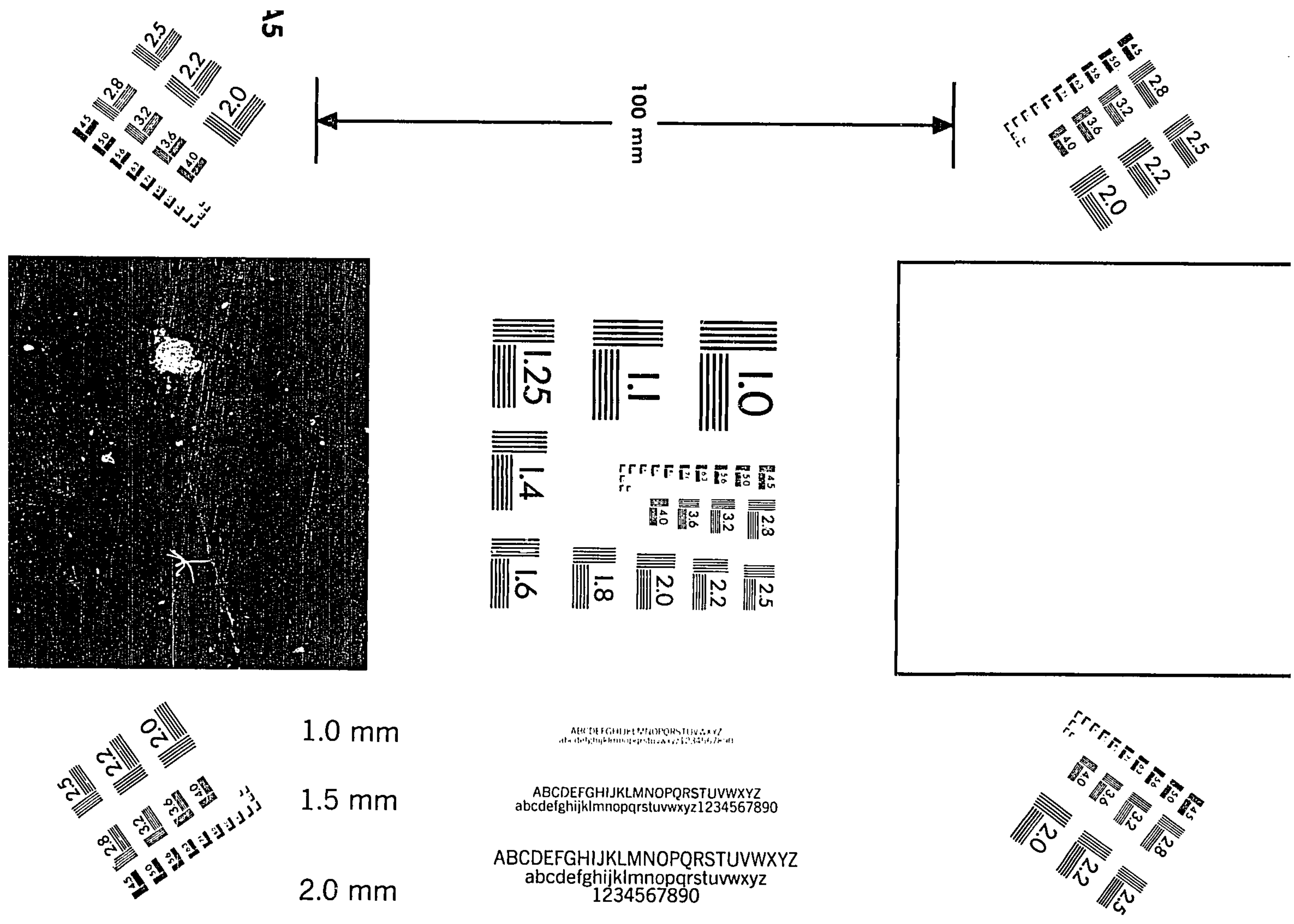


100 mm
1.0 mm
1.5 mm
2.0 mm
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz1234567890
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890

DOCUMENT RESUME

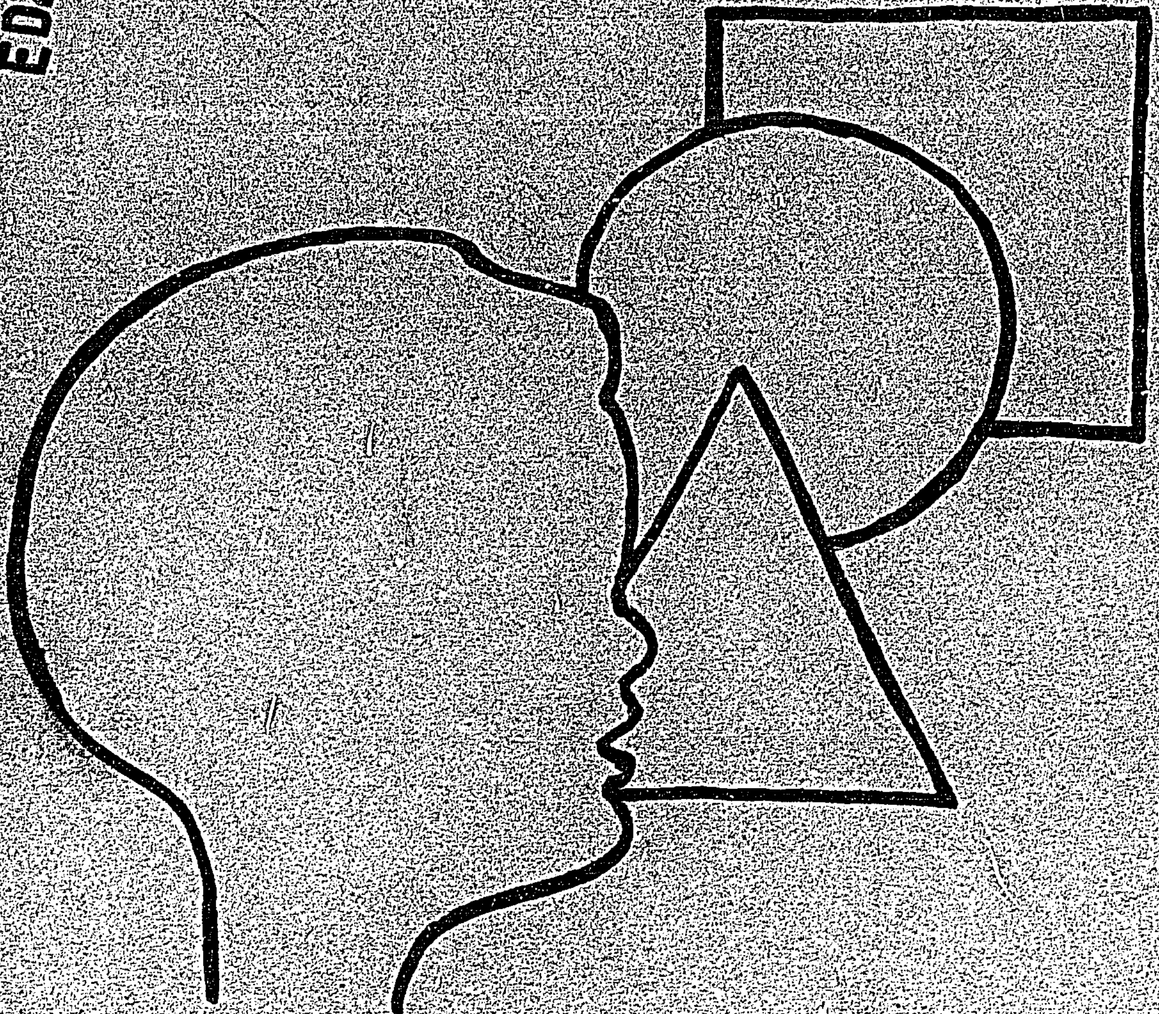
ED 283 095 CG 019 984

AUTHOR	Matthews, Doris B.
TITLE	A Comparison of Relaxation Strategies.
INSTITUTION	South Carolina State Coll., Orangeburg.
SPONS AGENCY	Cooperative State Research Service (DOA), Washington, D.C.
PUB DATE	Sep 86
NOTE	69p.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*Adolescents; Intermediate Grades; Junior High Schools; *Physiology; *Preadolescents; Recall (Psychology); *Relaxation Training; *Short Term Memory; *Stress Management

ABSTRACT

Some researchers argue that all relaxation techniques produce a single relaxation response while others support a specific-effects hypothesis which suggests that progressive relaxation affects the musculoskeletal system and that guided imagery affects cognitive changes. Autogenics is considered a technique which is both somatic and cognitive. This study was conducted to measure physiological and cognitive attributes of four techniques: progressive relaxation, autogenics, guided imagery, and a neutral stimulus. Physiological measures examined were frequency of brain waves, muscle tension, and peripheral temperature which were measured during, and at the conclusion of, each relaxation exercise or neutral stimulus. Immediately following each technique, subjects answered questions measuring short-term memory. Four tests of recall used were auditory forward and auditory backward digit span, and recollection of lists of nonsense syllables and familiar nouns. Subjects were 40 students in grades six, seven, and eight. Even though subjects came to the observation session in a surprisingly relaxed state, relaxation exercises increased peripheral temperature; however, the other physiological measures and the four tests of recall did not respond to the relaxation exercises. The three types of treatment failed to produce difference levels of either physiological measures or test performance. Practice had some effects on subjects. Muscle tension and both auditory forward and backward digit span revealed an association with the order of observations. A 44-item reference list, two appendices and 29 tables are included. (NB)

A COMPARISON OF RELAXATION STRATEGIES



Published as a Technical Contribution from:
South Carolina State College
Orangeburg, South Carolina
September, 1986

A COMPARISON OF RELAXATION STRATEGIES

by

Doris B. Matthews, Ph.D.

Principal Investigator

Office of 1890 Research

and

Professor of Education

Department of Education

South Carolina State College

In Cooperation with:

Cooperative State Research Service
U. S. Department of Agriculture

Table of Contents

List of Tables. iv

Acknowledgments vi

Abstract. viii

Introduction. 1

Related Literature. 2

Hypotheses. 9

Methods 9

Sample 9
Procedure. 10
Instrumentation. 11

Monitoring Instruments 11
Cognitive Tests. 12

Relaxation Training. 13

Progressive Relaxation 14
Autogenics 15
Guided Imagery 16

Neutral Stimulus 16

Observations 17

Analysis of Data 18

Results 20

Summary 41

Recommendation for Further Research 44

References. 46

Appendix A. 53

Appendix B. 55

List of Tables

1. Means of Three Physiological Measures Observed Prior to Each of Four Treatment Levels 21

2. Means of Corrected Peripheral Temperature by Treatment. 23

3. Analysis of Variance Summary Table for Corrected Peripheral Temperature by Treatment. 23

4. Means of Muscle Tension (EMG) by Treatment. 24

5. Analysis of Variance Summary Table for Muscle Tension by Treatment 24

6. Means of Brain Wave Frequency by Treatment. 26

7. Analysis of Variance Summary Table for Brain Wave Frequency by Treatment. 26

8. Means of Auditory Forward Digit Span by Treatment . . 29

9. Analysis of Variance Summary Table for Auditory Forward Digit Span by Treatment. 29

10. Means of Auditory Backward Digit Span by Treatment. . 31

11. Analysis of Variance Summary Table for Auditory Backward Digit Span by Treatment 31

12. Means of Nonsense Syllable Recall by Treatment. . . . 32

13. Analysis of Variance Summary Table for Nonsense Syllable Recall by Treatment 32

14. Means of Noun Recall by Treatment 33

15. Analysis of Variance Summary Table for Noun Recall by Treatment. 33

16. Means of First and Final Corrected Peripheral Temperatures for Four Observations (Practice Effect). 34

17. Analysis of Variance Summary Table for First and Final Corrected Peripheral Temperatures for Four Observations (Practice Effect). 34

List of Tables (continued)

18. Means of First and Final Muscle Tension Measures (EMG) for Four Observations (Practice Effect). . 36

19. Analysis of Variance Summary Table for First and Final Muscle Tension Readings for Four Observations (Practice Effect) 36

20. Means of First and Final Brain Wave Frequencies for Four Observations (Practice Effect). 38

21. Analysis of Variance Summary Table for First and Final Brain Wave Frequency Readings for Four Observations (Practice Effect) 38

22. Means of Auditory Forward Digit Span for Four Observations (Practice Effect) 39

23. Analysis of Variance Summary Table for Auditory Forward Digit Span across Four Observation Sessions (Practice Effect) 39

24. Means of Auditory Backward Digit Span for Four Observations (Practice Effect) 40

25. Analysis of Variance Summary Table for Auditory Backward Digit Span across Four Observation Sessions (Practice Effect) 40

26. Means of Nonsense Syllable Recall for Four Observations (Practice Effect) 42

27. Analysis of Variance Summary Table for Nonsense Syllable Recall across Four Observation Sessions (Practice Effect) 42

28. Means of Noun Recall for Four Observations (Practice Effect). 43

29. Analysis of Variance Summary Table for Noun Recall across Four Observation Sessions (Practice Effect). 43

Acknowledgments

The success of this research was dependent upon the efforts and cooperation of a number of persons. The Principal Investigator is grateful to the faculty and staff of Felton Laboratory School at South Carolina State College for their cooperation. Mrs. Oscarola M. Pitt, Director, was helpful in planning, coordinating, and implementing the study. Mrs. Carolyn J. Woodberry, Counselor, and Mrs. Juliet M. Floyd, Administrative Assistant, were extremely efficient in the scheduling of participants. The teachers and parents of students offered their cooperation by consenting for pupils to be dismissed from classes in order to take part in the research. Research studies like this one need volunteer participants; therefore, the Principal Investigator is very appreciative of the students who gave willingly of their time.

The staff of the Miller F. Whittaker Library at South Carolina State College is to be commended for the assistance they gave in locating library materials. Their help was essential to the writing of this document.

Mrs. Beulah El-Amin, Biofeedback Technician, did a superior job in monitoring the biofeedback equipment and administering the relaxation techniques and tests. It was she who collected and organized data for analysis.

The Principal Investigator acknowledges the expertise of Dr. Jimmy L. Quinn as a consultant. Dr. Quinn offered his guidance in the planning stage and assisted in the development of tests. In addition, he maintained and repaired the biofeedback equipment and worked diligently to provide accurate data analysis.

The services of Mrs. Barbara Lin Odom were invaluable in the preparation of the final document. Through word processing, she worked energetically in the supervision of the text to the final camera-ready proofs.

The researcher thanks, also, the Department of Education, the Department of Natural Sciences, and the Office of 1890 Research at South Carolina State College for their contributions. The Department of Education provided the laboratory facilities, and the Department of Natural Sciences lent the oscilloscope which was used to monitor the amplitude of brain waves. The Office of 1890 Research, in cooperation with the U. S. Department of Agriculture, supplied the necessary funding.

Abstract

In an experimental study using subjects as their own controls, the researcher studied three different types of relaxation exercises and a control, or no treatment, condition for their effects on three physiological measures and four simple tests of recall. The three physiological measures were commonly used measures of stress: peripheral temperature, muscle tension, and brain wave frequency. The four tests of recall were auditory forward and auditory backward digit span, and recollection of lists of nonsense syllables and familiar nouns. Even though subjects came to the observation session in a surprisingly relaxed state, relaxation exercises increased peripheral temperature; however, the other physiological measures and the four tests of recall did not respond to the relaxation exercises. The three types of treatment--progressive relaxation, guided imagery, and autogenics--failed to produce difference levels of either physiological measures or test performance.

Practice had some effects on subjects in the study. Muscle tension and both auditory forward and backward digit span revealed an association with the order of observations.

Introduction

The differential effects of various types of relaxation exercises emerge in the literature. Benson (1975) argues that all relaxation techniques produce a single "relaxation response." However, other authorities (Davidson & Schwartz, 1976) have a specific-effects hypothesis. The specific-effects hypothesis suggests that progressive relaxation affects the musculoskeletal system; therefore, it is classified as a somatic technique. Guided imagery is a cognitive technique and, therefore, should sharpen the imagination and cause other cognitive changes. Since autogenics is both somatic and cognitive, it affects the autonomic nervous system more than progressive relaxation.

Since the research is inconclusive regarding the two theories, this study aimed to measure physiological and cognitive attributes of four techniques: progressive relaxation, autogenics, guided imagery, and a neutral stimulus in which a filmstrip was viewed to act as a control condition. In the study the researcher measured the frequency of brain waves, muscle tension, and peripheral temperature during, and at the conclusion of, each relaxation exercise or neutral stimulus. Immediately following each technique, the subject answered questions which measured short-term memory.

Related Literature

Bearing upon this research are findings from other studies of the physiological and cognitive effects of various relaxation techniques. Also, issues related to the effect of practice on relaxation, the validity of using audiotape exercises, and the relationship between subject characteristics and relaxation success appear in the literature and assist in the interpretation of the study. Research using adults is much more prevalent than studies with children. Of the research with children, the targeted population is more often special students than regular ones.

To test the single versus specific theory of relaxation, Armstrong (1985/1986) designed a study to test whether techniques labeled somatic (progressive muscle relaxation) and cognitive (visual imagery training) would produce different patterns of reductions in physiological measures of somatic and cognitive arousal in test-anxious children. He found no significant differences among the effects of progressive relaxation, visual imagery training, and vague instructions. However, both relaxation training techniques resulted in improved fine motor performance, while vague instruction to relax resulted in reduced performance.

Other research disagrees with a single response theory. Lehrer (1978) found that progressive relaxation in normal subjects blocks alpha brain waves while it decreases sympathetic reactivity. Additionally, Lehrer, Schoicket, Carrington, and Woolfolk (1980) suggested, as a result of their findings from self-report data, that cognitive techniques, such as meditation, reduce cognitive anxiety symptoms more than brief training in progressive relaxation.

Two studies show the relationship between physiological measures. When examining muscle tension and skin temperature, Cinciripini (1982) found baseline electromyographic (EMG) levels to be good predictors of skin temperature changes. The relationship between the variables was an overall correlation of -0.32. His study showed, also, significant reductions in EMG readings and increases in skin temperature between feedback and baseline periods. Matthews (1982) found a weak negative correlation ($r = -0.12$) between wrist temperature and average brain wave frequency in middle school children. The finding suggested that as the child's brain wave frequency decreased, the peripheral temperature tended to increase weakly.

Several studies with adults found that at least comparable increases in hand temperature can be obtained using autogenic phrases alone versus autogenic phrases plus biofeedback training (Keefe, 1978; Surwit, Pilon & Fenton, 1978; Keefe, Surwit & Pilon, 1980). However, few studies of the two methods exist using children. An exception is the study by Kelton and Belar (1983) in which neither biofeedback nor autogenic phrases produced increases in hand temperature across trial blocks within sessions.

Three studies used audiotape relaxation exercises and reported changes in skin temperature. Using guided imagery exercises, Matthews (1984; 1986) reported finding significant differences between pre- and post-readings of children who relaxed and those that did not relax. Carlton (1973/1974) used a tape recorded autogenic exercise, a tape recorded relaxation exercise, and a tape recorded autogenic exercise plus biofeedback and found no relationship between the three treatment levels and the degree of temperature change. Vasilos and Hughes (1979) used an autogenic audiotape and temperature biofeedback with male prisoners and found that both methods were equally useful for inducing skin temperature increases.

Relaxation training affects muscle tension levels. While EMG biofeedback and guided imagery produced significant differences between experimental and control subjects, Brusman (1985) found no difference in muscle tension levels using the techniques as anxiety reduction methods. In a study by Tetkoski (1983), students who received EMG biofeedback training had lower muscle tension than subjects who received oral instructions to relax. EMG biofeedback and a combination of biofeedback with therapy produced significant reduction in frontalis muscle tension for Khan (1978).

Electroencephalographic (EEG) readings show brain wave changes as a result of the type of activity in which one is engaged. Klinger, Gregoire, and Barta (1973) conducted an interesting study of psychophysiological correlates of mental activity using five types of tasks: imagination, suppression, concentration, mental search, and choice. Monitoring the left occipital lobe, the researchers found a high percentage of alpha in the left occipital area during imagination, suppression, and search tasks and a low percentage of alpha (blocking) during concentration and choice tasks. Also, Lehrer (1978) found that progressive relaxation produced increases in occipital alpha among anxiety neurotics, but borderline significant decreases in alpha among normal subjects.

Authorities disagree as to the amount of practice needed to elicit the relaxation response and, thus, to show physiological changes. Benson (1975) and Stroebel (1982) tend to think that the skill can be learned in one session. Jacobson (1938) and others (Schwartz, Davidson & Goleman, 1978) believe that a number of sessions facilitate learning. Kappes (1983) found, using progressive relaxation, autogenics, temperature, and EMG treatment, that volunteer participants improved on all physiological measures with time regardless of the technique. However, after eight sessions, only small amounts of improvement occurred as a result of practice. Lubar (1985) stated that learning disability children require four months or more to learn EEG biofeedback control. On the other hand, Lehrer (1978) reported that normal subjects with little or no relaxation training are able to relax very deeply.

Whether relaxation exercises are conducted live or on tape may affect physiological measures. Paul and Trimble (1970) found live training in progressive relaxation to be superior to taped training on all physiological systems measured. Russell, Sipich, and Knipe (1976) found, also, that live training was superior to taped training. Reinking and Kohl (1975) found EMG biofeedback superior to taped relaxation instructions for the facial muscles on reductions in forehead muscle tension in psychology students. In support of other researchers' findings are Beiman, Israel, and Johnson (1978), who found live training to be more effective than taped exercises of progressive relaxation when reducing physiological arousal.

Subject variables may tend to affect physiological changes associated with relaxation training. For example, Luthe (1963) indicated that children below nine years of age have difficulty maintaining concentration using autogenic training, while teenagers tend to regard the repetitive phrases as somewhat ridiculous. On the other hand, children seem to enjoy learning the techniques of progressive relaxation since these exercises deal directly with self-knowledge. Frederick (1979) reported, also, that children learn to relax much faster than adults, whereas adults are more receptive than children to suggestions of all kinds. In a research study using first and fifth graders, Cramer (1981) found the use of interactive imagery more facilitative for older children than for younger children.

Other subject characteristics were the findings of Felder, Russ, Montgomery, and Horwitz (1954) which showed that subjects with high basal skin temperatures were less likely to produce large scale increases than subjects with low basal temperatures. Tetkoski (1983) found no sex differences in response to biofeedback treatment, and Johnson and Meyer (1974) found that persons with internal locus of control increase alpha activity better than persons with external locus of control.

Research reports both positive and negative cognitive effects as a result of relaxation training. On the positive side were the findings of Khan (1978), Galyean (1981; 1982), Matthews (1986), and Lubar (1985). Using EMG biofeedback and a combination technique of EMG and relaxation training, Khan found that high-anxious children in the experimental group outperformed the control group on most subtests of the <u>Weschsler Intelligence Scale for Children--Revised</u> after treatment. Students trained with biofeedback ranked first in achievement. Galyean, using guided imagery immediately before instruction with junior high school students, found that Spanish skills significantly increased. In another study, Galyean was able to increase art and composition skills of tenth graders using a 10-minute imagery session before instruction. Matthews found similar results with high school students in keyboarding instruction. Those students who participated in guided imagery exercises before instruction performed better than similar students without relaxation training. With long-term training, Lubar reported that learning disabled students increased two and one-half grade levels per year after learning to control brain waves with EEG biofeedback. On the negative side were the findings of Matthews (1982) and Nathan (1984). Using relaxation training, including EEG biofeedback, with regular middle school students, Matthews found no significant differences between experimental and control students on French achievement. Likewise, Nathan found relaxation training alone did not produce higher levels of auditory attention with high-risk academic students. However, when relaxation training plus verbal suggestions were combined, students in the experimental group showed significant improvement over subjects in the control group.

The present study, which examined the physiological and cognitive effects of relaxation techniques in middle school students, adds to the body of literature. The study used a neutral stimulus, a filmstrip, and audiotaped exercises of three different relaxation strategies: progressive relaxation, autogenic training, and guided imagery.

Hypotheses

The research hypotheses for this study are the following:

1. The type of relaxation strategy is related to students' (a) brain wave frequency, (b) muscle tension, and (c) peripheral temperature at the end of 20 minutes.

2. Each type of relaxation activity is related to (a) lower brain wave frequency, (b) reduced muscle tension, and (c) higher peripheral temperature when compared to a neutral, nonrelaxing activity when observed at the end of 20 minutes.

3. Students' immediate recall, measured as (a) auditory forward digit span, (b) auditory backward digit span, (c) recollection of 10 nonsense syllables (Consonant-Vowel-Consonant) studied for one minute, and (d) recollection of a list of 10 familiar nouns studied for 1 minute, is related to the type of relaxation activity (progressive relaxation, autogenics, or guided imagery) and a neutral activity.

Method

Sample

The study used middle school students from Felton Laboratory School at South Carolina State College in Orangeburg, South Carolina. From the 60 students who volunteered, researchers selected 40 sixth, seventh, and eighth graders. The sample consisted of 42.5% sixth, 35%

seventh, and 22.5% eighth graders. In relation to sex, the sample content was 42.5% males, and 57.5% female. Only students whose parents signed consent forms were in the pool of volunteers. The great majority, 90%, were black.

Procedure

The study utilized controlled observation in a relaxation laboratory over the course of ten weeks (March 3 to May 9). Each student reported to the relaxation laboratory for four sessions of 45 minutes each. Each student reported at the same time of day and on the same day of the week. Observations were two weeks apart. The researcher assigned participants randomly to times and days for observation.

The laboratory technician observed each student while the child was participating in each of the three types of relaxation activities (progressive relaxation, autogenics, and guided imagery) and a neutral activity consisting of the showing of a filmstrip. This last activity served as a control for purposes of comparison with the relaxation exercises. The researcher randomized the order of the four activities for each participant so that the student engaged in one activity per day. The laboratory technician made four observations, allowing each type of activity to be observed once.

Upon arrival in the laboratory, the student sat quietly as the technician connected monitoring equipment to the student to record physiological signs. After recording initial physiological data, the technician sat behind the student and started the audiotape for the appropriate relaxation treatment. In order to minimize distractions during the observation, all dials, meters, and printouts were behind the student.

Instrumentation

Monitoring Instruments. Three types of instruments provided physiological measures on the students. These instruments measured muscle tension, brain wave frequency and amplitude, and finger temperature. The design of the study required reading of the devices at the outset of an observation and at the end of 20 minutes. The technician made measurements, also, at 5, 10, and 15 minutes into each observation. The technician recorded the measures on a data collection form developed for that purpose. (See Appendix A.)

The Cyborg J33 measured muscle tension, or motor neuron activity. Although small, the portable electromyographic unit is sensitive to activity within the range of 0.7 and 1000 microvolts. The operator of the monitoring equipment attached the sensors to a triple-electrode strip placed on the forearm extensor muscles. The placement allowed for observation of large groups of muscles.

The Autogen 120a measured brain wave frequency and amplitude. The encephalograph analyzer which was attached to an Autogen 5500 Data Acquisition Center and printer gave the average brain wave frequency and amplitude in intervals of five minutes. The occipital-temporal regions on the scalp of the left hemisphere were the areas for electrode placement. Taking of amplitude measures was for no other reason than to test the brain wave frequency for credibility. The EEG analyzer sometimes reports frequencies with very low amplitudes. Such frequencies are probably not trustworthy because an accurate frequency measurement demands sufficient amplitude to provide data to the analysis. Second, very large amplitudes frequently warn the technician of problems in measurement which are caused, for example, by loose electrodes and faulty cables to the electrodes. All of the amplitudes observed in the study lay within a range which lent credibility to the frequency measures.

The Ouroboros TEMP-3811 measured finger temperature. The device measures the temperature of the skin and displays it on a large panel to the nearest tenth of a Fahrenheit degree. The technician attached the temperature probe, which extended from the device, to the middle finger of the dominant hand with a porous hypoallergenic tape. Within the biomedical range of 70 to 100 degrees Fahrenheit, the instrument accuracy is trustworthy.

Cognitive Tests. The researcher developed four types of cognitive tests to use immediately after the treatment and control activities. The tests measured auditory forward digit span, auditory backward digit span, written recalled nonsense syllables, and auditory recalled nouns. Since students were tested after each procedure, the researcher developed four forms of each test. Additionally, the researcher designed a form for the student's written response to the remembered nonsense syllables. The tests and recording form are in Appendix B. After the laboratory technician was satisfied that data were being collected reliably, the technician made a set of measures for each dependent variable and initiated the relaxation activity.

Relaxation Training

Relaxation exercises were on audiotapes. The researcher used a tape recorder placed near the student so that the sound level could be low, but the student could hear the exercises with ease. The exercises represented three techniques: progressive relaxation, autogenics, and guided imagery. The audiotape used for progressive relaxation was "Deep Muscle Relaxation" by Lowenstein (1978a). For autogenics, the study used an audiotape from the Charlesworth Relaxation and Stress Management Program (1977) entitled "Autogenic Training." "Guided Imagery Relaxation," another audiotape by Lowenstein (1978b), was representative of guided imagery.

Progressive Relaxation. Progressive relaxation, a technique started by Edmund Jacobson (1938), concentrated on tensing and relaxing the various muscles of the body. When learning to control the skeletal musculature and, thence, the rest of the body, one has to cultivate an ability, comparable to the natural unlearned ability to perceive the external environment, for making sensitive observations of the internal sensory world (autosensory observation). In acquiring heightened internal sensory observation, one learns primarily to recognize a subtle state of tension. Then, for control, one contrasts that tension sensation with the later elimination of tension, which is relaxation. Systematic contraction of each major muscle group in turn permits the learner to identify the unique tension sensation (the control signal) for that muscle group. Then, reducing muscle tension permits achievement of a state of relaxation. Thus, in progressive relaxation, one learns to control all of the skeletal musculature so that any portion thereof may be systematically relaxed or tensed in order to accomplish the individual's immediate purpose.

The audiotape used in the research focused on four sets of muscles: hands, forearms, and biceps; head, face, throat, and shoulders; chest, stomach, and lower back; and thighs, buttocks, calves, and feet. The voice asked the student to participate in exercises of tightening and releasing the various muscle groups so that feelings of tension and relaxation could be internalized. For example, the child clenched the right fist and then opened the hand. Next, the child clenched both fists and then opened both hands. Exercises continued until all of the muscle groups were completed. Progressive relaxation is an active method which requires participant involvement.

Autogenics. Autogenics, a system of psychosomatic self-regulation that was developed in Germany about the turn of the century, permits the gradual acquisition of autonomic control (Schultz & Luthe, 1969). The control is not active; rather, it develops out of a "passive concentration" through which the trainee intends to move toward certain effects, for example, relaxation, and yet remains detached as to the student's actual progress. The focal point of one's concentration is on visual, auditory, and somatic imagery which are employed to induce specific physiological changes, such as increasing hand warmth during progressive muscle relaxation.

With the audiotape as the leader, the student focused on the arms and legs becoming warm and heavy, the heartbeat becoming calm and regular, and the whole body becoming quiet, heavy, comfortable, and relaxed. The messages given the brain in this relaxed state cause the brain to program the physical body for changes. Autogenic training shows the relationship between the mind and body, as do other cognitive techniques.

Guided Imagery. Guided imagery is a technique which integrates cognitive with experiential learning and involves focusing, passivity, and receptivity. The technique enhances the development of the imagination. Guided imagery utilizes both the mind and the emotions as tools for exploring and objectively understanding oneself. Around the turn of the century, Emil Coué (1922) realized the power of positive thinking and the use of the imagination. Coué believed that the power of the imagination far exceeded that of the will; therefore, the imagination could be used to evoke the relaxation response.

In the guided imagery exercise used in this research, the child, through the imagination, traveled down a road on a bright sunny day and explored, through the five senses, various aspects of the environment. Some examples of suggestions made by the audiotape were: walk to the edge of the road, see the fence, hear the gurgling stream in the background, see the trees on either side of the road, hear the wind blowing gently through the trees, smell the cool and damp wood, and look up at the deep blue sky. Interspersed between the sensual suggestions were prompts to breathe deeply, feel relaxed, and let the fears and tensions go.

Neutral Stimulus

In order to determine the effects of the various relaxation techniques, the study needed a neutral stimulus (control exercise). For the neutral stimulus, the researcher used a filmstrip-tape program. The student watched a program about stress and diseases which was authored by Rhines (1985). A projector advanced the film automatically, thus allowing the student to be a passive listener and viewer.

Research of the type embodied in this study demands a control condition. Useful interpretation of the comparison of different relaxation strategies is impossible unless the set of strategies can be compared to a condition of no treatment. Finding a condition of no treatment in a study of relaxation strategies is difficult, since almost any activity which requires the participant to sit quietly in a dimly lighted laboratory is likely to be relaxing to a degree. If the subject does <u>not</u> sit quietly, however, it is not possible to compare physiological measures collected under the condition to those which were made under the relaxation exercises. The choice of a control condition is difficult to make and to defend. In this study, the selected control condition was similar to a nonrelaxing learning activity commonly encountered in school.

<u>Observations</u>

As the activity progressed, the technician observed the following at five-minute intervals:

1. the peripheral temperature;
2. the ambient temperature;
3. the time of day;

4. the mean brain wave frequency averaged over 1 minute;

5. the mean brain wave amplitude averaged over 1 minute; and

6. muscle tension measured in microvolts.

At the end of each activity the technician administered, in random order, four simple psychometric tests designed to measure short-term recall. These tests were:

1. auditory forward digit span;

2. auditory backward digit span;

3. recall of nouns from a 10-word list of common nouns studied for 1 minute; and

4. recall of 10 nonsense syllables studied for 1 minute.

Four forms of each test were used. Test forms were randomized, as well as the order in which each test was administered. At the end of testing, the participant left the laboratory, and the observation ended.

Analysis of Data

Since all 40 students received each level of the treatment variable, it is possible to conceptualize each physiological measure as the sum of components associated with four sources: (1) the student, (2) the treatment, (3) the student-treatment interaction, and (4) error. Normally, the practice effect (which suggests that subjects improve in their ability to elicit the relaxation response as they continue to exercise) contaminates the research as a biased source of error variance. To manage practice effect, randomization of the order of treatment for each subject was necessary. Since the variance component associated with each student was of no interest to the research beyond its use to reduce the observed variance, the researcher confounded purposely other possibly contaminating variables, such as time of day and day of week, with the student effect by having each student report for treatment at the same time and day in each two-week observational cycle. For Hypothesis 1, then, after the treatment means were computed, analysis of variance of each physiological measure was accomplished by using a two-factor analysis of variance where the two crossed main effects were: (1) student (a random factor with 40 levels) and (2) treatment (a fixed factor with four levels). The component of variance for the denominator of the F-statistic for each main effect is the mean-square associated with the treatment-by-student interaction. For Hypothesis 2, the researcher used *a priori* contrasts to compare the aggregated three relaxation exercises to the control condition. Summary data from Hypothesis 1 facilitated this analysis. Prior research had revealed that the peripheral temperature (finger temperature, in this study) as a measure of relaxation is contaminated by ambient temperature and the time of day in which the temperature is measured (Matthews &

Quinn, 1986). Consequently, the technician recorded both ambient temperature and the time of day. Time of day had to be converted to a measure of the ordinate of the circadian thermal cycle (CTC) which has a minimum at 5:00 a.m. and reaches a plateau near noon. (Other systematic changes in CTC lie outside of the hours spanned by the experiment and are not relevant to this study.) For Hypotheses 1 and 2, the researcher residualized peripheral temperature by subtracting the linear component of finger temperature associated with both ambient temperature and CTC before its further analysis. After this correction was made, the researcher referenced the measure as "corrected peripheral temperature."

For Hypothesis 3, the researcher used the same two-crossed-factor analysis of variance as was used in Hypothesis 1. Instead of the physiological measures, however, student test performance was the dependent variable.

Results

Table 1 shows mean physiological measures made prior to each relaxation exercise by treatment level. The table reveals the fact that the experimental subjects began each treatment in a state of near total relaxation. The peripheral temperatures are surprisingly high, the EMG readings are quite low, and the brain wave frequencies lie easily within the alpha range, denoting alert, relaxed consciousness. The results of this study, then, have to be

Table 1

Means of Three Physiological Measures Observed Prior to Each of Four Treatment Levels

Measure	Treatment				Mean
	Progressive Relaxation	Guided Imagery	Autogenics	Control	
Corrected Peripheral Temperature[a]	92.96	93.01	93.88	93.38	93.31
Muscle Tension[b]	.77	.79	.76	.87	.80
Brain Wave Frequency[c]	11.11	10.66	11.20	11.26	11.06

[a]Expressed in Fahrenheit degrees.

[b]Expressed in microvolts.

[c]Expressed in Hertz.

interpreted as a comparison of relaxation strategies on children who were relaxed to a very high degree before the comparisons were made.

Two-factor analyses of variance on each of the three sets of measures revealed no significant differences by treatment prior to the relaxation exercises. Since the same 40 students were submitted to the four treatments in a random order, this finding is evidence of good experimental control of between-treatment variation at the beginning of treatment. Thus, the four groups were comparable, prior to treatment, on all three physiological measures.

Table 2 reports the mean corrected peripheral temperature, measured at the end of each 20-minute session, for each of the four treatment levels. Note that the means range from 92.87 for the control condition to 94.67 for guided imagery. The analysis of variance summary table for a test on these means appears in Table 3. In the analysis, a strong and significant student effect was evident. The treatment effect, however, failed to achieve statistical significance.

Tables 4 and 5 parallel Tables 2 and 3, except that, instead of corrected peripheral temperature, they examine muscle tension. Even though the means ranged from .710 microvolts for autogenics to .990 microvolts for progressive

Table 2

Means of Corrected Peripheral Temperature by Treatment[a]

Progressive Relaxation	Guided Imagery	Autogenics	Control
94.51	94.67	93.78	92.87

[a]Expressed in Fahrenheit degrees and measured after the treatment.

Table 3

Analysis of Variance Summary Table for Corrected Peripheral Temperature by Treatment

Source of Variability	df	SS	MS	F	$P>F \mid H_o$
Student	39	1415.37	36.29	3.53	.0001*
Treatment	3	81.04	27.01	2.63	.0537
Student-Treatment Interaction	117	1203.39	10.29		

*Probability < .05.

Table 4

Means of Muscle Tension (EMG) by Treatment[a]

Progressive Relaxation	Guided Imagery	Autogenics	Control
.990	.720	.710	.795

[a]Expressed in microvolts and measured after the treatment.

Table 5

Analysis of Variance Summary Table for Muscle Tension by Treatment

Source of Variability	df	SS	MS	F	$P>F \mid H_0$
Student	39	21.83	.56	1.09	.3520
Treatment	3	2.02	.73	1.31	.2730
Student-Treatment Interaction	117	6.00	.51		

relaxation, there was no significant difference among treatment means. Surprisingly, there was no observable student effect among the EMG measures either.

Tables 6 and 7 parallel Tables 2 and 3, also, with the exception that the measure is brain wave frequency. There was neither an observable treatment effect nor an observable student effect among these measures.

Tables 2 through 7 provide no support for Hypothesis 1. However, the fact that students entered each treatment condition, on average, in an advanced state of relaxation with little chance of becoming substantially more relaxed makes the finding of little importance. The four treatments may be very different in relaxing tense or anxious students, but this study cannot address such an issue.

When the study was planned, the researcher organized the observation sessions so that each physiological measure was observed initially and at the end of each five-minute interval. When significant differences among treatments were observed using the final measures, the researcher intended to examine the measures made after 5, 10, and 15 minutes to study when the changes occurred. When no significant effect on the measures could be associated with the treatment level, these measures lost their value to the study and were not used.

Hypothesis 2 anticipates a relation between the same three physiological measures and two treatment conditions.

Table 6

Means of Brain Wave Frequency by Treatment[a]

Progressive Relaxation	Guided Imagery	Autogenics	Control
10.63	10.59	10.45	10.95

[a]Expressed in Hertz and measured after the treatment.

Table 7

Analysis of Variance Summary Table for Brain Wave Frequency by Treatment

Source of Variability	df	SS	MS	F	$P>F\|H_o$
Student	39	171.58	4.40	.89	.6599
Treatment	3	5.44	1.81	.36	.7798
Student-Treatment Interaction	117	584.28	4.99		

In one condition, students received a relaxation exercise (either progressive relaxation, guided imagery, or autogenics). In the other, the students viewed a filmstrip which was used as a control. Investigation of the hypothesis is possible by employing the same measures and analysis procedures as those that were used in Hypothesis 1, with the exception of submitting the means to a priori linear contrasts to test the hypothesis. Under the necessary condition that the sum of weights must be 0, the contrast of interest here uses a weight of 1/3 for each treatment mean in the set of three relaxation methods and a weight of -1 for the control group. Tests of the hypothesis are directional for each physiological measure.

Using the means for corrected peripheral temperature in Table 2, the control mean is 92.87°F. The mean of the other three groups is 94.32°F. Because the difference in the two means is 1.45°F in the hypothesized direction, the researcher computed the mean square for the contrast (Winer, 1971, p. 172) to be 63.08. Employing the student-by-treatment interaction in Table 3 as the denominator mean square, the F ratio for the contrast is $F_{(1,117)} = 63.08/10.29 = 6.13$, a highly significant F.

Using a similar procedure for muscle tension (See Tables 4 and 5.), the control mean is .795 microvolts. The mean of the other three treatment levels is .807 microvolts. Because the difference of means is in a direction opposite to that hypothesized, the researcher made no further statistical tests.

For brain wave frequency, the two means of interest are 10.95 for the control group and 10.56 for the treatment group. The means, though close, differ in the hypothesized direction. The $\underline{F}$ statistic for the contrast, computed as $\underline{F}_{(1,117)} = 1.22$, was too small to be significant.

In summary for Hypothesis 2, while neither brain wave frequency nor muscle tension differed from the control group to the relaxation group, corrected peripheral temperature, when compared to the control condition, appears to have been increased by submitting the students to a relaxation exercise. This finding is interesting, given the initial high level of relaxation indicated by high levels of pretreatment corrected peripheral temperature.

Tables 8 through 15 report the results of tests of Hypothesis 3, which hypothesizes that the different treatments affect student performance on simple learning tasks. Table 8 discloses the four treatment means for the span of digits remembered by students when the digits were presented in the order in which they were to be remembered. Table 9 summarizes the analysis of variance which tests the difference in means for significance. Even though a highly significant student effect was observed, the treatment effect was not significant. The number of digits remembered

Table 8

Means of Auditory Forward Digit Span by Treatment

Progressive Relaxation	Guided Imagery	Autogenics	Control
7.80	7.70	7.85	7.68

Table 9

Analysis of Variance Summary Table for Auditory Forward Digit Span by Treatment

Source of Variability	df	SS	MS	F	$P>F \mid H_o$
Student	39	151.74	3.89	5.36	.0001*
Treatment	3	.82	.27	.38	.7705
Student-Treatment Interaction	117	84.93	.73		

*Probability < .05.

correctly for each group [illegible]urprisingly high, indicating, once again, that the students were performing at a very high level, even under the control condition.

The use of auditory backward, rather than forward, digit span produced entirely parallel results, as is reported in Tables 10 and 11. Tables 12 and 13 repeat the same story for recall of nonsense syllables. Repetition of the identical pattern is observable in Tables 14 and 15 for the number of nouns recalled.

In summary, there is <u>no</u> support found in the data for Hypothesis 3, even though this finding must be interpreted in light of students' overall high performance on all tests and their initially high levels of relaxation.

The researcher studied the effect of practice in relation to physiological measures and performance on short-memory tests. Table 16 reports the corrected peripheral temperature for each of four successive observations. Since the treatment was randomized for each student, any component of variance associated with a treatment effect is randomized, also, tending to inflate the error variance. The comparison across observation remains valid, however. Table 16 shows both initial readings (before any treatment) and final readings (after 20 minutes of treatment). There is no linear trend suggested by the means across four observations, either for first or final readings. Table 17 reports two analyses of variance in which student and observation (1, 2, 3, or 4)

Table 10

Means of Auditory Backward Digit Span by Treatment

Progressive Relaxation	Guided Imagery	Autogenics	Control
5.28	5.70	5.55	5.75

Table 11

Analysis of Variance Summary Table for Auditory Backward Digit Span by Treatment

Source of Variability	df	SS	MS	F	$P>F \mid H_o$
Student	39	300.99	7.72	5.91	.0001*
Treatment	3	5.47	1.82	1.40	.2475
Student-Treatment Interaction	117	152.78	1.31		

*Probability < .05.

Table 12

Means of Nonsense Syllable Recall by Treatment

Progressive Relaxation	Guided Imagery	Autogenics	Control
5.95	5.38	5.65	5.83

Table 13

Analysis of Variance Summary Table for Nonsense Syllable Recall by Treatment

Source of Variability	df	SS	MS	F	$P>F \mid H_o$
Student	39	471.10	12.08	6.57	.0001*
Treatment	3	7.45	2.48	1.35	.2613
Student-Treatment Interaction	117	215.05	1.84		

*Probability < .05.

Table 14

Means of Noun Recall by Treatment

Progressive Relaxation	Guided Imagery	Autogenics	Control
8.48	8.23	8.28	8.38

Table 15

Analysis of Variance Summary Table for Noun Recall by Treatment

Source of Variability	df	SS	MS	F	$P>F \mid H_0$
Student	39	203.28	5.21	4.09	.0001*
Treatment	3	1.48	.49	.39	.7633
Student-Treatment Interaction	117	149.03	1.27		

*Probability < .05.

Table 16

Means of First and Final Corrected Peripheral Temperatures for Four Observations (Practice Effect)[a]

	Observation Number			
Reading	1	2	3	4
First	94.18	93.17	92.71	93.17
Final	94.18	93.87	93.58	94.19

[a]Expressed in Fahrenheit degrees.

Table 17

Analysis of Variance Summary Table for First and Final Corrected Peripheral Temperatures for Four Observations (Practice Effect)

Source of Variability	df	SS	MS	F	$P>F \mid H_o$
First Reading (Prior to Treatment)					
Student	39	1998.39	51.24	2.06	.0170*
Observation Number	3	45.93	15.31	.61	.6071
Student-Observation Interaction	117	2916.65	24.93		
Final Reading (After Treatment)					
Student	39	1415.36	36.29	3.33	.0001*
Observation Number	3	10.16	3.39	.31	.8174
Student-Observation Interaction	117	1274.00	1[illegible].89		

*Probability < .05.

are crossed factors and which are tested against the student-by-observation interaction. Neither differences in first nor final readings are statistically significant. The significant student effect is not surprising, but the finding does not relate to the study's hypotheses.

Tables 18 and 19 parallel Tables 16 and 17, but, instead of examining corrected peripheral temperature, the variable under study is muscle tension. While no student effect was noted, there was a noticeable observation effect both before treatment and following treatment. Tukey's hsd *post hoc* test (used to analyze into homogeneous subsets a set of means which was found to differ significantly) reveals: For both first and final readings, the first observation mean of muscle tension is isolated statistically from all three later means, all three of which form a homogeneous subset. These data support the existence of a practice effect. Upon arriving for the first observation, students were tense, a tension which showed itself as an inflated muscle tension. This tension persisted through the treatment until the final reading aggregated across all four treatments. Returning later for the second, third, and fourth observations, students' personal experience of the first observation seems to have reduced the level of stress, since the treatment had become less mysterious and had proven itself to be neither painful nor embarrassing.

Table 18

Means of First and Final Muscle Tension Measures (EMG) for Four Observations (Practice Effect)[a]

	Observation Number			
Reading	1	2	3	4
First	1.21	.68	.66	.62
Final	1.16	.74	.62	.71

[a]Expressed in microvolts.

Table 19

Analysis of Variance Summary Table for First and Final Muscle Tension Readings for Four Observations (Practice Effect)

Source of Variability	df	SS	MS	F	$P>F \mid H_o$
First Reading (Prior to Treatment)					
Student	39	6.06	.16	1.20	.2284
Observation Number	3	9.45	3.15	24.31	.0001*
Student-Observation Interaction	117	15.17	.13		
Final Reading (after Treatment)					
Student	39	21.83	.56	1.19	.2386
Observation Number	3	6.91	2.30	4.89	.0031*
Student-Observation Interaction	117	55.11	.47		

*Probability < .05.

Tables 20 and 21 use brain wave frequency instead of corrected peripheral temperature (Tables 16 and 17) or muscle tension (Tables 18 and 19). The means differ little and do not suggest a trend. The summary in Table 21 shows neither a significant student effect nor a practice effect for either first or final reading.

Tables 22 through 29 report the practice effect on the four memory tasks following treatment. In Table 22 the mean auditory forward digit span ranged from 7.50 for Observation 1 to 8.08 for Observation 2. The summary in Table 23 reveals that the means differ significantly by observation, as well as by student. A Tukey hsd *post hoc* test on the four means revealed: Only the first and second observations were significantly different. The third and fourth observations belonged to both of the subsets containing Observations 1 and 2. Students coming to the second observation remembered significantly more digits than they did in the first observation, but this practice effect was not sustained over subsequent observations.

In Table 24, the mean number of digits remembered in reverse order is reported for each of the four observations. The means ranged from 5.05 for the first observation to 5.88 for the third. Table 25 reports both a significant student effect and a significant observation effect. A Tukey hsd *post hoc* test on the means found two homogeneous subsets.

Table 20

Means of First and Final Brain Wave Frequencies for Four Observations (Practice Effect)[a]

Reading	Observation Number			
	1	2	3	4
First	11.41	10.91	11.18	10.73
Final	10.99	10.32	10.85	10.46

[a]Expressed in Hertz.

Table 21

Analysis of Variance Summary Table for First and Final Brain Wave Frequency Readings for Four Observations (Practice Effect)

Source of Variability	df	SS	MS	F	$P>F \mid H_o$
First Reading (Prior to Treatment)					
Student	39	141.48	3.63	1.24	.1881
Observation Number	3	10.85	3.62	1.24	.2990
Student-Observation Interaction	117	341.67	2.92		
Final Reading (after Treatment)					
Student	39	172.58	4.43	.90	.6444
Observation Number	3	11.95	3.98	.81	.4926
Student-Observation Interaction	117	577.77	4.94		

*Probability < .05.

Table 22

Means of Auditory Forward Digit Span for Four Observations (Practice Effect)

Observation Number			
1	2	3	4
7.50	8.08	7.78	7.68

Table 23

Analysis of Variance Summary Table for Auditory Forward Digit Span across Four Observation Sesssions (Practice Effect)

Source of Variability	df	SS	MS	F	$P>F \mid H_o$
Student	39	151.74	3.89	5.78	.0001*
Observation Number	3	6.97	2.32	3.45	.0189*
Student-Observation Interaction	117	78.78	.67		

*Probability < .05.

Table 24

Means of Auditory Backward Digit Span for Four Observations (Practice Effect)

Observation Number			
1	2	3	4
5.05	5.55	5.88	5.80

Table 25

Analysis of Variance Summary Table for Auditory Backward Digit Span across Four Observation Sesssions (Practice Effect)

Source of Variability	df	SS	MS	F	$P>F \mid H_o$
Student	39	300.99	7.72	6.38	.0001*
Observation Number	3	16.67	5.56	4.59	.0045*
Student-Observation Interaction	117	141.58	1.21		

*Probability < .05.

The lower subset contains Observations 1 and 2. The higher subset contains Observations 2, 3, and 4. Such a pattern of means is consistent with the existence of a practice effect; that is, recall improved with practice.

Neither the recall of nonsense syllables (Tables 26 and 27) nor the recall of familiar nouns (Tables 28 and 29) show any observation effect and, consequently, cannot be used to support the existence of a practice effect.

Summary

Using a sample of students noteworthy in their advanced level of relaxation prior to relaxation treatment, the researcher found no differences among three types of relaxation strategies and a control condition in any of three common measures of stress: corrected peripheral temperature, muscle tension, and brain wave frequency. When the aggregate mean from the three relaxation strategies was compared to the control condition, corrected peripheral temperature showed a significant difference. Apparently, peripheral temperature responded to relaxation treatment as compared to the control condition, even though the three different strategies did <u>not</u> produce significant differences in peripheral temperature among themselves.

Performance on memory tests posterior to each treatment and the control condition did not vary significantly, even though overall performance on the tests was impressively

Table 26

Means of Nonsense Syllable Recall for Four Observations (Practice Effect)

Observation Number			
1	2	3	4
5.43	5.85	5.78	5.75

Table 27

Analysis of Variance Summary Table for Nonsense Syllable Recall across Four Observation Sesssions (Practice Effect)

Source of Variability	df	SS	MS	F	$P>F \mid H_0$
Student	39	471.10	12.08	6.48	.0001*
Observation Number	3	4.25	1.42	.76	.5191
Student-Observation Interaction	117	218.25	1.87		

*Probability < .05.

Table 28

Means of Noun Recall for Four Observations (Practice Effect)

Observation Number			
1	2	3	4
8.10	8.65	8.30	8.30

Table 29

Analysis of Variance Summary Table for Noun Recall across Four Observation Sesssions (Practice Effect)

Source of Variability	df	SS	MS	F	P>F | H_o
Student	39	203.28	5.21	4.23	.0001*
Observation Number	3	6.28	2.09	1.70	.1715
Student-Observation Interaction	117	144.23	1.23		

*Probability < .05.

high. Studies of student performance with higher stress levels prior to treatment would be quite interesting but lie beyond the scope of this study.

When the data were analyzed for any effects associated with the order of observations, a significant effect was found for muscle tension. Since muscle tension dropped significantly from the first to the second observation and remained subsequently low, a practice effect seems to have occurred. No practice effect, nor even an observation effect, was observed on peripheral temperature or brain wave frequency measures.

When the four memory tests were analyzed for an observation effect, performance on auditory forward digit span contained an observation effect which suggested a practice effect. Performance on auditory backward digit span contained an observation effect, and the evidence of a practice effect was quite strong. No observation effect was found for recall of nonsense syllables or nouns.

Recommendation for Further Research

This study should be repeated for a group of students identified as being under stress. While the researcher expected a sample of middle school students to display at least moderate levels of stress, this expectation was unfounded. The sample came to treatment in such a relaxed state that relaxation strategies produced only slightly higher levels of relaxation.

References

Armstrong, F. D. (1986). Relaxation training with children: A test of the specific effects hypothesis. (Doctoral dissertation, West Virginia University, 1985). Dissertation Abstracts International, 46, 4004B.

Beiman, I., Israel, E., & Johnson, S. A. (1978). During training and post training effects of live and taped extended progressive relaxation, self-relaxation, and electromyogram biofeedback. Journal or Consulting and Clinical Psychology, 46(2), 314-321.

Benson, H. (1975). The relaxation response. New York: William Morrow and Company, Inc.

Brusman, M. M. (1985). A comparison of EMG biofeedback and guided imagery upon anxiety reduction in high-risk college students. (Doctoral dissertation, Northern Arizona University, 1985). Dissertation Abstracts International, 46(6), 1157A.

Carlton, P. H. (1974). The biofeedback techniques as a facilitator in autogenic training. (Doctoral dissertation, Oklahoma State University, 1973). Dissertation Abstracts International, 34(10), 5183-5184B.

Charlesworth, E. A. (Author). (1977). Autogenic training [Cassette Recording]. Houston, TX: Stress Management Research Associates.

Cinciripini, P. M. (1982). Relationship between frontalis muscle tension and digital skin temperature during EMG biofeedback. Perceptual and Motor Skills, 54, 895-898.

Coué, E. (1922). Self-mastery through conscious auto-suggestion. London: Allen and Unwin.

Cramer, P. (1981). Imagery and learning: Item recognition and associative recall. Journal of Educational Psychology, 73(2), 164-173.

Davidson, R. J., & Schwartz, G. E. (1976). Psychobiology of relaxation and related states. In D. Mostofsky (Ed.), Behavior modification an control of physiological activity. Englewood Cliffs, NJ: Prentice-Hall.

Felder, D., Russ, E., Montgomery, H., & Horwitz, O. (1954). Relationship in the toe of skin surface temperature to mean blood flow measured with a plethysmogram. Clinical Science, 13, 251-257.

Fredrick, A. B. (1979, January). Relaxation: Education's fourth "R". Washington, DC: National Institute of Education (DHEW). (ERIC Document Reproduction Service No. ED 164 497)

Galyean, B. C. (1981). The effects of a guided imagery activity on the writing skills of remedial English students. Preliminary report for the Center for Integrative Learning, Long Beach, CA.

Galyean, B. C. (1982). Visualization and imagery in education: A preliminary report. Report for the Center for Integrative Learning, Long Beach, CA.

Jacobson, E. (1938). Progressive relaxation. Chicago, IL: University of Chicago Press.

Johnson, R. K., & Meyer, R. G. (1974). The locus of control construction in EEG alpha rhythm feedback. Journal of Consulting and Clinical Psychology, 42(6), 913.

Kappes, B. M. (1983). Sequence effects of relaxation training, EMG, and temperature biofeedback on anxiety, symptom report, and self-concept. Journal of Clinical Psychology, 39(2), 203-208.

Keefe, F. J. (1978). Biofeedback vs. instructional control of skin temperature. Journal of Behavioral Medicine, 1(4), 383-390.

Keefe, F. J., Surwit, R. S, & Pilon, R. N. (1980). Biofeedback autogenic training and progressive relaxation in the treatment of Raynaud's disease: A comparative study. Journal of Applied Behavior Analysis, 13(1), 3-11.

Kelton, A., & Belar, C. D. (1983). The relative efficacy of autogenic phrases and autogenic-feedback training in teaching hand warming to chindren. Biofeedback and Self-Regulation, 8(3), 461-475.

Khan, M. A. (1978). The effects of EMG biofeedback assisted relaxation training upon problem-solving abilities of anxious children. (Doctoral dissertation, Western Michigan University, 1978). Dissertation Abstracts International, 39(5), 2476B.

Klinger, E., Gregoire, K. D., & Barta, S. G. (1973). Physiological correlates of mental activity: Eye-movements, alpha, and heart rate during imagination suppression, concentration, search, and choice. Psychophysiology, 10, 471-477.

Lehrer, P. M. (1978). Psychophysiological effects of progressive relaxation in anxiety neurotic patients and of progressive relaxation and alpha feedback in nonpatients. Journal of Consulting and Clinical Psychology, 46, 389-404.

Lehrer, P. M., Schoicket, S., Carrington, P., & Woolfolk, R. L. (1980). Psychophysiological and cognitive responses to stressful stimuli in subject practicing progressive relaxation and clinically standardised meditation. Behaviour Research and Therapy, 18, 293-303.

Lowenstein, T. J. (Author & Speaker). (1978a). Deep muscle relaxation: Major muscles (Cassette Recording No. 101). Manhattan, KS: Conscious Living Foundation.

Lowenstein, T. J. (Author & Speaker). (1978b). Guided imagery relaxation (Cassette Recording No. 103). Manhattan, KS: Conscious Living Foundation.

Lubar, J. F. (1985). EEG biofeedback and learning disabilities. Theory into Practice, 24(2), 106-111.

Luthe, W. (1963). Autogenic training: Method, research, and application in medicine. American Journal of Psychotherapy, 17, 174-195.

Matthews, D. B. (1982). Super power for effortless and efficient digest of language for expression with alpha rhythms in nature. (Research Bulletin No. 24). Orangeburg, SC: South Carolina State College, Office of 1890 Research. (ERIC Document Reproduction Service No. ED 217 713)

Matthews, D. B. (1984). A study of academic and psychosocial effects of relaxation training on rural preadolescents. (Research Bulletin No. 34). Orangeburg, SC: South Carolina State College, Office of 1890 Research. (ERIC Document Reproduction Service No. ED 252 801)

Matthews, D. B. (1986). The effects of timed relaxation on keyboarding achievement. (Research Bulletin No. 46-B). Orangeburg, SC: South Carolina State College, Office of 1890 Research. (ERIC Document Reproduction Service No. CG 019 097)

Matthews, D. B., & Quinn, J. L. (1986, April). A study of repeated wrist temperature of sixth, seventh and eighth graders. Paper presented at the Annual Convention of the American Association of Counseling and Development, Los Angeles, CA. (ERIC Document Reproduction Service No. CG 019 065)

Nathan, M. A. (1984). The effects of relaxation training and verbal suggestion phrases on auditory attention of high risk academic students. (Doctoral dissertation, Ball State University, 1984). Dissertation Abstracts International, 45(1), 131A.

Paul, G. L., & Trimble, R. W. (1970). Recorded versus "live" relaxation training and hypnotic suggestion: Comparative effectiveness for reducing physiological arousal and inhibiting stress response. Behavior Therapy, 1, 285-302.

Reinking, R. H., & Kohl, M. L. (1975). Effects of various forms of relaxation training on physiological and self-report measures of relaxation. Journal of Consulting and Clinical Psychology, 43, 595-600.

Rhines, K. L. (Author). (1985). Stress and Disease. [Filmstrip]. Pleasantville, NY: Human Relations Media.

Russell, R., Sipich, J., & Knipe, J. (1976). Progressive relaxation training: A procedural note. Behavior Therapy, 7, 566-568.

Schultz, J. H., & Luthe, W. (1969). Autogenic therapy (Vol. 1, Autogenics Methods). New York: Grune & Stratton.

Schwartz, G. E., Davidson, R. J., & Goleman, D. T. (1978). Patterning of cognitive and somatic processes in the self-regulation of anxiety: Effects of meditation versus exercise. Psychosomatic Medicine, 40, 321-328.

Stroebel, C. F. (1982). QR the quieting reflex. New York: Berkley Books.

Surwit, R. S., Pilon, R. N., & Fenton, C. H. (1978). Behavioral treatment of Raynaud's disease. Journal of Behavioral Medicine, 1(3), 323-335.

Tetkoski, M. W. (1983). Sex of subject and cognitive style as predictors of successful biofeedback performance. (Doctoral dissertation, Loyola University of Chicago, 1983). Dissertation Abstracts International, 44(12), 3947B.

Winer, B. J. (1971). Statistical principles in experimental design. New York: McGraw-Hill Book Company.

Vasilos, J. G., & Hughes, H. (1979). Skin temperature control: A comparison of direct instruction autogenic suggestion, relaxation, and biofeedback training in male prisoners. Journal of Behavior Technology, 25(4), 119-122.

APPENDIX A

DATA COLLECTION FORM

Observation No.: ______ Type of Activity: P I A C

Student Name ______________________________

Race: W B O Sex: M F Student ID No.: ____ ____

Date: __________________ Day of the Week: M T W TH F

	Minutes				
	0	5	10	15	20
Ambient Temp. (3 digits)					
Peripheral Temp. (3 digits)					
Time of Day (4 digits)					
Muscle Reading (6 digits)					
Average B-W Freq. (4 digits)					
Average B-W Ampl. (4 digits)					

Auditory Forward Digit Span ____ ____

Auditory Backward Digit Span ____ ____

Nonsense Syllable Recall ____ ____

Noun Recall ____ ____

APPENDIX B

DIGIT SPAN TESTS--FORWARD*

FORM A	FORM B	FORM C	FORM D
604	908	924	764
260	753	910	623
468	823	423	485
3021	3902	4308	7926
9725	4569	1842	6845
3195	7260	6783	1697
87054	87469	71654	68274
93082	72490	14695	20469
58926	70689	50386	15396
862057	135426	261948	840169
146930	963704	392541	568074
405692	864135	439657	548705
2583407	5689041	6185032	3806571
4195086	4920638	8079463	3829751
4051289	2536718	6209358	9470218
79358204	50746239	37502691	53679021
63204795	96103842	65412907	83152674
49637825	78294031	81604952	38124657
261708439	816734902	209846153	478501326
584730291	890136542	516784309	197068523
208695371	726089134	561037489	423758601
7194035862	2193465708	8435976012	5234716098
6712948305	9207453681	3872596014	7604329518
8460257913	2318704569	9736502481	4821736905

*Each grouping of numbers represents one trial.

DIGIT SPAN TESTS--BACKWARD*

FORM A	FORM B	FORM C	FORM D
758	950	407	261
483	805	960	901
278	853	658	254
5012	2513	8631	4369
3245	4176	8921	2367
6941	1572	2156	3412
70254	82079	60274	10546
82370	75602	86520	70148
86152	16395	68341	54023
920613	490156	650381	735190
52910[illegible]	320964	415062	982170
369870	821306	791543	148036
9062384	3507962	2071648	6725814
8907461	7246903	1807249	8739651
5642389	4589267	6598140	2105983
15039768	16048397	57819362	94628375
84629107	93451860	45061278	59204186
26703419	83019627	75692481	26170958
479680325	652438017	732081645	793851026
390567241	753061942	478053219	610493528
238706549	735801964	295761384	402189765
2160873459	1784352096	4325716098	1946532708
2398175406	6985274130	7308142569	3560429178
9750231468	4350869271	3814729056	7843915026

*Each grouping of numbers represents one trial.

NOUN RECALL TESTS*

FORM A	FORM B	FORM C	FORM D
librarian	antenna	architect	utensil
banjo	laughter	victory	blouse
merchant	cabinet	certificate	waffle
decision	napkin	caterpillar	department
operator	elbow	employee	youngster
foreman	photograph	pajamas	fertilizer
quail	manager	gravity	restaurant
hatchet	recipe	sandal	helicopter
satellite	hamburger	jewelry	telegram
jeans	tourist	warehouse	invitation

*Each word represents one trial.

NONSENSE SYLLABLE RECALL TESTS*

FORM A	FORM B	FORM C	FORM D
tib	lec	bab	vip
rax	ros	pab	dif
pem	dom	bup	nec
gir	ral	wog	xum
jez	sug	wip	dos
har	med	soc	har
gef	han	pon	zad
mog	viv	sud	lod
bif	jak	cep	bev
kal	wog	zow	cag

*Each word represents one trial.

NONSENSE SYLLABLE RECALL ANSWER SHEET

Name ______________________________

Date ____________ ID# ____________

Test A B C D Score ____________

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

END

U.S. DEPT. OF EDUCATION

OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT (OERI)

ERIC®

DATE FILMED

NOV. 5 1987