A DOUBLE BLIND INVESTIGATION OF THE EFFECTS OF RELAXATION INSTRUCTIONS ON EMG BIOFEEDBACK LEARNING IN HIGH AND AVERAGE MUSCLE TENSION SUBJECTS

By

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Bachelor of Science

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1976

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
May, 1979

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Thesis Approved:

Thesis Adviser

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ACKNOWLEDGMENTS

I would like to express my appreciation to my major adviser, Dr. Phillip J. Murphy, for his assistance in all aspects of this study. His considerable knowledge in this area contributed significantly to quality of this research, while his humor and support made the task of designing and running it much easier.

My thanks to committee members Dr. Kenneth Sanvold and Dr. Robert Schlottmann for their helpful suggestions and advice during the drafting of this manuscript.

My personal appreciation is expressed to Craig Angus, Karen Maley, and Pat Novak, for their help in the initial stages of this experiment. Thanks also to Jackie, Laura, Noble, and Tony who served as experimenters.

Finally, I would like to thank my parents, Von Edwards and Okemah Edwards, for their continual support of my professional efforts.

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INTRODUCTION

Over the last one hundred and fifty years a shift in disease patterns has begun to occur in western cultures. Advances in medical science have been successful in dealing with various communicable diseases and other diseases with specific, identifiable, etiologies. However, as these types of medical problems have been increasingly eliminated, diseases involving stress and degenerative disorders have become much more prevalent (Dubois, 1965; Stoyva, 1976). The casual factors involved in these emerging patterns are somewhat more vague than the earlier pattern, so that previously successful medical approaches have not been as effective in dealing with these problems. There are, however, indications that certain life styles which include habitual, excessive, responses to stressful situations, can increase the probability of incurring this type of disorder (Friedman and Rosenman, 1974). An understanding of the crucial processes operating in stress related disorders will facilitate the effective diagnosis and treatment of these problems.

Physiological Theories

Numerous theories are concerned with the physiological mechanisms operating in stress responses. Cannon (1932), in describing the flight or fight reaction, focuses on immediate responses to a stressful situation. To deal with threat, the individual exhibits increased sympathetic nervous system activity which results in general arousal of the organism. Wenger (1966) in an extension of Cannon's work to long term patterns, developed the concept of autonomic balance. He uses seven autonomic variables to produce a measure where low scores reflect sympathetic dominance and high scores reflect parasympathetic dominance. In a twenty year follow up study on 1000 aviation cadets, he found that subjects obtaining a score indicating increased sympathetic dominance had a greater incidence of high blood pressure, persistent anxiety, and heart trouble.

Charvat, Dell, and Folkow (1964) suggest that modern civilization requires suppression of the motor components of what they label the defense-alarm reaction. However, visceral and endocrine components of this reaction are still present. The continued blocking of discharge of this arousal is hypothesized to have damaging long term effects. Selye (1950, 1956), in related research with animals, has focused on the effects of long term exposure to physiological stressors such as cold, fasting, and physical trauma. His work has indicated a non-specific systemic response to a broad variety of stressors which is characterized by increased hormonal activity in the pituitary and adrenal cortical systems. He labels this response the general adaptation syndrome.

Wolff (1968) and Malmo (1966) both postulate certain deficiencies in individuals who sucumb to stress related disorders. Wolff presents data suggesting that these individuals are hyper-reactive, especially in the pathological organ system. This pattern of organ specific hyper-reactivity in response to a stress interview was found in subjects having cardiac problems, hyper-cholesterolemia, vascular headaches, and duodenal ulcers. Malmo's theory suggests a more general deficit in autonomic system regulatory mechanisms which produces physiological over reactions to stressful situations. Malmo and Shagass (1952) found that during a mirror drawing task neurotics' systolic blood pressure tended to increase as the experiment progressed, while normals' blood presure tended to level off.

Sternbach (1966) presents a model which integrates many of the above theories. He suggests that two inter-linked factors must be present in order to produce a stress related disease. First, the individual must display response stereotypy, where a variety of stressful situations produce increased arousal in a specific physiological system. Second, the individual must be exposed to stresses often enough to prevent the affected physiological system from returning to normative levels. Sternbach suggests that the presence of these two factors results in a permanent failure in homeostatic mechanisms resulting in constant arousal in the specific system and eventual disease.

An issue which the above theories do not resolve, which is of importance in designing treatment approaches for stress disorders, is that of response stereotypy. Adherents to a generalized pattern of response to stress such as Cannon and Selye maintain that everyone has a similar, diffuse arousal pattern in response to stress. However, Lacy (1967), in an elaborate review of research in this area, cites numerous studies supporting the notion of complex, idiosyncratic physiological response patterns. In earlier work (Lacy, 1959), which also supports this view, he presents data consistent with his concept of directional fractionation. This occurs when given physiological systems display reactivity in a direction opposite to that predicted by the generalized theories.

Summarizing these physiological approaches, it appears that long term exposure to stress produces changes in homeostatic mechanisms which eventually results in physiological damage. In addition, many individuals tend to manifest this arousal in a specific physiological system with the resultant damage occurring in that system.

Cognitive Influences in Stress Reaction

While some of the theories reviewed in the previous section acknowledge the contribution of psychological variables in stress reactions, as a whole they give negligible emphasis to these factors. Selye, for example, maintains that the general adaption syndrome is a completely biological defensive reaction to various physically harmful stimuli. In contrast to this view, Mason (1971) has produced research supporting the central influence of cognitive processes in the mediation of physiological stress reactions. He notes that most physically noxious agents used in previous stress research also produce substantial psychological malaise. When he used experimental treatments which minimized the psychological impact of the stressors, the endocrine system activation normally associated with a broad variety of physical stressors did not occur in all instances. Mason suggests that the primary mediator underlying physiological stress reactions is psychological responses to stress. Support for the occurrence of this process in humans comes from observations of patients dying from diseases or injury (Symington, Currie, Curran, and Davidson, 1955).

They found that patients who remained unconscious during the fatal period did not show any adrenal cortical changes, while patients who were conscious did display these responses. In line with this view, Lazarus (1966, 1975) suggests that the quality and intensity of emotional responses with their concomitant physiological component depend heavily upon cognitive appraisals. He emphasizes the role of various psychological coping processes (how the individual cognitively deals with a stressful situation) in the overall cognitive appraisal.

A model proposed by Gellhorn and Kiely (1972) offers a neurophysiological basis for the connection between cognitive and somatic processes. They first distinguish between ergotrophic and trophotropic systems. Stimulation of the ergotrophic center produces sympathetic discharge, increased striate muscle tension, and cortical excitation evidenced by EEG desynchronization, while stimulation of the trophotropic center produces parasympathetic discharge, reduction of tension in striate muscle groups, and reduced cortical excitation. The authors propose that alterations in the balance between these two systems may be accomplished either by input into the reticular formation and hypothalamus (somatic influences).

While the above studies provide support for the notion of an intimate link between cognitive and physiological aspects of stress responses, a recent theoretical stance taken by Davidson and Schwartz (1976) suggests that while simultaneous activation of both cognitive and somatic systems occurs frequently, the two processes may be somewhat independent of each other. Citing two studies (Smith, Brown, Tolman, and Goodman, 1947; Campbell, Sanderson, and Laverty, 1964), where human subjects given curare type drugs simultaneously experienced cognitive anxiety states, they conclude that the two processes are not casually linked.

Overall, the above studies involving cognitive influences, indicate that cognitive and physiological processes are intimately related in the maintenance of stress reactions, but the relationship between the two factors is not fixed. In fact, under certain conditions, there is evidence that the two can vary independently.

Implications for the Treatment of Stress Disorders

The foregoing studies suggest two important general implications for the treatment of stress related disorders. First, since individuals displaying stress reactions often tend to exhibit a pattern of response stereotypy in one physiological system, any treatment approach should identify the individual's most reactive system and match the treatment modality to this system. Second, the importance of cognitive influences in the maintenance of stress reactions should be considered when designing any treatment procedure. Any approach should not only consider cognitive aspects which affect the client's perception of stressful situations, but also the concepts that the client has about the treatment process itself (Meichenbaum, 1976).

Both of these issues have been increasingly emphasized in treatment approaches utilizing biofeedback. Biofeedback can now be provided for many physiological processes. This allows accurate matching of the treatment modality to the physiological system in which the individual demonstrates response stereotypy. The important role of cognitive influences in biofeedback applications has been recently discussed by both Lazarus (1975) and Meichenbaum (1976). Davidson and Schwartz (1976) present a theory which integrates both physiological and cognitive considerations. Their multiprocess theory focuses on the need to consider the total pattern of an individual's anxiety or stress reaction, evaluating both cognitive and somatic components when designing a treatment approach.

Unfortunately, research in this area has typically confounded the impact of cognitive effects with the effects of physiological feedback. There are four studies in this area (Reinking and Kohl, 1975; Haynes, Mosely and McGowen, 1975; Hutchins and Reinking, 1976; and Coursey, 1975) which do not severely confound these two effects. Taken together, these studies suggest that EMG feedback is necessary to achieve significant reductions in EMG levels, while only one condition using relaxation only produced a significant EMG reduction. This same condition, a passive relaxation technique, was ineffective in another study. These studies indicate the importance of EMG feedback, but they do not differentiate between EMG feedback and EMG feedback plus relaxation treatments. The two studies comparing these conditions (Reinking and Kohl, 1975; Hutchins and Reinking, 1976) found both conditions to be effective in reducing EMG levels. In contrast to the above findings, a study using response stereotypic subjects (Zigrang, 1977), found EMG feedback alone ineffective in reducing EMG levels. There is a need to differentiate the effects of these two treatments conditions, and to assess the impact of these two treatments on both response stereotypic and non-stereotypic subjects.

The Present Study

The present study will examine the effects of instructional set on two subject populations; with one group displaying response stereotypy and the other group displaying no such stereotypy. Specifically, it will investigate the interaction of the two treatment modalities with two subject populations. Subjects will be divided into a high muscular reactivity group and a group with average muscular reactivity as determined by the Fenz-Epstein Modified Anxiety Scale. This scale will provide a differentiation between subjects who show response stereotypy in in the striate muscular system and subjects who show no such stereotypy. The treatment modality used in this study will be EMG biofeedback to match the response stereotypy of the subject.

Two training conditions will be used to explore the effect of cognitive influences on biofeedback learning. A previous study (Zigrang, 1977) has indicated the absence of learning effects when high muscle tension subjects are given EMG feedback. This study used a rather stark instructional set, with no information provided to facilitate relaxation. The present study will employ one condition where the instructions make no mention of relaxation and a second condition which will include suggestions for achieving a relaxed state. Both groups will receive eight twenty-one minute sessions of EMG biofeedback.

Physiological changes will be assessed by amount of EMG level reduction. Subjective changes will be assessed by pre-post differences obtained on the STAI state and triat anxiety scales. All training and data collection will be performed within a double blind design where both the subject and trainer are unaware of the specific nature of the treatment involved.

Hypothesis

It is hypothesized that high muscle tension subjects in the EMG feedback plus relaxation treatment will exhibit greater reduction of EMG levels across sessions than will the high muscle tension subjects in the EMG feedback only treatment.

The second hypothesis is that high muscle tension subjects in the EMG feedback plus relaxation treatment will exhibit greater pre-post differences on the STAI-trait scale than will the high muscle tension subjects in the EMG feedback only treatment.

The third hypothesis is that average muscle tension subjects will exhibit no significant differences in reduction of EMG levels across sessions when comparing treatment modalities.

The fourth hypothesis is that average muscle tension subjects will exhibit no significant differences on pre-post comparisons using the STAI-trait scale.

The fifth hypothesis is that correlations between the STAI-trait scale and initial EMG baselines will differ significantly when the high muscle tension and average muscle tension groups are compared. The high muscle tension group is expected to exhibit a significantly larger positive correlation.

CHAPTER II

METHOD

Subjects

Thirty-two undergraduate females will be selected from undergraduate psychology classes on the basis of their scores on the muscle tension subscale of the Fenz-Epstein Modified Anxiety Scale. The scale was given to 335 female undergraduates. The 16 students who obtain the highest scores on the muscle tension subscale will be used as subjects (high muscle tension group). The 16 students who score closest to the median of the larger group of 335 students will be used as subjects (average muscle tension group).

Instruments

All subjects will be given the Fenz-Epstein Modified Anxiety Scale (Fenz and Epstein, 1965). This instrument consists of three subscales, two of which will be used in this study. The first subscale, which refers to symptoms of autonomic arousal, will not be used. The second subscale refers to symptoms of striated muscle tension, and includes items referring to tremor, motor incoordination, backache, rapid breathing, pressure headaches, and skin sensitivity. The third subscale, referring to subjective states of fear and insecurity, includes items concerned with inability to concentrate or relax, the tendency to worry excessively, unexplained feelings of fear and panic, fitful sleep, compulsive mannersims, and stated feelings of insecurity.

The scale has 53 items. Scores on each test item range from one to five, with one corresponding to a response of "never", and five corresponding to a response of "nearly always". A subject's score on each subscale is obtained by summing the scores on all items contained in that subscale and then dividing by the number of items. A subscale score, then, represents the mean response to all items on that subscale.

This instrument was given to 52 female and 46 male undergraduates (Fenz and Epstein, 1965). Odd-even reliability coefficients were computed independently for the three scales, and corrected for attenuation. A reliability coefficient of .83 was obtained for the autonomic arousal scale, while coefficients of .84 and .85 were obtained for the striated muscle tension and feelings of anxiety scales, respectively.

Two further studies suggest that this instrument identifies specific patterns of response stereotypy. Brandt and Fenz (1971) found consistent, but not significant, differences between high autonomic and high muscle tension groups on measures of skin resistance, basal conductance, heart rate, eyeblinks, and EMG levels when the two groups were exposed to three levels of stress. Howarth and Fenz (1971), employed a design similar to that used by Brandt and Fenz with neurotic subjects. Results showed consistent but non-significant differences between groups for heart rate and electrodermal measures. Consistent and significant differences between groups were found for EMG measures.

A second instrument, the State-Trait Anxiety Inventory (STAI) (Spielburger, Gorsuch, and Luschene, 1970), will be given to subjects both before and after biofeedback training. The STAI consists of two scales. The A-Trait scale contains items concerned with how the subject generally feels, while the A-State scale contains items concerned with how the subject feels "right now". Items on the A-Trait scale were chosen on the basis of comparisons with other measures of trait anxiety, such as the Taylor MAS (1953). Items on this scale refer to feelings of fatigue, lack of self-confidence, excessive worry, difficulty in making decisions, and feelings of being overcome by life's problems. The A-State scale contains items intended to evaluate feelings of tension, nervousness, worry, and apprehension.

Each scale has 20 items. Scores on each item range from one to four, with one corresponding to a response of "not at all" and four corresponding to a response of "very much so". The overall score for each scale is obtained by summing the responses to the individual items (for some items referring to positive feelings, eg., I feel calm, the scoring is reversed).

For the A-Trait scale various studies have produced internal reliability coefficients ranging from .86 to .92. Correlations between the A-Trait scale and either the IPAT Anxiety Scale or the Taylor Manifest Anxiety Scale, using various groups of college students and psychiatric patients as subjects, range from .73 to .85.

Apparatus

EMG measures will be recorded from an Autogen 5100 digital integrator connected to an Autogen 1700 Feedback Myograph. Electrodes will be connected to both the frontalis and the forearm flexor of the dominant arm. Standard placements (Venables and Martin, 1967), with electrodes placed two inches from the center of the forehead and one inch above the eyebrows, will be used for the frontalis muscle. The ground electrode will be attached midway between the other electrodes. Another set of electrodes will be spaced two inches apart and attached to the skin above the forearm flexor. The ground electrode will be placed on the forearm at a point equidistant from the other two electrodes.

Subjects will receive auditory feedback of ongoing muscular tension level through headphones connected to the Autogen 1700 unit. The feedback will be presented in the form of clicks which will be logarithmically proportional to the averaged EMG activity of the frontalis and forearm flexor muscles.

GSR responses will be recorded from an Autogen 3400 Feedback Dermograph. Standard electrodes, each having an area of one square centimeter, will be attached to the first three fingers of the don-dominant hand. The ground electrode will be connected to the index finger.

Procedure

Phase I

In this phase potential subjects were asked in their undergraduate psychology classes to fill out the Fenz-Epstein Modified Anxiety Scale. This scale was given to 335 female students. The 16 subjects reporting the highest scores on the striate muscle tension subscale will be chosen for the high muscle tension group. The 16 subjects scoring closest to the median on this same subscale will be chosen for the normal muscle tension group. After these 32 subjects have been selected, they will be required to fill out the State-Triat Anxiety Inventory prior to the first training session.

Phase II

In this phase eight high muscle tension subjects and eight average muscle tension subjects were placed in each of two training conditions. This procedure resulted in four treatment groups. Eight high muscle tension subjects and eight average muscle tension subjects received one treatment condition, while another eight high muscle tension subjects and another eight average muscle tension subjects received the second treatment condition. All conditions consisted of eight one-half hour sessions. In both conditions subjects were first seated in a comfortable chair and then had the EMG and GSR electrodes attached. Subjects were then instructed to sit quietly with both arms and legs uncrossed for three minutes. During this period baseline data was recorded. EMG levels (in microvolts) were recorded for the frontalis and forearm flexor muscles individually and in combination. GSR baselines (in ohms resistance) were also recorded. After the baseline period, headphones were placed on the subject's head and tape recorded instructions appropriate to the condition was played.

In the EMG feedback only condition the following instructions were played:

> This is an experiment on the effects of biofeedback upon an individual's physiological pattern of responses. Through the earphones, you will hear a series of clicks. As you decrease the number of clicks, you will be gaining control over your particular physiological pattern. These machines are quite sensitive and often record, not only your physiological pattern, but also movement artifacts. To control for the artifacts, we have placed electronic filters on the machines which screen out movements. However, occasionally the bodily movements will override the filters. At this time, you will hear an increase in the clicks. Therefore, try to remain as still as possible during the session. The session will last approximately 21 minutes. Any questions?

Input to the headphones was then switched from the tape recorder to the

Autogen 1700 Feedback Myograph. Subjects received six two-minute periods of feedback, interspersed with one minute rest intervals. During the rest periods, no audible sound was heard over the headphones. At the conclusion of the session subjects were asked to write down any strategies they found helpful during the training session.

In the EMG feedback plus relaxation instructions the following instructions were presented through the headphones:

> This is an experiment on the effects of biofeedback upon an individual's physiological pattern of responses. Through the earphones, you will hear a series of clicks. As you decrease the number of clicks, you will be gaining control over your particular physiological pattern. Let yourself begin to feel quite relaxed. We have found that the following procedures generally produce the most relaxation. Close your eyes. Try not to blink, swallow or move your face but let it feel heavy and sagging. Breath deeply and rhythmically. Try to settle into a daydreaming type of state. Let relaxing images come into your mind. These machines are quite sensitive and often record, not only your physiological pattern, but also movement artifacts. To control for the artifacts, we have placed electronic filters on the machines which screen movements. However, occasionally the bodily movements will override the filters. At this time you will hear an increase in the clicks. Therefore, try to remain as still as possible during the session. The session will last approximately 21 minutes. Any questions?

Following these instructions the input to the headphones was switched to the Autogen 1700. Subjects received feedback on a schedule identical to that used in the first condition. With the exception of the differing instructions, the two conditions were identical in all respects.

All training and data collection were performed within a double blind design where both the subject and experimenter are unaware of the treatment received. Specifically, experimenters had no knowledge of either subject's classification (high vs. average muscle tension group) or which set of instructions has presented to the subject.

Subjects were also informed that the experimenter was blind to some aspects of the experiment, and were asked not to question the experimenter. This was done to avoid the possibility of a subject's question cueing the experimenter to the treatment being received.

The subject's Fenz-Epstein forms were numerically coded, so that the experimenter did not have access to the subject's name when scoring the forms. After scoring, lists of high and average muscle tension subjects were prepared, using the coded numbers only. These two lists of numbers were then given to an individual not serving as an experimenter, who used the initial codes to determine the subjects' names for the high and average muscle tension lists. Half of each list was randomly assigned to one instructional condition, while the other half was assigned to the remaining instructional condition. Instructional conditional was represented by two letter codes, either BC or CD. The above lists were combined into one final code list, which consisted only of the subject's name paired with a two letter code. This final list was the only information the active experimenters had access to.

The experimenter utilized identical procedures for all subjects. First, electrodes were attached to the subject and baseline readings were taken. The two sets of instructions were on separate tape cassettes, and were appropriately coded either BC or CD. The experimenter selected the cassette matching the subject's code and placed it in the tape recorder. Audio output from the tape recorder and the Autogen 1700 were routed to a switch box which could feed either source into the subject's headphones. The switch was put in the tape recorder position and the tape recorder was started. After two minutes and 15 seconds, which allowed time for complete playback of the pre-recorded instructions, the switch was moved to the Autogen 1700 position, allowing the subject to receive the EMG biofeedback. Training and data collection procedures for the remainder of the session were identical for all subjects.

Four physiological measures were monitered throughout the training sessions. Each of the four measures were taken once during each of six three-minute trials. During the first two minutes of the trial the Autogen 5100 Digital Integrator was used to produce a reading which reflects the average amplitude of the EMG level in microvolts. The EMG measure was taken from an input which combines the frontalis and forearm flexor EMG signals, so that the measure reflects the average over a two-minute period of the combined EMG levels of the two muscles. During the third minute of each trial, three other measures were taken. Average EMG level in microvolts over a 15 second period from the frontalis muscle only was taken. Average EMG level in microvolts over a 15 second period from the forearm flexor muscle only was also taken. Finally, a GSR measure (in ohms resistance) was taken, using an Autogen 3400 feedback demograph.

Following the completion of the eighth session all subjects were again required to fill out the State-Trait Anxiety Inventory. At a subsequent meeting subjects were debriefed concerning the nature of the experiment, and given information on their own performance on the biofeedback task, if desired.

Design

Independent Variables

The independent variable used in this study was instructional set. Specifically one-half of the subjects received instructions making no mention of relaxation or reduction of muscle tension, while the other half-received instructions emphasizing the role of relaxation in the biofeedback process.

The classification variable used in this study was individual differences in physiological reactivity. One-half the subjects used were those obtaining the highest muscle tension scores. The other group of subjects were those obtaining scores closest to the median of a group of 335 students initially given the Fenz-Epstein Modified Anxiety Scale.

There were two independent within subjects variables used in this study: sessions (eight); and trials (seven).

Dependent Variables

The dependent measures used in this study were EMG level of combined frontalis and forearm flexor muscles, EMG level of frontalis muscle only, EMG level of forearm extensor only (all EMG measures are in microvolts), GSR level in ohms resistance, pre-post differences on scores from the STAI A-Trait scale, and finally, pre-post differences on the STAI A-State scale.

CHAPTER III

RESULTS

Introduction

Results will be presented in six sections. The first section will examine the classification variable taken from the Fenz-Epstein Modified Anxiety Scale. The second section will report results of the analysis of the combined EMG measure, while the third section examines data taken from the frontalis and forearm extensor muscles separately. The fourth section will examine results from the GSR measure. The fifth section reports correlations between the various physiological measures. The final section examines the STAI measures and their relationship to initial EMG baselines.

Classification Variable

The high muscle tension groups obtained an average score of 2.555 on the muscle tension subscale of the Fenz-Epstein, with a standard deviation of .367. The average muscle tension group obtained a mean of 1.630 on this subscale, with a standard deviation of .085. A one-way t-test was done to determine if these groups differed significantly on this dimension. Results of this test indicate a strongly significant difference between these groups, $t(30)=9.81$, $p<.0005$.

The two groups are thus differentiated adequately on the basis of the Fenz-Epstein Modified Anxiety scale.

Combined EMG Measure

A four way ANOVA using a split plot factorial design (Kirk, 1968) was performed on the combined EMG data (Table I). Groups (high vs. average muscle tension) and treatment modality (biofeedback and relaxation instruction vs. biofeedback only) were between-subjects variables, while sessions (8) and trials (7) were within-subjects variables.

There were no significant group or treatment main effects, however, the treatment main effect did approach significance $F(1,28)=3.51$, $p=.07$. Examination of the means for treatment modality indicates that the biofeedback only group had a higher average combined muscle tension level. However, this treatment effect was not significant in the ANACOVA, $F(1,27)=1.42$, p=N.S., indicating that this effect was due to baseline differences rather than treatment changes.

The main effect for sessions was significant, $F(7,196)=3.30$, $p=.0025$, indicating that, when all greoups were averaged together, learning effects were occurring across sessions. The main effect for trials was also significant, $F(6,168)=57.32$, $p=.001$. However, examination of the trial means shows that this effect is apparently due to the large drop between the baseline reading (Trial 1) and the first training trial (Trial 2). When the ANOVA was rerun, eliminating baselines, this impression was confirmed. The trials effect without baselines was not significant, $F(5,140)=1.73$, p=N.S.

TABLE I

ANALYSIS OF VARIANCE SUMMARY TABLE FOR EFFECTS OF PHYSIOLOGICAL RESPONSIVITY (HIGH VERSUS AVERAGE MUSCULAR) AND RELAXATION INSTRUCTIONS (WITH VERSUS WITHOUT) ON COMBINED FOREARM-FOREHEAD EMG

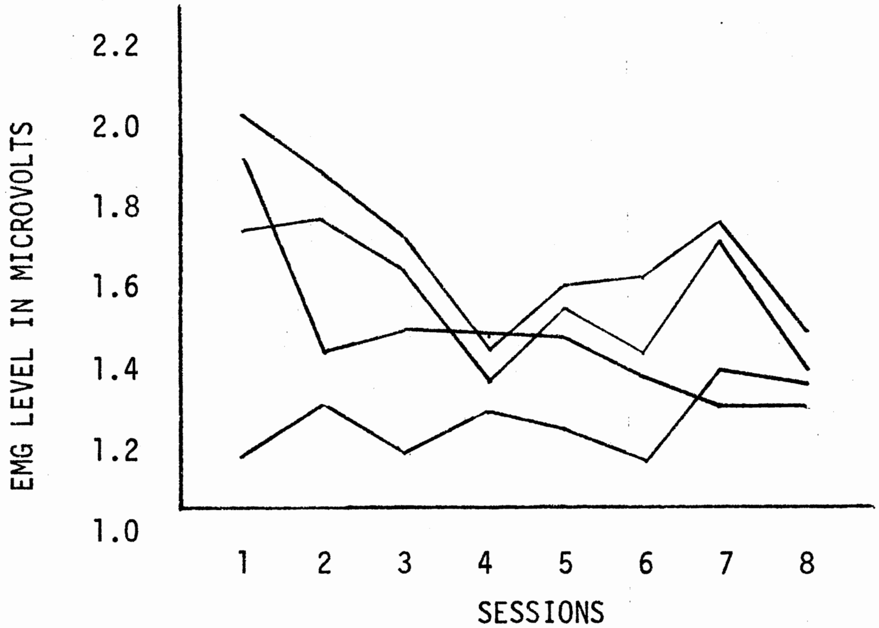
Source	SS	df	MS	F	P
Between Subjects (Ss)					
Group (G)	13.17	1	13.17	1.33	NS
Treatment (R)	34.74	1	34.74	3.51	.0716
G xR	.83	1	.83	.08	NS
Ss W. Grps-Trts	277.32	28	9.90		
Within Ss					
Sessions (S)	22.77	7	3.25	3.30	.0025
G x S	11.76	7	1.68	1.70	NS
R x S	8.71	7	1.24	1.26	NS
G x R S	4.21	7	.60	.61	NS
S x Ss W. Grps-Trts	193.21	196	.99		
Trials (T)	147.78	6	24.63	57.32	.0001
G x T	3.91	6	.65	1.52	NS
R x T	.35	6	.06	.14	NS
G x R x T	1.01	6	.17	.39	NS
T x Ss W. Grps-Trts	72.19	168	.43		
S x T	12.17	42	.28	1.26	NS
G x S x T	14.67	42	.35	1.52	.0188
R x S x T	12.21	42	.29	1.26	NS
G x R x S x T	15.63	42	.37	1.62	.008
S x T x Ss W. Grps-Trts	270.34	1176	.23		

The significant group by sessions by trials interaction (F(42,1176) =1.52, p=.019) is also apparently due to group differences in the drop between baseline and the initial training trial which varied across sessions. This effect was not significant in the ANOVA without baselines F(35,980)=1.08, p=N.S.

Finally, the group by treatment by session by trials interaction is significant, F(42,980)=1.62, p=.008. This does not appear to be an effect of the drop from baseline to trial 2, as this effect remains significant when baselines are removed from the analysis, F(35,980)-1.45, p=.0449. To further investigate this interaction, separate analyses were run on each of the four possible group and treatment combinations. In all analyses the trials effect was significant; however, when the analyses were rerun without baselines all trials effects were non-significant, indicating that the trials effect was again due to the drop between the baseline and the first training trial.

Sessions effects in these individual analyses did differentiate between the four groups. Sessions effects were significant for the average muscle tension group with relaxation instructions (F(7,392)= 5.25, p=.0001), and for the high muscle tension group without relaxation instructions (F(7,392)=2.60, p=.0124). The sessions effect for the high muscle tension group with relaxation instructions was not significant, F(7,392)=1.30, p=N.S. Session means for the four groups are presented in Figure 1.

Fisher's least significant difference test was used to determine significant differences between individual session means within each group. The difference between sessions one and four was



AX - Average MT Group without Relaxation Instructions
AR - Average MT Group with Relaxation Instructions
HX - High MT Group without Relaxation Instructions
HR - High MT Group with Relaxations Instructions

Figure 1. Sessions Means for the Combined EMG Measure

significant for both the average muscle tension group with biofeedback only (2.02-1.42=.60, $p<.05$) and the high muscle tension group with biofeedback only (1.71-1.31=.40, $p<.05$). The increase between session four and seven was also significant for both the average muscle tension group with biofeedback only (1.42-1.73=-.31, $p<.05$) and the high muscle tension group with biofeedback only (1.31-1.70=-.39, $p<.05$). The final drop between session seven and eight for these two groups is significant (1.70-1.35=.35, $p<.05$) for the high tension group, but does not quite reach significance for the average tension group (1.73-1.46=.27, p(.05)=.28). The two groups without relaxation instructions thus performed in similar manner, dropping to a low point in the middle of training, rebounding to a higher level as training progressed further, and then dropping again in the last session.

The two groups with relaxation instructions were less variable. The high muscle tension group with relaxation instructions (HR) maintained a low integrated EMG level across all eight sessions, with no significant differences between session means. Examination of the trials occurring in session one indicated that this group dropped to a low level within the first half of the session. For the average muscle group with relaxation the large drop occurring between session one and two was significant, (1.90-1.40=.50, $p<.05$). This group maintained a low integrated EMG level for the remaining six sessions, with no significant differences between these remaining session means.

For both high and average muscle tension groups, the relaxation instructions produced a more rapid drop in EMG levels which was maintained for the remainder of training. The two groups without relaxation instructions took longer to achieve lowered EMG levels, and were not able to maintain this low level throughout the remainder of training.

In order to further explore treatment effects, an analysis of covariance, using the same design as the above ANOVA, was also performed on the combined EMG measure. Multiple covariates were used, with the baseline of each session serving as the covariate for the remaining trials in that same session. Results of this analysis are presented in Table II. The covariates accounted for a significant amount of the variation $F(1,28)=27.29$, $p<.001$. There is a significant sessions effect $F(7,196)=2.58$, $p<.014$, indicating that the overall learning effects noted previously are still present after the removal of effects due to varying baselines. In addition, the group by treatment by sessions by trial interaction remains significant in this analysis, $F(35,980)=1.45$, $p=.045$. This indicates that the four way interaction was due to training as well as baseline changes. The groups main effect in this analysis approached significance, $F(1,27)=3.81$, $p=.061$. The groups by session interaction also approaches significance, $F(7,195)=1.89$, $p=.073$. Session means, which had been adjusted for varying baseline effects, were inspected to determine the source of these trends. Examination of these adjusted means indicates that the average muscle tension group had a slightly higher combined EMG level, while the interaction appears to be due to a high adjusted mean in session one for the average tension group which drops to a lower level.

In summary, learning effects were apparent in all groups. The group not showing learning effects, high muscle tension subjects with

TABLE II

ANALYSIS OF COVARIANCE SUMMARY TABLE FOR EFFECTS OF PHYSIOLOGICAL RESPONSIVITY AND RELAXATION INSTRUCTIONS ON COMBINED FOREARM-FOREHEAD EMG USING SESSION BASELINES AS COVARIATES

Source	SS	df	MS	F	P
Groups (G)	15.98	1	15.98	3.81	.061
Treatment (T)	5.96	1	5.96	1.42	NS
G x R	.26	1	.26	.06	NS
Covariates	114.55	1	114.55	27.29	.001
Error	113.35	27	4.20		
Sessions (S)	14.65	7	2.09	2.58	.014
S x G	10.75	7	1.54	1.89	.073
S x R	9.74	7	1.39	1.72	NS
S x G x R	9.85	7	1.41	1.73	NS
Error	158.14	195	.81		
Trials (T)	2.18	5	.44	1.73	NS
T x G	1.55	5	.31	1.24	NS
T x R	.29	5	.06	.23	NS
T x G x R	1.01	5	.20	.80	NS
Error	35.19	140	.25		
S x T	5.08	35	.15	1.26	NS
S x T x G	4.35	35	.12	1.08	NS
S x T x R	5.38	35	.15	1.33	NS
S x T x G x R	5.86	35	.16	1.45	.045
Error	113.03	980	.11		

relaxation instructions, dropped to what may be a minimal value within the first session. The relaxation instructions resulted in subjects reaching lower EMG levels more rapidly and remaining at those low levels. In contrast, the absence of relaxation instructions produced a slower and less consistent EMG drop.

Frontalis and Forearm Flexor EMG Data

The data from each of these individual muscle groups were subjected to three analyses. A four way ANOVA was employed, using the same design as in the previous section. The first analysis was done with baselines included in the data, while the second analysis omitted the baselines. The third analysis was an analysis of covariance (ANACOVA) which used multiple covariates. The baseline for a given session was used as the covariate for only that session, so that the training trials were adjusted for baselines on a session by session basis.

Using the forearm flexor data, all sources in the ANOVA using baselines were non-significant, with the exception of the trials variable, $F(6,168)=28.01$, $p=0001$. Examination of the data suggests that this effect was due to the drop between the baseline and the initial training trial. This was confirmed when the ANOVA was done without baselines, resulting in a non-significant trials effect, $F(5,140)=1.36$, p=N.S.

The covariates effect in the ANACOVA was significant, $F(1,27)= 6.89$, $p=.014$, indicating that baseline differences were highly predictive of training levels for the forearm extensor data. No other sources in the ANACOVA were significant. However, the treatment by sessions by trials interaction did approach significance, F(35,980)=1.42, p=.056. Examination of the data indicates that the two treatment groups were highly variable on trials within each session, and that no consistent trends were apparent.

The initial ANOVA on the frontalis data resulted in a significant groups main effect (F(1,28)=4.66, p=.0396), a significant sessions effect (F(7,196)=4.61, p=.0001), and a significant trials effect (F(6,168)=12.14, p=.001). Examination of the means indicates that the average muscle tension group was higher than the high muscle tension group (2.06 vs. 1.61 average integral microvolts). The significant sessions effect indicates that across all treatment and group combinations the frontalis EMG sessions means were differing, and inspection of the data indicates that these levels were dropping as the sessions progressed. The significant trials effect was again due to the drop between baselines and the first training trial, as the trials effect was non-significant when baselines were eliminated from the analysis, F(5,140)=.51, p=N.S.

The ANACOVA on the frontalis data produced a significant effect for the covariates (F(1,27=16.59, p .001), a significant groups main effect (F(1,27)=4.86, p=.036) and a significant sessions effect (F(7,195)-3.13, p=.004). The significant effect for covariates indicates that frontalis baselines were highly predictive of subsequent frontalis levels within each session. The significant groups main effect is consistent with the initial ANOVA done on this data, and indicates that this effect is not due to baseline differences, but is due to differences in the training measures. The significant sessions effect is also consistent with the initial ANOVA, and indicates that this effect is not due to baseline differences.

Summarizing this section, it appears that baselines are highly predictive of training levels achieved for both frontalis and forearm flexor data. In addition, the significant trials effect found for both variables is due to the drop between baselines and the first training trial. The treatment by session by trials interaction found for the forearm extensor data that approached significance does not appear to be due to any consistent trend, but rather to differences that appear on some trials in an inconsistent manner. The frontalis data produced a group effect where the average muscle tension group had a higher average frontalis EMG level than the high muscle tension group; this effect was due to training and not baseline differences. Finally, a sessions effect resulting from lowered frontalis levels as training progressed was found.

GSR Data

Due to equipment failure GSR data was only obtained for the first six sessions, and only five subjects per cell were available for analysis. A four way ANOVA using a split-plot factorial design was performed on the data. Groups (2) and treatment modality (2) were between-subject variables, while sessions (6) and trials (7) were within-subjects variables.

The sessions effect was significant, $F(5,80)=5.51$, $p=.0002$. Examination of the session means reveals that the greatest difference occurs between sessions one and two. Post hoc analysis confirms that this drop is significant, and that differences between means for sessions two through six are non-significant. This data suggests that subjects are becoming more relaxed across sessions, as the higher GSR levels in later sessions indicate a more relaxed state.

The trials effect was also significant, $F(6,96)=27.10$, $p=.0001$. Post hoc analysis indicates that the difference between trial one and trial two is significant, while differences between following means are non-significant. It appears that the above pattern is also occurring across trials.

The session by trials interaction was significant, $F(30,480)=1.68$, $p=.0146$. Since this interaction did not differentiate between the classification or treatment variable it was not investigated further. In summary, analysis of the GSR data indicates rapid drops in the measure, followed by little change, with this effect occurring across both session and trials. GSR measures did not differentiate between group or treatment modalities. While this data may indicate a habituation effect, data presented in the following section would suggest that the EMG training is affecting this measure.

Correlations Between Physiological Measures

A four by four matrix of Pearson product moment correlations was calculated using the combined EMG, forearm flexor EMG, frontalis EMG and GSR measures (Table III. Correlations between the measures were calculated for individual subjects across both baselines and training trials. These individual correlations were then squared, averaged together, and then the square root of this average was taken. All correlations were transformed using Fisher's r to z transformation, and were then tested for significance using a z test (Hays, 1973).

TABLE III

CORRELATIONS BETWEEN COMBINED EMG (EMGC), FRONTALIS EMG (EMGF), FOREARM FLEXOR EMG (EMGA), AND GSR

	EMGC	EMGA	EMGF	GSR
EMGC		.566**	.550*	-.480*
EMGA			.306	-.330
EMGF				-.318
GSR				

**p < .01
*p < .05

The combined EMG measure correlates significantly with the three other physiological measures. The combined EMG correlated significantly with the forearm extensor EMG, $r(20)=.566$, $p<.01$. It also correlated significantly with frontalis EMG, $r(20)=.550$, p .05 and GSR, $r(20)= -.480$, $p<.05$. The combined EMG variable, which was the measure on which subjects received feedback, was significantly able to predict the other physiological measures.

The above significant correlations between the combined EMG and GSR measures would not support the possible habituation effect mentioned in the previous section. This conclusion is further supported by correlations between these two measures calculated on session and trial means. The correlation between these measures across session means was significant, $r=-.77$, $p=.025$. It was also significant across trial means, $r=-.94$, $p=.001$. While this data cannot be used to indicate a causal relationship, it does not support the conclusion that a habituation effect was occurring in the GSR data.

None of the remaining three correlations between frontalis EMG, forearm flexor EMG, and GSR were significant. Overall, this data would suggest the training measure is varying fairly closely with the other variables, while the interrelationship among the other variables is substantially weaker.

STAI State and Trait Measures

Both the STAI-state and STAI-trait measures were analyzed using a two (groups) x two (treatments) x two (pre-post) analysis of variance. All sources in the STAI-trait ANOVA were non-significant. The only significant source of variation in the STAI-state analysis was pre-post difference, $F(1,28)=16.29$, $p=.004$. The pre-test mean was 42.94, while the post-test mean was 34.09. This effect may be partially due to a regression to the mean phenomena, as the mean on this test has been previously reported as 35.12 for female undergraduates (S, G & L). However, the magnitude of the effect, and the fact that the post-test dropped below the previously reported mean, would suggest that treatment effects were also present.

It was initially hypothesized that the correlations between EMG level and STAI-trait anxiety would differ significantly when the high muscle tension group and the low muscle tension group were compared. Correlations were calculated between the initial EMG baseline and the STAI-trait pre-test for both groups. This resulted in a correlation of .262 for the high muscle group and a correlation of -.547 for the average muscle tension group. The high group only produced a mild positive correlation, while the average group produced a strong negative relationship. Correlations were transformed into Z scores and tested for significant differences using a Z test. This difference proved to be significant, $z=2.25$, $p<.05$. The relationship between muscle tension and subjective anxiety is significantly different and reversed for these two groups. Before training, for the average muscle tension group, the higher the muscle tension, the lower the subjective anxiety. For the high muscle tension group, the higher the muscle tension the higher the anxiety.

CHAPTER IV

DISCUSSION

The major focus of this study was the effect of the interaction between relaxation instructions and individual differences in physiological reactivity upon the subject's ability to learn EMG biofeedback. A previous study (Zigrang, 1977) had indicated that a group displaying high physiological reactivity was unable to significantly reduce their EMG levels. Recent emphasis on cognitive influences in biofeedback training suggested that the addition of a cognitive component promoting relaxation would aid in the learning of EMG biofeedback. This study, then, attempted to assess the relative contribution of cognitive components and biofeedback components in learned reductions of EMG levels for both normal and stereotypic groups.

One major focus of this study was concerned with the link between cognitive and physiological aspects of stress responses. Both Lazarus and Mason assign an antecedent role to cognitive factors. Lazarus (1966) states that the quality and intensity of an individual's response depends upon the initial cognitive appraisal of the upcoming situation. Mason (1971), in research using animals, has noted the role of physiological discomfort in stress responses, and suggests that the initial mediator of effects previously thought to be purely physiologically reactions may be cognitive.

It would appear, then, that approaches utilizing only biofeedback are intervening at the second, or physiological, stage of stress related reaction. Approaches which intervene at both cognitive and physiological levels might be expected to be more effective when treating subjects exhibiting stress related, response stereotypic patterns. This study investigated the possibility that the addition of relaxation instructions would facillitate biofeedback training for these subjects.

Another focus of this study was the relative contribution of cognitive components and physiological feedback in learning to reduce EMG levels. Very few studies appearing in the literature attempt to separate these components, and most of the studies that are available in this area often confound these two components. For example, a study by Cox, Freudlich, and Meyer (1975) attempted to compare verbal relaxation instructions with EMG biofeedback. However, following these two treatments, both groups were instructed to use cue controlled breathing while using the covert self instructions, "relax". This cognitive component suggesting relaxation was present in both groups, making it impossible to assess the relative contribution of the two components. This error, which consists of adding some cognitive component suggesting relaxation to the biofeedback only treatment condition, is typical of the research in this area. The present study compared an EMG feedback only treatment to an EMG feedback plus relaxation instructions treatment. The EMG only treatment was "pure" in that no mention of relaxation or of any techniques to achieve reduced arousal was made.

It was initially hypothesized that high muscle tension subjects in the biofeedback plus relaxation instructions condition would exhibit more reduction of EMG levels as training progressed than high muscle tension subjects in the biofeedback only condition. Results indicate that the relaxation instructions condition produced a drop in EMG level within the first session which was maintained for the remainder of training. In contrast, the group without relaxation instructions took longer to achieve a lowered EMG level, and was not able to maintain this reduction throughout the remainder of training. While the relaxation instructions group did not achieve significantly lower EMG levels, this group did display the increased learning effects noted above. It appears that the relaxation instructions facilitate the high muscle tension group's ability to reduce EMG levels.

It was also hypothesized that average muscle tension subjects would exhibit no significant differences in reduction of EMG levels when comparing treatment modalities. It was thought that the relaxation instructions would have less impact on subjects who are not classified as response stereotypic. However, results indicate a pattern similar to that of the high muscle tension subjects. The group with relaxation instructions dropped rapidly to a low EMG level which remained low throughout the remainder of training, while the lack of relaxation instructions produced a slower, less consistent drop.

It appears that the influence of the relaxation instructions was effective regardless of the pattern of physiological reactivity that the person displayed. While the relaxation instructions affected both groups, the addition of these instructions did have more impact on the high muscle tension group occurred within the first session, while the drop for the average muscle tension group occurred between sessions one and two. Although this difference is not large, it does suggest that the addition of a cognitive element to biofeedback training is more important when using subjects demonstrating response stereotypic patterns.

The unexpected impact of the relaxation instructions on the average muscle tension group might be due to this group's being response stereotypic in some other physiological system. If this were the case, the study would actually be comparing two stereotypic groups, rather than an average and high group. To investigate the possibility that the average group was excessively reactive in the autonomic dimension, an average of the scores from the autonomic arousal sub-scale of the Fenz-Epstein scale was calculated. The obtained mean of 1.86 was compared to a previously published mean for female undergraduates (Fenz and Epstein, 1965), which was 1.96. The average muscle tension group is not excessively reactive in the autonomic dimension; therefore, the aforementioned possibility can be rejected.

The predicion of greater efficiency for relaxation instructions in the high muscle tension group was based on the premise that these individuals would be more likely to have anxiety arousing cognitions, which would be reduced by the relaxation instructions. While these instructions did impact the high muscle tension group earlier, it was not expected that the two groups would be so similar. A possible additional component in the relaxation instructions may account for the similarity between the two groups. Examination of the two instructional sets will show that the relaxation instructions include not only suggestions of relaxation, but also instructions which tend to focus the subject's attention on various bodily sensations and techniques for achieving reduced arousal. The relaxation instructions, then, contain both suggestions of relaxation and information which serves as an aid in learning biofeedback. It is suggested that this additional component of the instructions would increase both the average and high muscle tension subject's ability to achieve reduced EMG levels. To avoid confounding these two aspects of the instructions, it is recommended that future studies investigating cognitive effects in biofeedback training use instructions which focus as much as possible on suggestions of a relaxed cognitive state and which eliminate statements referring to specific techniques to reduce arousal.

The results of this study differ somewhat from a previous study, (Zigrang, 1977) employing response stereotypic groups. In that study the high muscle tension subjects did not achieve significant reductions in EMG levels. In the present study the high muscle tension subjects who were not given relaxation instructions, were able to reduce their EMG levels significantly, although this reduction was not consistently maintained. There are several methodological differences between these two studies which should qualify any comparison of results. The high muscle tension subject's selection in the earlier study was based on differences between the muscle tension symptoms scale and the autonomic arousal symptoms scale. In the present study, the high tension group was selected on the basis of the muscle tension scale only. Subjects were also given a different form of training, in that the present study provided feedback from both the frontalis and the forearm extensor, while only frontalis feedback was used in the earlier study. A third difference involved the use of a double blind paradigm in the present study. In the earlier experiment the experimenter was aware of the subjects Fenz-Epstein physiological reactivity score, while the experimenters in this study were blind to both the subject's reactivity score and the subject's treatment condition.

In addition to the above, the dependent measures used vary somewhat. The present study employed a measure which averaged data from the frontalis and forearm flexor muscles, while the previous study used data from the frontalis muscle only. However, it should be noted that the two measures are not tapping completely different sources, but rather one measure has an additional component. Given the similarity of these two measures, but noting the above mentioned differences in the two studies, results from comparable treatments will be examined. Another source of data in the present study, which was taken from the frontalis muscle only, will be compared to the earlier study. However, this measure was not taken while the subjects were receiving feedback, but was obtained during the intervals which were interspersed between the feedback periods.

The high muscle tension group without relaxation instructions in this study will be compared to the muscle tension group in the previous study. In addition to the subject selection differences noted above, there is a slight difference in instructional sets. The previous study included no relaxation instructions; however, the word "relax" did appear in the instructions. The comparable group in this study made no mention of relaxation.

Although the earlier study produced no significant results, there was a non-significant trend in the EMG data towards learned reductions. Given the above qualifications, it is interesting to note that the trend appearing in the earlier study is somewhat similar to the pattern of the current data for the comparible groups. In this study the subject's combined EMG levels fell for the first four sessions and then started increasing. In the previous study, which used only five sessions, this same pattern was evident. Results from the frontalis only EMG data in the present study roughly parallel this same pattern, in that a slow drop to the lowest level occurs which is then followed by an increase. However, for this data the increase in EMG level occurs at session six. In both studies, then, subjects who did not receive relaxation instructions tended toward reduction of EMG levels in early training sessions, but could not consistently maintain this reduction.

In the literature concerned with assessing the comparative effects of cognitive components and physiological feedback there are four studies which do not confound some type of relaxation training with the EMG feedback only condition. However, two of these studies (Reinking & Kohl, 1975; Haynes, Moseley, and McGowan, 1975) do mention the word "relax" in their EMG only conditions. The other two studies use the terms tension level, or muscle tension in their EMG only conditions (Hutchings and Reinking, 1976; Coursey, 1975). The Hutchings and Reinking study used subjects with tension headache problems, while the remaining three studies used normal subjects.

In all of these studies, conditions including EMG biofeedback always produced significant reductions in EMG level. This effect occured when EMG feedback alone was used, when it was combined with relaxation instructions, and in one study, when it was combined with a monetary reward. In only one study was there a treatment, i.e., passive relaxation, not including EMG biofeedback which produced a significant reduction in EMG level. However, this same treatment in another study, failed to produce significant EMG reductions. These studies seem to suggest that EMG biofeedback is a necessary element in EMG reduction. They do not indicate that relaxation instructions aid in achieving lowered EMG levels. Finally these studies suggest that relaxation instructions alone are not capable of producing consistent EMG reductions, regardless of the relaxation technique used.

In contrast to the above studies, the present study indicates that relaxation instructions do increase the effectiveness of EMG feedback. This discrepancy may possibly be due to differences in the definition of effective EMG learning. The earlier studies focused on the subjects ability to achieve the lowest possible EMG level. The present study did not find differences on this dimension, but rather found that with the addition of relaxation instructions a more rapid drop was maintained more consistently. These results would suggest that future studies in this area should employ designs which are sensitive to the speed and consistency with which EMG reductions are achieved.

Another critical difference between the present study and earlier research is the use of a double-blind methodology in this study. The results of the present study indicate that the addition of relaxation instructions produces rather subtle changes in EMG training results. In addition, the treatments used differ only in the wording of the instructions. Experimenter bias, which was not controlled in the earlier studies, could have easily confounded these subtle differences. The results of this study, which indicates effects of relaxation instructions not previously found in the literature, would suggest that the use of double-blind designs is desirable for the development of precise methodological studies in this area.

The ability of frontalis training to generalize to other muscle groups has been recently questioned (Alexander, 1975). To promote generalization of EMG biofeedback to other muscles in the body, this study used combined feedback from both the frontalis and the forearm flexor muscles. However, within each session, forearm flexor EMG fell rapidly to near tonic levels and then remained near this level for the rest of the session. Across sessions there were no learning effects for this muscle. Since data from this muscle was averaged with the frontalis, this would result in subjects receiving feedback which tended to indicate that the subject was doing well. This may have produced a placebo effect which aided learning. This effect might contribute to the significant EMG reductions achieved in the biofeedback only group. In an attempt to clarify the relationships between the frontalis and forearm muscles, data from the frontalis muscle alone was examined. The frontalis only data produced an overall significant sessions effect, with EMG levels becoming lower as training progressed. However, the training difference between the various groups, which were apparent in the combined data, did not appear in the frontalis only data. It would appear that the presence of the forearm data in the combined measure is somehow contributing to the effects found, but it is impossible to specify what this contribution is with the present design. Future studies in this area should note the problems referred to above, and consider these effects before using feedback from multiple muscle groups.

Another aspect of the generalization issue is concerned with the generalization of biofeedback training effects in one physiological system to other physiological systems. Correlations between combined EMG and GSR in this study give an indication of the magnitude of this effect. The high correlations between combined EMG and GSR obtained in this study would suggest that EMG training is affecting the autonomic system. If further research, using GSR as a dependent variable, were to indicate that this is the case, it could have important implications for biofeedback training. If a biofeedback modality could be found that generalized to some other physiological systems, it would then become less critical to determine the specific response stereotype of the individual.

The personality measures used in this study resulted only in a significant pre-post reduction in STAI scores, with no differences between groups or treatments. While a regression to the mean phenomena may account for some of this effect, as indicated in the results section, it may also be a product of the sequence in which the tests were administered. The pre-post test was given before the first session, while the post-test was given following the last session. Since this was a state measure, reflecting how the individual is currently feeling, this finding indicates that subjects were feeling less anxious following the last biofeedback session. Unfortunately, giving the pre and post tests in the manner noted above results in confounding of sessions effects with the pre-post effect of the last session. It is recommended that future studies using this design administer any psychological measures before and after each session to avoid this confounding effect.

Results also indicated a significant difference in the relationship between subjective anxiety as measured by the STAI-trait scale and initial EMG baselines for the two groups. As the high muscle tension groups anxiety increased, their muscle tension increased. In the average muscle tension group, as anxiety increased, muscle tension decreased. These findings are consistent with the initial conceptualization that the high muscle tension individuals are manifesting anxiety somatically through increased muscle tension, while the average group is manifesting anxiety through some other channel.

In conclusion, results of this study indicate that the addition of a cognitive component (relaxation instructions) to biofeedback training enhances the subject's ability to achieve EMG reductions. This effect was not manifested in subjects obtaining substantially lower EMG levels, but in a more rapid drop to low levels which was then maintained. The addition of relaxation instructions, then, provides for greater efficiency and consistency in EMG biofeedback training. However, it is not clear whether relaxation instructions have greater impact on response sterotypic individuals. While the data suggest that this may be occurring, results in this area must be considered inconclusive at this time. Overall, biofeedback appears to be a useful adjunct to treatment of stress related disorders, but this study indicates that the use of biofeedback procedures does not reduce the need to examine and treat the individual's psychological reactions to stress.

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APPENDIX

APPENDIX A

A LITERATURE REVIEW OF STUDIES INVESTIGATING THE COMBINED AND SEPARATE EFFECTS OF VERBAL RELAXATION TECHNIQUES AND VARIOUS BIOFEEDBACK MODALITIES

A LITERATURE REVIEW OF STUDIES INVESTIGATING THE COMBINED AND SEPARATE EFFECTS OF VERBAL RELAXATION TECHNIQUES AND VARIOUS BIOFEEDBACK MODALITIES

I. The Combined Use of Biofeedback and Verbal Relaxation Techniques

For the past forty years Jacobson (1938, 1970) has espoused deep muscle relaxation techniques as a treatment for various anxiety and stress related disorders which he claimed had a common basis in chronic, high levels of skeletal muscle tension. His approach, which consists of tensing and relaxing various muscle masses of the body in order to increase the patient's ability to perceive and reduce his muscular tension level, is now used commonly in clinical settings.

Another treatment approach, autogenic training, also puts an emphasis on deep muscle relaxation. This technique, developed by Schultz and Luthe (1959, Luthe, 1963) uses hypnotic type suggestions which promote a calm, relaxed state in the patient. Both progressive relaxation and autogenic training rely heavily upon subjective reports of reduced muscle tension from the patient.

The advent of biofeedback systems allowed, for the first time, the immediate, objective feedback to the patient of information concerning his physiological states. The patient practicing a relaxation technique could now use this information as an accurate measure of the success or failure of his efforts. The possible advantages of using combined biofeedback and relaxation procedures became apparent, and began to be investigated in the early seventies.

Studies combining biofeedback and relaxation modalities can be categorized into three areas: 1) the treatment of anxiety and phobias, 2) the treatment of headaches, and 3) various case studies investigating several different applications.

Raskin, Johnson, and Rondestvedt (1973) treated ten chronically anxious subjects with a combination of EMG frontalis feedback, general relaxation instructions, and home practice. Subjects were trained in one hour sessions for periods of time ranging from two weeks to three months until a specific low criterion EMG level was reached. This training resulted in improvement of anxiety level in four of the ten patients, as measured by subjective reports and therapist evaluations.

Three studies combined biofeedback with systematic desensitization. Reeves and Mealiea (1975) used EMG biofeedback assisted cue-controlled relaxation to treat three adult males with flight phobias. During EMG feedback subjects paired a self-generated cue word with low EMG levels. This was followed by a standard systematic desensitization procedure. All three subjects experienced an alleviation of symptoms which was maintained at a one year follow-up. Wickramsekera (1972), in a single case study, reported the successful use of combined systematic desensitization, verbal relaxation instructions, and EMG feedback in the treatment of a forty-two year old female phobic patient. Javel and Denholtz (1975), in another single case study, combined GSR feedback and systematic desensitization in the treatment of a twenty-six year old female with a spider phobia. The authors report that this case suggests that the procedure used is effective.

Four studies have investigated the treatment of headaches. Budzynski, Stoyva, and Adler (1970) reported on five case studies employing EMG feedback, home relaxation practice, and daily recording of headache activity. Training time ranged from four weeks to two months. Data from the five subjects was averaged and indicated significant differences between baseline and combined week three and four averages for both headache activity and EMG levels. Wickramasekera (1972) used ten female subjects who had been diagnosed as having chronic tension headaches. His design employed a three week baseline period followed by three weeks of non-contingent feedback, and finally twelve weeks of contingent EMG feedback relaxation training. Results indicated no significant difference in frequency and intensity of headache activity between the baseline and non-contingent period, and a significant decrease in these measures during the contingent feedback period. Sargent, Green, and Walters (1973) used a handwarming technique which included autogenic training and hand to temperature feedback in the treatment of twenty-eight migraine and tension headache sufferers. Three raters evaluating symptomatic improvement agreed in rating nineteen cases. Of these nineteen cases, fifteen were migraine sufferers, twelve of which were rated as improved. Two of the remaining four tension headache sufferers were rated as improved. The authors suggest that this treatment is useful for migraine headaches, but that tension headaches may require a different approach. Budzynski, Stoyva, Adler, and Mullaney (1973) compared EMG feedback and home relaxation practice to non-contingent feedback and no training control groups. All eighteen subjects, suffering from tension headaches, were trained for

for sixteen half-hour sessions. Results showed a significant reduction in headache activity for the treatment group, and in addition showed a significant difference in EMG levels between the treatment and non-contingent groups.

Finally, four case studies indicate the broad range of current application of combined biofeedback and relaxation techniques. Johnson and Meyer (1974) report the use of a phased sequence of relaxation training, EMG feedback, and alpha and theta feedback to control epileptic seizures in an individual. After a one year period the subject had obtained a 46% reduction in monthly seizures. Stephenson (1976) successfully treated two cases of Raynaud's disease using a combination of deep muscle relaxation training, EMG feedback, autogenic training, finger temperature feedback, and in one of the cases, supportive psychotherapy. In a follow-up at two months for one subject and sixteen months for the other subject all symptoms were in complete remission. In another study, Stephenson (1976) reports the successful treatment of an individual with a two year history of blepharospasm and tic. The combined deep muscle relaxation and EMG feedback produced a remission of symptoms which was maintained at a one year follow-up.

In summary, the studies in this section suggest that combined biofeedback-relaxation approaches are effective in most of the applications investigated to date. All three studies involving phobic patients reported successful results. All four of the studies involving headache sufferers reported symptomatic improvement, with the indication that hand temperature feedback may be more effective for the treatment of migraine headaches. Three more case studies suggest the efficacy of combined modalities in the treatment of epileptic seizures, Raynaud's disease, duodenal ulcers, and belpharospasm. However, in one study investigating the treatment of chronic anxiety, only four of ten subjects gained symptomatic improvement.

II. Studies Attempting to Separate the Effects of Biofeedback and Verbal Relaxation Techniques

Another line of investigation has focused on the need to assess the comparative effectiveness of various biofeedback modalities as opposed to verbal relaxation techniques. These studies can be categorized into four groups: 1) assorted clinical studies, 2) studies using anxious subjects, 3) studies using subjects with headache problems and 4) research using normal subjects.

Five studies have investigated the differences between biofeedback and relaxation approaches in the treatment of varied clinical problems. Gregg (1976) compared two groups of 100 pregnant females, with one group receiving childbirth education and relaxation training, while the other group received in addition biofeedback training. The biofeedback group reported shortened labor times and reduced medication usage. Anderson (1976), in a study done with 36 male hyperkinetic children, compared four treatment groups consisteing of a no treatment control, verbal relaxation training, EMG feedback, and combined EMG feedback-relaxation training. Results indicate a significant between groups difference on measures of EMG level, but no significant differences were found on behavioral measures.

Coursey, Frankel, and Gaarder (1976) compared EMG feedback, frontalis feedback, autogenic training, and electrosleep therapy in the treatment of 22 chronic, primary sleep-onset insomniacs. Employing fairly stringent improvement criteria involving various measures of sleep latency, they found that three patients given EMG training and two patients given autogenic training improved. Probability for these success rates vs. the control condition equals .036 for the EMG group and .125 for the autogenic group (Fisher exact probability). Miller, Murphy, Miller, and Smouse (1976) compared the effectiveness of EMG feedback, progressive relaxation, and a self relaxation control, in the treatment of 21 patients with a history of dental stress reactions. Results showed significant decreases on pre-post measures of EMG level, rate anxiety and dental anxiety for both EMG and progressive relaxation groups.

Surwit and Shapiro (1976), using 24 borderline hypertensives as subjects, compared three treatment groups: feedback for heart rate and systolic blood pressure, integrated forearm and frontalis EMG feedback, or a relaxation procedure (similar to Benson's). Results indicate that the groups did not differ significantly, and that none of the treatments lowered blood pressure below the baseline levels.

Comparing verbal relaxation and biofeedback modalities in these five studies, four of the five suggest that the effectiveness of the two approaches is equal in the treatment of hyperkinesis, insomnia, dental stress reactions, and hypertension. In the study involving childbirth education, the methodology makes it impossible to directly compare the effects of biofeedback and relaxation procedures, although results indicate that a combined relaxation-feedback group is superior to a relaxation only group.

Of the four studies involving subjects with anxiety problems, three compared EMG feedback to some other treatment modality, while one study compared alpha EEG feedback to a relaxation treatment. Townsend, House, and Addario (1975) contrasted EMG feedback with a psychotherapy control group. Subjects were 30 psychiatric patients with chronic anxiety problems. In the ten biofeedback subjects who completed the training there were significant decreases in EMG level, mood disturbance, and trait anxiety. In a study employing 48 adult psychiatric patients with anxiety neurosis Canter, Kondo, and Knott (1975) found that both EMG feedback and modified progressive relaxation produced significant reductions in frontalis muscle tension. However, EMG feedback was found to produce larger reductions in muscle activity and anxiety symptoms for a greater number of subjects. The third EMG study used neurotically anxious female college students as subjects. With these subjects Siverson (1974) found no significant difference between a self relaxation control group and a EMG feedback group on measures of EMG level, pulse rate, and self reports of anxiety. Summarizing these three EMG studies, two using psychiatric populations support the efficacy of EMG feedback in the treatment of anxiety, while one study using college students does not support this conclusion.

Benjamens (1976) investigated the treatment of snake phobics using 50 female undergraduates assessed as being highly or moderately fearful of snakes. Two treatment groups, alpha feedback and progressive relaxation, were compared to a control group. Results showed that both treatments reduced fear more than the control group, and that the alpha feedback group reduced trait anxiety more than the other two groups.

Six studies involved the treatment of headaches. Using 10 subjects with headache symptoms, Ehrisman (1973) compared the effectiveness of alpha enhancement training to progressive relaxation training. Both treatments proved equally effective in reducing headache symptomology, in addition, no significant differences were found between groups on alpha amplitude or EMG amplitude.

Turin and Johnson (1976) put seven migraine headache sufferers into a finger warming biofeedback group, and three other subjects with the same symptomology into a finger cooling group to control for any placebo or expectation effects. In the first group headache activity was substantially reduced, while subjects in the control group remained at baseline level or increased on measures of headache activity. In another study employing finger temperature feedback, Graham (1974) used 30 migraine headache sufferers screened for hypnotic susceptibility. Three treatment groups were used: Hypnosis only, finger temperature feedback only, and combined hypnosisbiofeedback. All three groups were trained to a specific criteria (2^0 warming in 60 seconds), with the combined treatment group reaching this level fastest. Results show no significant differences in headache duration, frequency, or reduction of headache activity.

Using 21 college students with tension headache problems as subjects, Haynes, Griffen, Mooney, and Parise (1975) compared the effectiveness of EMG feedback, relaxation instructions, and a control group told to relax, but given no specific instructions. Results showed that both treatment groups produced significant decreases in headache frequence and overall headache activity, and that the two treatments did not differ significantly on these measures. In another study by Hutchins and Reinking (1975) EMG feedback was compared to Jacobson-Wolpe-autogenic relaxation training and to a group combining these two approaches.

Eighteen medically documented tension headache sufferers were used as subjects. All three groups were found to reduce EMG tension levels significantly. On measures of headache activity, the two groups using EMG feedback had an earlier impact, with both reducing activity approximately 66% from baseline levels. The relaxation only group decreased headache activity approximately 20% from baseline levels. The last EMG study in this group compared EMG feedback with progressive relaxation and a medication placebo group. Using 27 tension headache cases as subjects, Cox, Freudlich, and Meyer (1975) found significant differences between the biofeedback vs. placebo group and the relaxation vs. placebo group in reduction of EMG levels, but no difference between the biofeedback and progressive relaxation group.

In summarizing the research using subjects with headache problems, EMG feedback was found to be as effective as relaxation training in three studies, while one study indicates that alpha feedback was also as effective as verbal relaxation procedures. Another study found finger temperature feedback as effective as hypnosis in relieving symptoms, and a final study indicates the effectiveness of finger temperature alone. It appears that, in the treatment of headaches, biofeedback approaches are as effective as relaxation techniques, but are not necessarily superior to them.

In nine studies done with normal subjects, two compared heart rate feedback to relaxation techniques, two compared hand temperature feedback, and five compared EMG feedback to relaxation approaches. Barrick (1973), using 30 volunteer subjects, assessed the effectiveness of three treatment groups in reducing heart rate. One group used focused attention to increase passive awareness and control of heart rate. The second group employed deep muscle relaxation instructions, and the third group used heart rate biofeedback. Results indicate that focused attention and heart rate biofeedback are equally efficacious in reducing heart rates, and that both these groups produced significantly greater decreases than the relaxation group. Blankenstein (1973) exposed each of 100 high school students to one of ten one hour treatments. Various combinations of a cognitive mediator (relaxing imagery), a somatic mediator (slow deep breathing), and feedback of heart rate and respiration were compared to a progressive relaxation group, a group given general instructions to relax, and a no treatment control group. Treatment effectiveness was assessed during a rest period and during a period involving some psychological stress. Results show that the largest heart rate decreases were found in the general instruction and no training groups. None of the groups including feedback seemed to facilitate physiological control. However, with only one hour of training, it is questionable whether any decisive conclusions can be drawn from this study concerning the effectiveness of heart rate biofeedback.

In a study comparing autogenic instructions, autogenic instruction plus finger temperature feedback, and relaxation instructions among thirty normal subjects Carlton (1974) found no significant differences in finger temperature reductions between groups. Sheridan, Boehm, Ward, and Justensen (1976) in another study assessing the effect of finger temperature feedback, used 20 male and 20 female subjects. Their four treatment groups were: autogenic phrases plus biofeedback, autogenic phrases alone, biofeedback alone, and a control group. Results showed that only the autogenic phrases group produced warming above control levels.

Five studies using normal subjects assessed the effectiveness of EMG frtontalis feedback in contrast to other treatments. Strauss (1976), using 30 subjects, compared EMG feedback without any suggestive phraseology, suggestive phraseology alone, a placebo, and a control group (given instructions to relax all over as much as you can). Results indicate no significant effects across the five training sessions, and no significance between groups differences. However there was a significant difference (repeated measures analysis) within each training session for each group.

Reinking and Kohl (1975), using 50 undergraduates as subjects, assessed the effectiveness of five treatment groups on both EMG level reduction and self report measures of relaxation. The five treatment groups used were a classic Jocobson-Wolpe relaxation procedure, EMG feedback, combined EMG and Jacobson-Wolpe procedures, EMG feedback with a monetary reward, and a control group. There were twelve training periods. On subjective measures, all groups reported a subjective relaxation effect, regardless of the amount of EMG reduction achieved. A significant between groups difference was found on EMG measures, with post hoc analysis indicating that the three EMG groups differ significantly from the relaxation training group which in turn differs significantly from the control group.

Using 30 normal females, Delman and Johnson (1976) compared EMG feedback, progressive muscle relaxation, and a self relaxation control group on measures of respiration rate and EMG level. The authors found that progressive relaxation produced the greatest decrease in measures of respiration rate. On EMG measures, the control group remained at baseline levels, the feedback group dropped sharply, and the relaxation group actually produced an increase in EMG level.

In a study using only one training trial, Haynes, Mosely, and McGowan (1975), using 101 male and female undergraduate students, found that EMG feedback and passive relaxation (Wolpe) produced significant pre-post reductions in EMG levels while active relaxation (Jacobson), false feedback, and a no treatment control (told only to relax) did not produce any significant reduction in EMG levels.

In a final study using 30 normal male undergraduates, Coursey (1975) compared EMG feedback with a cognitive strategy group and with a tone only control group. The cognitive strategies group was presented with relaxation strategies that other subjects learning biofeedback had reported as being useful, but the group did not receive EMG feedback. Results indicate significant differences between the EMG group and the other two groups, and no significant differences between the non-feedback groups on a measure of EMG level.

In summarizing studies done with normal subjects, feedback for heart rate, hand temperature, and skeletal muscle tension (EMG) has been compared to relaxation techniques. The two studies comparing heart rate feedback produced contradictory results, however, the study which found heart rate feedback ineffective used only one training trial. This may easily have been too short a period for training effects to occur. The two studies investigating ability to control finger temperature also produced contradictory results, with on finding no difference between autogenic training and finger temperature feedback, while the other study found the use of autogenic phrases superior. More research into both heart rate and finger temperature feedback are are necessary before any definite conclusions can be drawn.

Of the five studies done with normals involving EMG feedback, four found EMG feedback more effective than active relaxation techniques at lowering EMG levels. One of these studies found a passive relaxation technique as effective as EMG feedback at lowering EMG levels. A fifth study comparing suggestive phraseology to EMG feedback found no significant differences between the treatments.

When comparing the effectiveness of biofeedback and relaxation techniques, it appears that they are equally effective methods for the treatment of hyperkinesis, insomnia, dental stress reactions, hypertension and headaches. Biofeedback was found to be superior in three of four studies involving the treatment of anxiety and phobias. Results of comparison using normal subjects are inconclusive for heart rate and finger temperature feedback, while four of five studies comparing EMG feedback to relaxation approaches found EMG feedback to be superior. However, one of these studies found a passive relaxation technique to be as effective as EMG biofeedback.

In summary, it appears that treatment approaches combining biofeedback and relaxation procedures are effective in treating a variety of clinical problems. Data from studies assessing the relative effectiveness of these two procedures suggest that the two are equally effective in most applications. However, biofeedback was superior in the treatment of anxiety and phobias, and EMG feedback was superior in the production of relaxation in normal subjects.

Conclusive comparisons across studies are difficult because of varying subject populations and varying methodologies. Specifically, there are not studies in the literature comparing relaxation techniques and biofeedback across both normal and clinical populations. A single study, exposing both normal subjects and subjects who may experience some difficulty in controlling their physiological responses to the same treatment conditions, would allow assessment of the degree of importance of relaxation instructions versus biofeedback procedures in the treatment of these differing populations.

APPENDIX B

LIST OF ITEMS ON THE FENZ-EPSTEIN MODIFIED ANXIETY SCALE

AUTONOMIC AROUSAL ITEMS

I am troubled by discomfort in the pit of my stomach.
I have pounding headaches in which I can feel a definite beat.
I am bothered by dizziness.
I notice my heart pounding.
I am afraid I am going to blush.
I feel chilly at temperatures that are comfortable for others.
I suddenly feel hot all over, without apparent cause.
My finger tips or other extremities become cold.
In the absence of physical action my heart beats wildly.
I am either too hot or too cold and cannot get comfortable at a constant room temperature setting.
My mouth feels dry.
I am bothered with blushing.
When embarrassed, I break out in a sweat which annoys me greatly.
I have stomach trouble.
I break out in a sweat, which is not the result of heat or physical exertion.
I am troubled with diarrhea.

MUSCLE TENSION ITEMS

I am troubled with backaches.
The muscles in my neck ache as if they were tied in knots.
The top of my head feels tender.
I have a hard time swallowing.
I have trouble with my hand shaking while I write.
I clench my teeth when anxious.
I am troubled by tension interfering with my speech.
I have trouble with muscles twitching and jumping.
My hands shake when I try to do something.
My skin becomes painfully sensitive.
I have pains in the back of my neck.
I am short of breath without knowing why.
I have sensations of burning, tingling, or crawling in certain parts of my body.
I have enduring headaches that last over several days.
My head feels tender to the point that it hurst when I comb my hair or put on a hat.
I have trouble getting my breath, for no special reason.
I grind my teeth in my sleep.
I have preasure headaches in which my head feels as if it were caught in a vise or as if there was a tight band around it.

FEELINGS OF INSECURITY ITEMS

My feelings are easily hurt.
(R) I am an easy going person.
I have a tendency to worry.
I am a nervous person.
I have frightening dreams.
I do not think I am as happy as others.
I have feelings of panic for no special reason.
(R) I am a relaxed person.
I am easily frightened.
(R) I go to sleep without thoughts or ideas bothering me.
I take things hard.
(R) I take things in stride.
Life is a strain for me.
I become upset when I have to wait.
My sleep is fitful and disturbed.
I feel that I am about to go to pieces.
I worry about little things.
I have periods of such restlessness that I cannot sit still.
I become irritable about little things.

APPENDIX C

THE FENZ-EPSTEIN MODIFIED ANXIETY SCALE

NAME: ______________________________ PHONE NUMBER: __________

INSTRUCTOR: ______________________________

THE FOLLOWING ARE SOME STATEMENTS ON FEELINGS, DAYDREAMS, ATTITUDES AND BEHAVIOR. READ EACH STATEMENT AND DECIDE HOW OFTEN IT APPLIES TO YOU. CIRCLE "1" IF THE STATEMENT NEVER APPLIES TO YOU; "5" IF YOU EXPERIENCE IT ALMOST ALL THE TIME; USE "2", "3" AND "4" FOR INBETWEEN RATINGS. BE HONEST BUT DO NOT SPEND TOO MUCH TIME OVER ANY ONE STATEMENT. AS A RULE, FIRST IMPRESSIONS ARE AS ACCURATE AS ANY.

	NEVER				ALWAYS
I am troubled by discomfort in the pit of my stomach	1	2	3	4	5
I am troubled with backaches.	1	2	3	4	5
My feelings are easily hurt.	1	2	3	4	5
I have pounding headaches in which I can feel a definite beat.	1	2	3	4	5
The muscles in my neck ache as if they were tied in knots.	1	2	3	4	5
I am an easy-going person.	1	2	3	4	5
I am bothered by dizziness.	1	2	3	4	5
I notice my heart pounding.	1	2	3	4	5
The top of my head feels tender.	1	2	3	4	5
I have a tendency to worry.	1	2	3	4	5
I have a hard time swallowing.	1	2	3	4	5
I am a nervous person.	1	2	3	4	5
I am afraid I am going to blush	1	2	3	4	5
I have trouble with my hand shaking while I write.	1	2	3	4	5
I have frightening dreams.	1	2	3	4	5
I feel chilly at temperatures that are comfortable for others.	1	2	3	4	5
I clench my teeth when anxious.	1	2	3	4	5
I do not think I am as happy as others.	1	2	3	4	5
I suddenly feel hot all over, without apparent cause.	1	2	3	4	5
I am troubled by tension interfering with my speech.	1	2	3	4	5
I have feelings of panic for no special reason.	1	2	3	4	5
My finger tips or other extremities become cold.	1	2	3	4	5

I have trouble with muscles twitching and jumping.	1	2	3	4	5
I am a relaxed person.	1	2	3	4	5
In the absence of physical action my heart beats wildly.	1	2	3	4	5
My hand shakes when I try to do something.	1	2	3	4	5
I am easily frightened.	1	2	3	4	5
My mouth feels dry.	1	2	3	4	5
My skin becomes painfully sensitive.	1	2	3	4	5
I go to sleep without thoughts or ideas bothering me.	1	2	3	4	5
I am either too hot or too cold and cannot get comfortable at a constant temperature setting.	1	2	3	4	5
I have pains in the back of my neck.	1	2	3	4	5
I take things hard.	1	2	3	4	5
I am bothered with blushing.	1	2	3	4	5
I am short of breath without knowing why.	1	2	3	4	5
I take things in stride.	1	2	3	4	5
When embarrassed, I break out in a sweat which annoys me greatly.	1	2	3	4	5
I have sensations of burnign, tingling, or crawling in certain parts of my body.	1	2	3	4	5
Life is a strain for me.	1	2	3	4	5
I have stomach trouble.	1	2	3	4	5
I have enduring headaches that last over several days.	1	2	3	4	5
I become upset when I have to wait.	1	2	3	4	5
I break out in a sweat, which is not the result of heat or physical exertion.	1	2	3	4	5
My sleep is fitful and disturbed.	1	2	3	4	5
I am troubled with diarrhea.	1	2	3	4	5
My head feels tender to the point that it hurts when I comb my hair or put on a hat.	1	2	3	4	5
I feel that I am about to go to pieces.	1	2	3	4	5
I have trouble getting my breath, for no special reason.	1	2	3	4	5
I worry about little things.	1	2	3	4	5
I grind my teeth in my sleep.	1	2	3	4	5
I have periods of such restlessness that I cannot sit still.	1	2	3	4	5
I have pressure headaches in which my head feels as if it were caught in a vise or as if there were a tight band around it.	1	2	3	4	5
I become irritable about little things.	1	2	3	4	5

VITA ²

Charles R. Edwards

Candidate for the Degree of

Master of Science

Thesis: A DOUBLE BLIND INVESTIGATION OF THE EFFECTS OF RELAXATION INSTRUCTIONS ON EMG BIOFEEDBACK LEARNING IN HIGH AND AVERAGE MUSCLE TENSION SUBJECTS

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