The Effects of Progressive Relaxation Training and Biofeedback-Assisted Relaxation Training on Control of Stress Arousal

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THE EFFECTS OF PROGRESSIVE RELAXATION TRAINING AND BIOFEEDBACK-ASSISTED RELAXATION TRAINING ON CONTROL OF STRESS AROUSAL

BY

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B.A., Florida Technological University, 1976

THESIS

Submitted in partial fulfillment of the requirements for the degree of Master of Science: Clinical Psychology in the Graduate Studies Program of the College of Social Sciences of Florida Technological University at Orlando, Florida

Summer Quarter
1978
<table>
<thead>
<tr>
<th>Table of Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Method</td>
<td>9</td>
</tr>
<tr>
<td>Results</td>
<td>13</td>
</tr>
<tr>
<td>Discussion</td>
<td>26</td>
</tr>
<tr>
<td>Appendix A</td>
<td>29</td>
</tr>
<tr>
<td>Appendix B</td>
<td>30</td>
</tr>
<tr>
<td>Appendix C</td>
<td>32</td>
</tr>
<tr>
<td>Appendix D</td>
<td>34</td>
</tr>
<tr>
<td>Reference Notes</td>
<td>35</td>
</tr>
<tr>
<td>References</td>
<td>36</td>
</tr>
</tbody>
</table>
Introduction

Modern society, with its sophisticated technology and ever-increasing stores of new information, is characterized by an atmosphere which encourages high levels of ambition and productivity. An inevitable by-product of this fast-paced society is the presence of many sources of stress, those factors which cause an individual to subjectively feel nervous, pressured, and uneasy. Weybrew (1967) defined stressors as "factors or agents--external or internal to the person--which cause acute or chronic homeostatic imbalance, whether at a physiological, psychological, or psychosocial level" (p. 325).

Selye (1973) pointed out that although different stressors have various specific effects on the system, they all have in common the effect of making an increased demand on the body to readjust itself. Thus, he defined stress as "the nonspecific response of the body to any demand placed upon it" (p. 692). Lacey (1967) outlined the typical pattern of stress-induced changes to include sympathetic nervous system activities such as increased heart rate and blood pressure, vasoconstriction in the fingers, and increased palmar conductance, as well as reduction of resting alpha brainwave activity and increased levels of skeletal muscle tension. People are idiosyncratic in their stress reactions, so that each individual has a unique configuration of stress reactivity in which certain of these physiological functions are more susceptible than others (Dykeman, Ackerman, Galbrecht & Reese, 1963).
Benson (1975) pointed out that although stress is commonly conceived of as involving major traumatic events, it is the minor everyday difficulties and their cumulative effects which are most detrimental to the average individual's functioning. These situational stressors, such as job pressures, financial difficulties, family problems, test situations, being late for appointments, and so forth, all contribute to subjective feelings of anxiety and their physiological concomitants. Events which are commonly regarded as positive or pleasurable, such as marriage, a vacation, or a promotion, can also be stressful in that they too, require the body to readjust itself (Pelletier, 1977). When these stress responses are prolonged, or when they occur too frequently, they become sustained at increasingly higher levels. If no relief is offered, these changes may eventually result in the individual's loss of ability to recover from the stress by shifting back to parasympathetic dominance (Stoyva & Budzynski, 1974). This, in turn, may trigger a variety of psychophysiological disorders (Benson, 1975), which compound the stressful feelings experienced by the person. Since it would be unrealistic to attempt to eliminate the everyday sources of stress from our lives, it would seem that a method for enabling individuals to more effectively cope with these stressors would be in order. Selye (1973) suggested that one way to aid in this coping process is to try to adopt a change in attitude toward various life events so that the severity of subjective anxiety is reduced. A subjective reduction in tension is only part of the solution, however, and must be accompanied by decreased levels of physiological arousal if the individual is to effectively avoid a stress reaction that is detrimental to his functioning. Stoyva
and Budzynski (1974) suggested cultivating a low arousal condition through systematic training in muscle relaxation as a first step in changing stress reactivity. Their basic premise was that this low arousal condition should ideally be employed in a preventative fashion, so that people could actually relearn their responses to stressful stimuli and thus circumvent the possible damage incurred by repeated physiological reactivity to such situations.

A variety of techniques and procedures have been offered as means of modifying the stress response. Two of these methods, progressive relaxation training (Jacobson, 1938) and biofeedback training, have received increasing attention in recent years. The basic assumption underlying progressive relaxation is that by learning to attend to and discriminate sensations of muscular tension and relaxation, a person can decrease his levels of muscular contractions and thereby experience deep muscle relaxation (Bernstein & Borkovec, 1973). This is accomplished by having an individual systematically tense and then relax one muscle group at a time, while carefully attending to the physical, mental, and emotional feelings associated with these alternating states of tension and relaxation. There have been numerous modifications of the original outline for progressive relaxation training (Wolpe, 1973), since the original method was quite time-consuming and concentrated on only one major muscle group per session.

The correlate to progressive relaxation training within the field of biofeedback is electromyogram (EMG) feedback training. The EMG is a measure of the pattern of electrical activity in the motor neurons which activate the muscle fibers. This electrical stimulation results
in muscle contraction, so that the amplitude of the resulting waveform is directly proportional to the degree of muscular contraction. The electrical signals are amplified and displayed through feedback equipment, with the typical unit of measurement being expressed in microvolts. Through the use of an EMG feedback device, an individual may thus receive information relating to the level of tension in the particular muscle group being monitored and use this objective data to aid his progress in learning to reduce the degree of muscular contraction.

Several investigations (Bowles & Smith, Note 1; Coursey, 1975; Haynes, Moseley & McGowan, 1975; Reinking & Kohl, 1975; Schandler & Grings, 1976; Sheridan, Vaughan, Wallerstedt & Ward, Note 2; Staples, Coursey & Smith, Note 3) have compared progressive relaxation training with EMG biofeedback training in an effort to determine their relative effectiveness in promoting muscular relaxation in non-clinical populations. Bowles and Smith (Note 1) had two groups of nine female subjects each, undergo ten sessions of either progressive relaxation or a combination of EMG feedback and progressive relaxation training. In evaluating the changes from pre-training to post-training resting sessions, they found that the combination of relaxation and biofeedback training was superior to relaxation training alone in producing significantly greater decreases in resting EMG levels. In a comparison of EMG feedback training, relaxation training, and a control condition involving simple instructions to relax in whatever way possible, Coursey (1975) found that the EMG feedback group reached significantly lower EMG levels than the other two groups after seven training sessions. The relaxation group and the control group did not significantly differ from each
other. Haynes et al. (1975) employed five groups in their study: 1) EMG feedback training; 2) passive relaxation instructions (simply attend to and relax muscles); 3) active relaxation (tense-relax) training; 4) a false feedback group; 5) a no-treatment control group. The subjects in the EMG feedback group showed the most progress, with passive relaxation the next most effective, while the remaining three groups showed no significant differences. The results of this study must be viewed with caution since only one training session was employed for each group. In another comparative study, Reinking and Kohl (1975) examined five groups of subjects: 1) classic Jacobson-Wolpe instructions; 2) EMG feedback training; 3) EMG feedback plus Jacobson-Wolpe instructions; 4) EMG feedback plus a monetary reward; 5) a no-treatment control group. Training for the five groups included three baselines and twelve one-hour sessions. EMG measures showed that in speed of learning and depth of relaxation, the EMG groups were superior to the relaxation-only group by a wide margin, and the controls displayed no mastery of relaxation at all. Schandler and Grings (1976) compared two modes of EMG feedback (tactile and visual) with a group receiving progressive relaxation instructions and a control group. Their results demonstrated an equal degree of effectiveness for progressive relaxation and tactile EMG feedback training, both of which were superior to visual feedback and the control group. Since only one training session was used for each of the subjects, these results must be viewed with some reservation. Sheridan et al. (Note 2) compared EMG feedback, progressive relaxation training, and a control group in order to determine their relative effectiveness in decreasing on-going EMG levels, which
were monitored before, during, and after training. The authors concluded that several extraneous variables, including time of measurement during sessions, verbal vs. objective measures, number of sessions, and gender of subjects, all affected the outcome of the study to a point where virtually any ordering of the relative efficacies of the three groups could be demonstrated by selecting the appropriate levels of the interacting variables. Staples et al. (Note 3) examined three relaxation methods (EMG feedback training, progressive relaxation training and autogenic training) by providing eight training sessions to each group of thirteen subjects. They found that all three procedures produced significant relaxation within each session, however the progressive relaxation subjects enjoyed their training the most and felt that they had attained a greater understanding of deep relaxation than the other subjects.

The inconsistent results of these studies point out the need for further investigations comparing EMG biofeedback training to progressive relaxation training. One particular issue which has not received adequate attention in the literature comparing these two techniques is the relative effectiveness of the procedures in controlling physiological reactivity to experimental stressors. Most of the available studies have evaluated training effects by examining on-going physiological levels or assessing pre- to post-training baseline changes. Conclusions drawn from such studies are probably not valid for predicting an individual's ability to control his responses to a stressor as a result of type of training. Therefore, one of the objectives of the present study was to evaluate the relative efficacies of EMG biofeedback-assist-
ed relaxation training and progressive relaxation training by imposing
a post-training experimental stress situation and examining group dif-
fferences in reactivity. The stressor employed was developed in a pilot
study by Lindley, Cunningham and Abbott (Note 4). This study was de-
signed to validate a technique for inducing stress under experimental
conditions which would more closely simulate the types of real-life
stressors normally encountered than such traditionally used stimuli as
electrical shock or loud noises.

It is unreasonable to expect no reaction from subjects confronted
with a stressful situation. Cannon's (1932) "fight-or-flight" pattern
of responding is, after all, a basic homeostatic mechanism which would
be difficult as well as undesirable to eliminate entirely, since it
enables organisms to adapt to environmental changes. However it is
likely that people can develop the ability to minimize the intensity
of this reaction and to recover from anxiety more quickly when it does
occur (Budzynski & Stoyva, 1975). Budzynski (1977) pointed out that
the skeletal muscle system comprises a large percentage of the entire
body mass, so it is reasonable to expect changes in this system to
indirectly produce changes in autonomic and cortical functioning as
well. Brown (1977) suggested that the changes in the skeletal muscle
system produced by progressive relaxation training might be enhanced
by the addition of biofeedback training because of the added ability
for the detection of precise information about muscle activity that is
otherwise unfelt. Therefore, in the current study, it was hypothesized
that subjects who were given a combination of EMG biofeedback training
and progressive relaxation training would exhibit lower degrees of
arousal and a more rapid return to resting EMG, heart rate, and skin temperature levels after being confronted with a stressful situation than subjects who underwent progressive relaxation training alone.

The present study represents the third phase in an on-going research program investigating techniques for management of situational stress reactions. In the second investigation of this series (Lindley, Cunningham, & Abbott, Note 5) it was found that subjects in an EMG-biofeedback group with no specific instructions for how to relax, showed no significant improvement over subjects in a no-treatment control group after twelve 25-minute training sessions. This finding supports Brown's (1977) proposal that it may be the combination of progressive relaxation and EMG feedback training which is most successful in producing lowered arousal.
Method

Subjects. Eight male and ten female student volunteers ranging in age from 19 to 58 years ($M = 27.1$) served as subjects and were paid on a sliding scale based on the degree of progress made during training sessions. All volunteers were screened for the presence of any known medical disorders or routine use of medications, and for prior experience in Yoga, Transcendental Meditation, progressive relaxation training or biofeedback training. Subjects were randomly divided into two groups of nine each: 1) EMG biofeedback-assisted relaxation training (Group A), or 2) Modified progressive relaxation training (Group B).

Apparatus. An Autogen 1700 (Autogenic Systems, Inc.) was used to monitor EMG levels and provide feedback. The Bandpass Selector was set at 100-200 Hz, and the Average Time Selector for the feedback signal at 50 seconds. An Autogen 2000b was used to measure absolute peripheral skin temperature. Both the Autogen 1700 and 2000b were connected to Autogen 5100 Digital Integrators for computation of appropriate time integrals and accuracy of recordings. A pulse rate monitor (Gulf & Western Applied Science Laboratories, Cardio-Tach, Model 4600) was used to measure heart rate, and provided a digital display representative of a four-beat averaged reading. The final session (presentation of the stress situation) included the use of videotape recording equipment (Panasonic Camera, Model WV-2310; Sony videocassette recorder, Model VO-2600; Magnavox television recorder). Modified progressive relaxation training was provided with the use of cassette-recorded instruc-
tions from the series Quieting Response Training (Stroebel, 1978). The exercises on the tapes used provide for all major muscle groups to be covered in one session.

Procedure. All subjects read and signed an informed consent form (see Appendix A). They then selected session appointment times, which were scheduled three times a week for each person, for a total of 16 sessions. The first two sessions provided baseline data. During the first session, the student entered a small room and was seated in an armchair which was then placed in the reclined position. Electrodes were attached as follows: 1) EMG: After first preparing the skin surface with alcohol, the first active electrode was placed on the skin over the right forearm extensor muscle, approximately one-third the distance from the elbow to the wrist. The second active electrode was placed two inches down from this, and the ground electrode was attached at a point between and slightly to the subject's left of the active electrodes. 2) Skin temperature: The thermistor was attached to the palmar surface of the right middle fingertip. 3) Heart rate: The photoelectric sensor was attached to the palmar surface of the left middle fingertip. After attaching the electrodes, Experimenter 1 instructed the subject to remain quietly seated and still for a duration of 20 minutes, while readings were recorded at two-minute intervals in an adjacent room. The procedure for the second baseline session was identical to that of the first.

After baseline data were obtained, the two groups of subjects began training sessions. The procedure followed for the first six sessions was the same for all subjects. Upon entering the room, each stu-
dent was instructed to recline the chair and listen to the brief introductory comments provided on tape (see Appendix B). Then the first exercise tape was started. The tape used for the first six sessions was "Relaxing Skeletal Muscles for the Quieting Response" (Stroebel, 1978), which was 38 minutes in length. Immediately following every third training session, each subject was monitored for a five-minute period at one-minute intervals, following the same procedure used during baseline sessions.

After completion of the first six sessions, the subjects were told what the procedure for the remainder of the experiment would involve. Subjects in Group A listened to a brief tape which provided an introduction to biofeedback training (see Appendix C). For the last six sessions, they were given 20-minute periods of EMG biofeedback training using the frontalis muscle as the training site. The two active electrodes were each placed one inch above the eyebrows and centered above the pupils of the eyes, and the ground electrode was placed in between them. Auditory click feedback was provided over a small speaker. The Meter Scale Selector was set at X1 for all sessions, and no threshold levels were activated.

Students in Group B were provided with a different tape for their last six training sessions: "Contrasting Muscle Tension and Relaxation for the Quieting Response" (Stroebel, 1978). This tape was 33 minutes in duration. Five minute recording periods were continued following every third training session for the remainder of these six sessions for all subjects in both groups.
Following the final training session, a post-training 20-minute baseline session was conducted with all subjects for the purpose of comparison to initial baseline EMG levels, in order to determine amount of payment for each subject.

All subjects participated in one final session in which the experimental stress situation was imposed. In this session, electrodes were attached to the subject in the manner of the baseline procedure, and the videotape recording equipment was present in the room. The student was first instructed to sit quietly and try to relax for ten minutes, while being monitored for EMG, heart rate, and skin temperature at two-minute intervals. Experimenter$_2$ then entered the room and gave the subject a printed paragraph (see Appendix D) with instructions to try to memorize it within three minutes. Readings were taken at 15-second intervals during this memorization period. Following this, Experimenter$_2$ entered the room again and took the paragraph from the student. The videotape recording equipment was then turned on so that the subject could see himself on the television monitor. Experimenter$_2$ pointed the camera at the student and said "Go!" to indicate to the subject to begin reciting the paragraph. At this signal, Experimenter$_1$ began recording physiological levels at 15-second intervals. Following completion of the subject's recitation, instructions were given to remain quietly seated and try to relax for the duration of five minutes. Experimenter$_2$ then left the room. Throughout this five-minute period, Experimenter$_1$ continued to record physiological levels at 15-second intervals. At the end of this final session, all subjects signed final payment contracts so that monetary remuneration could be disbursed.
Results

For each subject, three change scores (Δ) were calculated for each of the three physiological functions monitored (forearm EMG, H.R., and skin temp.) Baseline change scores (BΔ) were derived by measuring the changes from the ten-minute readings (B₁) to the 20-minute readings (B₂) during the second baseline sessions. Stress arousal change scores (SΔ) represented the changes from the final readings of the initial ten-minute rest period (S₁) during the stress sessions, to the 15-second readings within the first minute of the subjects' recitations (S₂) which implied the highest arousal levels for each function (i.e., highest EMG levels, highest H.R.'s, lowest skin temps.) Recovery change scores (RΔ) were calculated by measuring the changes from S₂ to the 15-second readings within the third minute of the post-recitation rest period (R), indicative of the lowest arousal levels (i.e., lowest EMG levels, lowest H.R.'s, highest skin temps.)

Following the calculation of change scores BΔ, SΔ, and RΔ, two difference scores (D) were computed for all subjects on each of the three functions. Dstress was derived by subtracting BΔ from SΔ, thus indicating degree of physiological arousal induced by the stressor. Drecovery, representing the magnitude of subjects' reduction in arousal following the stress task, was calculated by subtracting SΔ from RΔ. These D-scores were then subjected to statistical analysis.
Effects of training on EMG levels. The means and standard deviations of the EMG levels for subjects in Groups A and B at the specified data points are shown in Table 1, along with the resultant change scores, and are graphically depicted in Figure 1.

It appears in Figure 1 that although subjects in Group A did not exhibit decreased EMG levels during the baseline session as a result of just sitting (as did Group B subjects), they showed less arousal after training during the stress session than students in Group B. It also appears that subjects in both groups recovered to low arousal levels near their original baselines following the stress task.

Statistical analysis of the $D_{\text{stress}}$ and $D_{\text{recovery}}$ scores for Groups A and B was performed using within-groups two-tailed $t$ tests. Despite the apparent trends, the results revealed no significant changes in arousal or recovery for either group, as shown in Table 2. An independent groups $t$ test performed on the $D_{\text{stress}}$ scores revealed no significant difference in degree of stress arousal between groups, $t (16) = -.839$, $p > .05$. In addition, the two groups did not significantly differ in magnitude of recovery, $t (16) = .614$, $p > .05$.

Effects of training on H.R. Table 3 shows the means and standard deviations of subjects' heart rates at the specified data points and the associated change scores. It can be seen in Figure 2 that the subjects in both groups evidenced an apparently large increase in H.R. when presented with the stressor, and returned to near-baseline resting levels during the post-task period. The data in Table 4 confirm the statistical significance of these trends.
Table 1

<table>
<thead>
<tr>
<th>Data Collection Points</th>
<th>Mean Baseline and Stress Session EMG Levels and Associated Change Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B1</td>
</tr>
<tr>
<td>Group A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>019</td>
</tr>
<tr>
<td></td>
<td>541</td>
</tr>
</tbody>
</table>

Group B

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.820</td>
<td>.712</td>
<td>.502</td>
<td>.307</td>
</tr>
<tr>
<td></td>
<td>.599</td>
<td>.293</td>
<td>.599</td>
<td>.293</td>
</tr>
</tbody>
</table>

Note. Unit of measurement: Microvolts (µV).
Figure 1. Mean EMG levels at designated data points during baseline and stress sessions.
<table>
<thead>
<tr>
<th></th>
<th>$D_{stress}$</th>
<th>$D_{recovery}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>2.880</td>
<td>-6.283</td>
</tr>
<tr>
<td></td>
<td>$t = 1.937^*$</td>
<td>$t = -2.159^*$</td>
</tr>
<tr>
<td></td>
<td>$df = 8$</td>
<td>$df = 8$</td>
</tr>
<tr>
<td>Group B</td>
<td>5.153</td>
<td>-9.613</td>
</tr>
<tr>
<td></td>
<td>$t = 2.277^*$</td>
<td>$t = -2.104^*$</td>
</tr>
<tr>
<td></td>
<td>$df = 8$</td>
<td>$df = 8$</td>
</tr>
</tbody>
</table>

$p > .05$
Table 3
Mean Baseline and Stress Session
Heart Rates and Associated Change Scores

<table>
<thead>
<tr>
<th>Data Collection Points</th>
<th>Mean Change Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BΔ</td>
</tr>
<tr>
<td><strong>Group A</strong></td>
<td></td>
</tr>
<tr>
<td><strong>M</strong></td>
<td>74.00</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td>17.67</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td></td>
</tr>
<tr>
<td><strong>M</strong></td>
<td>69.44</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td>13.29</td>
</tr>
</tbody>
</table>

*Note.* Unit of measurement: Beats per minute.
Figure 2. Mean heart rates at designated data points during baseline and stress sessions.
### Table 4
Analysis of Mean Difference Scores for Heart Rate

<table>
<thead>
<tr>
<th></th>
<th>$D_{stress}$</th>
<th>$D_{recovery}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>$\bar{D} = 34.22$</td>
<td>$\bar{D} = -67.00$</td>
</tr>
<tr>
<td></td>
<td>$t = 6.111^*$</td>
<td>$t = -7.920^*$</td>
</tr>
<tr>
<td></td>
<td>df = 8</td>
<td>df = 8</td>
</tr>
<tr>
<td>Group B</td>
<td>$\bar{D} = 31.11$</td>
<td>$\bar{D} = -68.78$</td>
</tr>
<tr>
<td></td>
<td>$t = 4.463^*$</td>
<td>$t = -5.819^*$</td>
</tr>
<tr>
<td></td>
<td>df = 8</td>
<td>df = 8</td>
</tr>
</tbody>
</table>

*$p < .01$
An independent groups \( t \) test performed on the \( D_{\text{stress}} \) scores revealed no significant difference between Groups A and B in degree of stress arousal, \( t (16) = .348, p > .05 \). There was also no significant difference in the amount of recovery displayed by the two groups, \( t (16) = .123, p > .05 \).

**Effects of training on skin temperature.** The means and standard deviations of subjects' skin temps. at the designated points during baseline and stress sessions are shown in Table 5. The graph of these data in Figure 3 shows that subjects in Groups A and B appeared to show differing patterns of skin temp. changes. Whereas Group A students displayed a mean increase in skin temp. during the baseline session, Group B subjects evidenced a mean decline. Subjects in both groups showed a similar V-shaped pattern of skin temp. changes during the stress session, indicating a decrease in skin temp. upon stress induction, followed by a recovery to near-resting levels in the post-task period. Despite the similarity of these patterns, the mean skin temps. for Group B subjects were consistently higher than those of Group A throughout this session.

Statistical analysis of the mean \( D \)-scores for skin temp., as shown in Table 6, revealed significant differences for both Groups A and B, indicating that both groups displayed arousal reactions of decreased skin temp. and recovered from these changes during the post-task period.

Statistical analysis of between-group differences was conducted with an independent groups \( t \) test. The results showed that there was no significant difference between Groups A and B in terms of stress arousal, \( t (16) = .096, p > .05 \). In addition, the two groups of sub-
Table 5
Mean Baseline and Stress Session
Skin Temperatures and Associated Change Scores

<table>
<thead>
<tr>
<th>Data Collection Points</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B₁</td>
<td>B₂</td>
<td>S₁</td>
<td>S₂</td>
<td>R</td>
</tr>
<tr>
<td>Group A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>91.21</td>
<td>92.22</td>
<td>89.88</td>
<td>86.88</td>
<td>89.62</td>
</tr>
<tr>
<td>SD</td>
<td>7.72</td>
<td>5.71</td>
<td>7.59</td>
<td>6.30</td>
<td>7.58</td>
</tr>
<tr>
<td>Group B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>93.33</td>
<td>91.86</td>
<td>94.74</td>
<td>89.08</td>
<td>93.61</td>
</tr>
<tr>
<td>SD</td>
<td>2.60</td>
<td>5.12</td>
<td>2.77</td>
<td>4.36</td>
<td>1.80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mean Change Scores</th>
<th>BΔ</th>
<th>SΔ</th>
<th>RΔ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>+1.01</td>
<td>-3.00</td>
<td>+2.74</td>
</tr>
<tr>
<td>Group B</td>
<td>-1.47</td>
<td>-5.66</td>
<td>+4.53</td>
</tr>
</tbody>
</table>

Note. Unit of measurement: Degrees Fahrenheit.
Figure 3. Mean skin temperatures at designated data points during baseline and stress sessions.
<table>
<thead>
<tr>
<th></th>
<th>D_stress</th>
<th>D_recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td>( \bar{D} = -4.01 )</td>
<td>( \bar{D} = 5.74 )</td>
</tr>
<tr>
<td></td>
<td>( t = -6.317^{**} )</td>
<td>( t = 4.606^{**} )</td>
</tr>
<tr>
<td></td>
<td>( df = 8 )</td>
<td>( df = 8 )</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td>( \bar{D} = -4.19 )</td>
<td>( \bar{D} = 10.19 )</td>
</tr>
<tr>
<td></td>
<td>( t = -2.797^{*} )</td>
<td>( t = 5.455^{**} )</td>
</tr>
<tr>
<td></td>
<td>( df = 8 )</td>
<td>( df = 8 )</td>
</tr>
</tbody>
</table>

\*p < .05

\**p < .01
jects did not significantly differ in regard to recovery changes, $t(16) = -1.983$, $p > .05$. 
Discussion

The results of this study failed to support the specific hypotheses that subjects who were given EMG biofeedback-assisted relaxation training would show significantly lower levels of arousal, as determined by EMG levels, heart rates, and skin temperatures, and that they would evidence greater magnitudes of recovery on these dimensions. These findings are similar to those reported by Staples et al. (Note 3) who found no significant differences between EMG biofeedback- and progressive relaxation-trained subjects in post-training evaluations.

Of the three physiological functions monitored, EMG was the only index that showed no significant change for either group of subjects in terms of stress-induced arousal or subsequent recovery. There was a trend in the direction of lower mean arousal levels for Group A subjects, but this trend failed to reach statistical significance. One reason for this outcome is the wide range of variability displayed by subjects in both groups in their levels of reactivity upon presentation of the stressor, thus making it difficult to obtain a large enough t score. This fact is in keeping with the notion of idiosyncratic response patterning as discussed by Dykeman et al. (1963); some subjects displayed large increases in EMG levels upon presentation of the stressor, while others showed little reactivity in this modality.

Data on heart rate and skin temperature showed that both groups of subjects showed significant levels of arousal and recovery on these dimensions but did not differ from each other in degrees of reactivity.
Based on Lacey's (1967) theoretical outline of the typical changes occurring in individuals confronted with a stressor, the fact that the EMG data did not show similar changes in arousal suggests that both types of training employed were effective in helping subjects control the stress reactivity of their skeletal musculature systems. This suggested control, however, did not generalize to the autonomic functions under examination. This finding disputes Budzynski's (1977) notion that changes in EMG levels are likely to produce changes in autonomic and cortical functioning as well.

One methodological problem with the experimental procedure used in the present study is that although the frontalis muscle was the site for EMG training in Group A subjects, only forearm extensor EMG data were recorded. Due to the fact that the stressor involved a verbal task, frontalis EMG data would have been contaminated by artifacts due to facial and jaw movements, and would therefore have been useless for analysis. However, in using EMG data from the forearm, this design assumed that training effects from the frontalis would generalize to other muscle sites. Other researchers (Alexander, 1975; Shedivy & Kleinman, 1977) have reported that frontalis EMG training effects did not generalize to untrained muscle sites. Thus, it would seem that in order to adequately assess the effects of frontalis EMG training in control of stress arousal, a non-verbal stress task would need to be developed so that frontalis EMG data could be validly examined.

The method of combining relaxation training with biofeedback training used in the present study might be modified in future investigations to determine whether such a change would affect the outcomes.
Perhaps if subjects were to receive a combination of both relaxation exercises and biofeedback training throughout all sessions in a fashion similar to the method employed by Bowles & Smith (Note 1), rather than training in one technique followed by subsequent training in the other, more significant training effects would be seen. In addition, the inclusion of shaping procedures would be likely to facilitate the development of a lowered arousal condition. In the present investigation, shaping procedures were not used in order to provide for greater experimental control, however this probably decreased the potential effectiveness of the biofeedback training.

As mentioned in other studies which have employed non-clinical populations as subjects (Coursey, 1975; Ohno, Yoshiharu, Takeya, Matsubara, Kuriya, & Komemushi, 1978; Reinking & Kohl, 1975) it is likely that subjects in the present study exhibited a floor effect in their training progress. Their baseline EMG levels were so low that it would have been difficult to show evidence for any substantial training effects, regardless of the potential differences between types of training.

It would seem, then, that some modifications in the experimental design of the present study, along with the use of a clinical population with documented stress-related problems as subjects, would be the next logical step to pursue in an effort to determine whether biofeedback-assisted relaxation training might be superior to progressive relaxation training in the control of stress arousal.
Please read the following information carefully before signing this form!

Subject participation in the experiment to be conducted during Spring & Summer Quarters, 1978, will involve the following conditions:

1) You will be required to participate in sixteen sessions, each lasting approximately 45 minutes, which will be scheduled three times a week on Monday and either Tuesday and Thursday or Wednesday and Friday.

2) During the first two sessions, you will be monitored for muscle tension, heart rate and skin temperature while you remain quietly seated for twenty minutes.

3) The next twelve sessions will involve either progressive relaxation training or a combination of relaxation and EMG biofeedback training. Following these twelve training sessions, there will be another twenty-minute baseline session.

4) During the final session, you will be given a paragraph to try to memorize within a specified amount of time. After this, you will be asked to recite the paragraph while being videotaped. Throughout this session, you will continue to be monitored for EMG, H.R., and skin temp.

5) If, at any time during the experimental sessions you begin to feel uncomfortable or reluctant to continue, you are encouraged to inform the lab technicians so that your participation can be terminated.

6) Payment for participation in the experiment will be made after all of the sessions have been completed. Rate of pay will be contingent upon the degree of progress made during the training sessions.

I have read and understood the foregoing information and consent to participate in this experiment.

DATE

SIGNATURE
Appendix B

Introduction to Relaxation Training

The technique known as Progressive Relaxation was developed in the 1930's by Edmund Jacobson. The basic principle underlying this systematic program is that by learning to attend to and discriminate between the sensations of muscular tension and relaxation, a person can eliminate muscular contractions and experience deep physiological relaxation. Jacobson and numerous other researchers felt that the ability to quickly achieve a state of true relaxation could be beneficial in treating a variety of physical disorders as well as enabling individuals to more adequately cope with the stresses and strains of everyday life. The relaxation training that you will receive while participating in this experiment is a variation of Jacobson's original method. The relaxation exercises will be conducted with the use of tape-recorded instructions. Please attend to and follow these instructions carefully, but remember that you must let yourself relax; you cannot force yourself to relax. So don't concentrate too hard on relaxing, or you will work against yourself. Just follow the exercise instructions and let your mind clear itself of any worries or concerns. While going through the exercises, try to keep your eyes closed, because a state of deep relaxation is usually achieved easier in this way. If you begin to experience any unusual bodily sensation as training progresses, don't be alarmed. Such feelings are often reported by people experiencing deep muscle relaxation for the first time.
Your first training session will be conducted today. Try to follow the exercise instructions provided on the tape, and if you have any questions, don't hesitate to ask the lab assistant now or at the end of the session.
Appendix C

Introduction to Feedback Training

The electromyogram, or EMG, is the pattern of electrical activity which accompanies muscle action. The level of EMG activity is usually expressed in microvolts or millionths of a volt. The rate of electrical activity which produces muscle stimulation is directly proportional to the level of muscle tension. Therefore, the EMG level may be interpreted as an index of muscular tension or relaxation.

During the first six sessions of this experiment, you were given progressive relaxation training to teach you how to voluntarily relax your muscles. For the remaining six sessions, you will be given EMG-feedback training to help you relax even further, by enabling you to discriminate more subtle changes in muscular activity. The muscle you will use for training is the frontalis, or forehead muscle. This site has been selected because the frontalis EMG level is a good general index of muscle tension throughout the head, neck, and shoulders. The sensors which are attached to your forehead are picking up the pattern of electrical activity in your frontalis muscle so that this pattern can be processed through the feedback myograph. This machine will then provide you with auditory feedback in the form of a series of clicks which you will hear over a small speaker. The rate of clicking corresponds to your EMG level; the faster the clicks, the higher the level of muscle tension, and, conversely, the slower the clicks, the greater the degree of muscular relaxation. In using this feedback, try to maintain the state of deep relaxation which you learned to produce during
the first six sessions. You will no longer need to initially tense your muscles, however. Instead, try to let them relax as deeply as possible, and in so doing, try to slow down the rate of the click feedback that you will be hearing.

Your biofeedback training sessions will last for twenty minutes each, with the first one beginning today. If you have any questions about the feedback procedure, feel free to ask the lab assistant before the session is begun.
Appendix D

Good evening, ladies and gentlemen. I would like to welcome you to the opening night ceremonies of the Hanover Fine Arts Center. The Boston Symphony Orchestra will perform for your pleasure tonight at 9:00 p.m. Until that time, you are invited to tour the rest of our facilities. Refreshments will be served in the Gold Room throughout the evening. Thank you all for attending this evening and please visit us often in the future.
Reference Notes


References


