5.5</td>
<td>4.0</td>
<td>5.5</td>
<td>4.6</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>5.9</td>
<td>5.2</td>
<td>2.9</td>
<td>3.2</td>
<td>4.6</td>
<td>4.8</td>
<td>3.4</td>
<td>5.6</td>
<td>4.6</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>5.8</td>
<td>3.7</td>
<td>3.0</td>
<td>3.4</td>
<td>5.5</td>
<td>5.9</td>
<td>8.6</td>
<td>5.6</td>
<td>4.9</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>4.3</td>
<td>3.9</td>
<td>3.7</td>
<td>5.5</td>
<td>6.2</td>
<td>4.8</td>
<td>5.6</td>
<td>4.6</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>2.8</td>
<td>7.0</td>
<td>3.2</td>
<td>3.6</td>
<td>5.4</td>
<td>4.9</td>
<td>5.6</td>
<td>5.6</td>
<td>5.1</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>3.7</td>
<td>5.5</td>
<td>2.9</td>
<td>3.8</td>
<td>4.9</td>
<td>5.4</td>
<td>5.8</td>
<td>5.6</td>
<td>4.6</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>4.7</td>
<td>2.9</td>
<td>4.3</td>
<td>5.2</td>
<td>4.4</td>
<td>5.4</td>
<td>5.8</td>
<td>4.5</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>2.9</td>
<td>4.1</td>
<td>5.4</td>
<td>7.0</td>
<td>5.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FRONTALIS EMG ACV RECORDED AT ONE MINUTE INTERVALS UNDER HIGH PHYSIOLOGICAL AROUSAL TEST CONDITION

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.7</td>
<td>6.9</td>
<td>7.6</td>
<td>7.1</td>
<td>10.7</td>
<td>9.4</td>
<td>7.6</td>
<td>14.7</td>
<td>13.0</td>
<td>38.0</td>
</tr>
<tr>
<td></td>
<td>12.9</td>
<td>6.9</td>
<td>7.9</td>
<td>14.5</td>
<td>5.9</td>
<td>9.1</td>
<td>23.5</td>
<td>12.3</td>
<td>14.5</td>
<td>32.2</td>
</tr>
<tr>
<td></td>
<td>11.3</td>
<td>6.2</td>
<td>9.4</td>
<td>13.0</td>
<td>9.6</td>
<td>10.5</td>
<td>18.8</td>
<td>10.3</td>
<td>11.2</td>
<td>13.4</td>
</tr>
<tr>
<td></td>
<td>19.3</td>
<td>15.2</td>
<td>7.5</td>
<td>11.6</td>
<td>6.9</td>
<td>9.2</td>
<td>17.4</td>
<td>11.6</td>
<td>11.8</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td>11.4</td>
<td>18.0</td>
<td>13.1</td>
<td>11.2</td>
<td>9.6</td>
<td>10.2</td>
<td>9.7</td>
<td>14.3</td>
<td>14.0</td>
<td>27.1</td>
</tr>
<tr>
<td></td>
<td>10.3</td>
<td>23.7</td>
<td>7.9</td>
<td>12.1</td>
<td>11.1</td>
<td>9.8</td>
<td>12.4</td>
<td>15.7</td>
<td>10.9</td>
<td>19.4</td>
</tr>
<tr>
<td></td>
<td>21.4</td>
<td>22.2</td>
<td>10.9</td>
<td>11.2</td>
<td>14.6</td>
<td>9.8</td>
<td>13.2</td>
<td>15.5</td>
<td>10.3</td>
<td>14.5</td>
</tr>
<tr>
<td></td>
<td>15.4</td>
<td>37.8</td>
<td>8.4</td>
<td>10.5</td>
<td>13.2</td>
<td>16.1</td>
<td>12.5</td>
<td>15.4</td>
<td>18.6</td>
<td>14.2</td>
</tr>
<tr>
<td></td>
<td>14.3</td>
<td>29.8</td>
<td>23.1</td>
<td>10.1</td>
<td>23.8</td>
<td>16.4</td>
<td>11.8</td>
<td>13.8</td>
<td>12.3</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td>14.5</td>
<td>39.4</td>
<td>14.1</td>
<td>12.0</td>
<td>19.6</td>
<td>15.4</td>
<td>11.3</td>
<td>14.8</td>
<td>16.7</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td>21.4</td>
<td>16.9</td>
<td>15.0</td>
<td>13.3</td>
<td>19.6</td>
<td>22.6</td>
<td>6.7</td>
<td>14.7</td>
<td>12.5</td>
<td>11.8</td>
</tr>
<tr>
<td></td>
<td>14.4</td>
<td>30.6</td>
<td>11.6</td>
<td>14.4</td>
<td>16.7</td>
<td>18.8</td>
<td>42.3</td>
<td>9.6</td>
<td>16.9</td>
<td>12.7</td>
</tr>
<tr>
<td></td>
<td>12.0</td>
<td>25.7</td>
<td>12.6</td>
<td>15.5</td>
<td>18.3</td>
<td>15.0</td>
<td>21.4</td>
<td>6.6</td>
<td>13.4</td>
<td>12.3</td>
</tr>
<tr>
<td></td>
<td>13.0</td>
<td>34.4</td>
<td>9.0</td>
<td>16.7</td>
<td>20.4</td>
<td>14.1</td>
<td>21.9</td>
<td>34.5</td>
<td>14.1</td>
<td>12.4</td>
</tr>
<tr>
<td></td>
<td>15.6</td>
<td>32.5</td>
<td>13.4</td>
<td>31.8</td>
<td>14.3</td>
<td>13.1</td>
<td>20.9</td>
<td>26.5</td>
<td>9.0</td>
<td>12.6</td>
</tr>
<tr>
<td></td>
<td>12.1</td>
<td>40.9</td>
<td>13.0</td>
<td>10.5</td>
<td>24.3</td>
<td>11.4</td>
<td>23.4</td>
<td>27.5</td>
<td>9.9</td>
<td>14.4</td>
</tr>
<tr>
<td></td>
<td>11.1</td>
<td>22.3</td>
<td>10.6</td>
<td>9.0</td>
<td>19.4</td>
<td>11.0</td>
<td>19.8</td>
<td>23.1</td>
<td>11.4</td>
<td>13.8</td>
</tr>
<tr>
<td></td>
<td>11.8</td>
<td>23.8</td>
<td>9.0</td>
<td>12.7</td>
<td>21.5</td>
<td>10.7</td>
<td>14.3</td>
<td>17.5</td>
<td>18.5</td>
<td>13.5</td>
</tr>
<tr>
<td></td>
<td>13.3</td>
<td>19.4</td>
<td>13.0</td>
<td>35.0</td>
<td>23.8</td>
<td>9.7</td>
<td>12.8</td>
<td>20.0</td>
<td>18.7</td>
<td>11.8</td>
</tr>
<tr>
<td></td>
<td>10.1</td>
<td>11.5</td>
<td>13.8</td>
<td>26.9</td>
<td>21.0</td>
<td>9.7</td>
<td>13.5</td>
<td>23.6</td>
<td>26.4</td>
<td>11.9</td>
</tr>
<tr>
<td></td>
<td>19.6</td>
<td>21.9</td>
<td>15.6</td>
<td>6.0</td>
<td>12.4</td>
<td>9.2</td>
<td>12.9</td>
<td>21.1</td>
<td>10.5</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>13.5</td>
<td>21.8</td>
<td>5.6</td>
<td>9.3</td>
<td>20.6</td>
<td>10.5</td>
<td>10.4</td>
<td>15.8</td>
<td>10.0</td>
<td>11.9</td>
</tr>
<tr>
<td></td>
<td>10.6</td>
<td>21.5</td>
<td>13.4</td>
<td>11.5</td>
<td>24.0</td>
<td>10.9</td>
<td>19.5</td>
<td>15.8</td>
<td>13.7</td>
<td>14.0</td>
</tr>
<tr>
<td></td>
<td>16.3</td>
<td>20.2</td>
<td>11.0</td>
<td>9.8</td>
<td>26.6</td>
<td>10.5</td>
<td>19.1</td>
<td>16.7</td>
<td>11.3</td>
<td>14.0</td>
</tr>
<tr>
<td></td>
<td>16.2</td>
<td>15.6</td>
<td>13.4</td>
<td>9.4</td>
<td>17.8</td>
<td>13.4</td>
<td>16.1</td>
<td>12.9</td>
<td>12.6</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>11.6</td>
<td>18.3</td>
<td>10.8</td>
<td>7.7</td>
<td>28.5</td>
<td>14.3</td>
<td>15.8</td>
<td>16.5</td>
<td>12.5</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td>10.5</td>
<td>13.9</td>
<td>20.7</td>
<td>21.8</td>
<td>15.2</td>
<td>13.7</td>
<td>11.3</td>
<td>11.0</td>
<td>16.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16.6</td>
<td>16.9</td>
<td>12.1</td>
<td>18.2</td>
<td>12.7</td>
<td>15.2</td>
<td>22.8</td>
<td>12.0</td>
<td>15.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.3</td>
<td>14.5</td>
<td>17.3</td>
<td>13.9</td>
<td>13.1</td>
<td>11.5</td>
<td>24.1</td>
<td>12.9</td>
<td>12.8</td>
<td></td>
</tr>
</tbody>
</table>
FRONTALIS EMG MYO Recorded at One Minute Intervals Under High Physiological Arousal Test Condition
(Continued)

<table>
<thead>
<tr>
<th>INTERVAL</th>
<th>SUBJECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>24.0</td>
<td>4.7</td>
</tr>
<tr>
<td>21.1</td>
<td>11.2</td>
</tr>
<tr>
<td>16.7</td>
<td>11.9</td>
</tr>
<tr>
<td>18.3</td>
<td>10.3</td>
</tr>
<tr>
<td>27.2</td>
<td>6.2</td>
</tr>
<tr>
<td>26.7</td>
<td>16.3</td>
</tr>
<tr>
<td>23.0</td>
<td>14.9</td>
</tr>
<tr>
<td>16.4</td>
<td>14.4</td>
</tr>
<tr>
<td>17.7</td>
<td>11.9</td>
</tr>
<tr>
<td>29.7</td>
<td>11.1</td>
</tr>
<tr>
<td>33.5</td>
<td>13.6</td>
</tr>
<tr>
<td>48.5</td>
<td>9.7</td>
</tr>
<tr>
<td>21.3</td>
<td>10.0</td>
</tr>
<tr>
<td>40.0</td>
<td>8.8</td>
</tr>
<tr>
<td>23.3</td>
<td>9.0</td>
</tr>
<tr>
<td>19.6</td>
<td>8.0</td>
</tr>
<tr>
<td>18.1</td>
<td>11.3</td>
</tr>
<tr>
<td>17.5</td>
<td>11.8</td>
</tr>
<tr>
<td>10.8</td>
<td>12.0</td>
</tr>
<tr>
<td>24.7</td>
<td>12.5</td>
</tr>
<tr>
<td>17.6</td>
<td>24.2</td>
</tr>
<tr>
<td>13.9</td>
<td>29.4</td>
</tr>
<tr>
<td>14.1</td>
<td>23.4</td>
</tr>
<tr>
<td>19.4</td>
<td>22.8</td>
</tr>
<tr>
<td>15.7</td>
<td>19.1</td>
</tr>
<tr>
<td>19.5</td>
<td>19.7</td>
</tr>
<tr>
<td>19.2</td>
<td>16.9</td>
</tr>
<tr>
<td>21.7</td>
<td>9.9</td>
</tr>
<tr>
<td>16.2</td>
<td>16.0</td>
</tr>
<tr>
<td>19.0</td>
<td>25.6</td>
</tr>
</tbody>
</table>
BIBLIOGRAPHY

Books


Articles


Marchetti, A., McGlynn, F. D. and Patterson, A. S., "Effects of Cue-Controlled Relaxation, a Placebo Treatment and No Treatment on Changes in Self-Reported and Physiological Indices of Test Anxiety Among College Students," Behavior Modification, 1, 1977, 47-52.


Mulhall, D. J. and Todd, R. W., "Deconditioning by the Use of EMG Signals," Behavior Therapy, 6, 1975, 125-127.

O'Brien, R. M., "Negative Practice and Desensitization of Anxiety about Examination," Psychological Reports, 38, (Pt. 2), 1147-1153.


