THE EFFECTS OF EMG AND GSR BIOFEEDBACK

TRAINING UPON BLOOD PRESSURE:

A CROSS-CULTURAL STUDY

By

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CHAPTER I

INTRODUCTION

Hypertension is one of the most common cardiovascular ailments affecting people at this time. However, there is no universally agreed upon single definition of the term hypertension. The World Health Organization and many life insurance companies use a definition that is similar to most of the current definitions. It is as follows: "Hypertension is a persistent elevation of the diastolic pressure above 90 mm Hg and of the systolic pressure above 140 mm Hg."

There are several ways of classifying hypertension: systolic and diastolic, intermittent and continuous, and primary and secondary. Intermittent hypertension occurs when the blood pressure is variable, fluctuating between normal and moderately elevated levels. Continuous hypertension develops when the arterioles are seriously damaged, and the blood pressure is always elevated. Systolic and diastolic hypertension refer to two types of blood pressure measures. One cardiac cycle is equivalent to one complete heart beat; it lasts 0.8 sec. Blood pressure is measured at two points in the cardiac cycle: systole and diastole. Systolic blood pressure is measured as both atria and then ventricles contract. Diastolic is measured as both atria and then both ventricles relax. Primary hypertension, also known as essential or idiopathic hypertension, has an unknown etiology. Secondary hyper-

tension develops as a result of primary diseases of the cardiovascular system.

Primary hypertension constitutes 90 percent of all cases of hypertension and affects at least one person in every ten in the United States. The morbidity rate for hypertension has been estimated to be approximately 100,000 lives per year in the United States alone. People living in stressful urban environments, males, and minority group members have the highest morbidity rates of all (Luckman and Sorenson, 1974). There are several theories of causation for primary hypertension, but one that is gaining support is one that involves environmental stress as a major precipitating factor (Brown, 1974, 1977).

Several strategies are used in the treatment of hypertension. The medical types of interventions typically involve the use of various drugs or surgical procedures. Another treatment strategy currently being used is that of biofeedback in the treatment of hypertension.

One of the first studies that suggested that biofeedback might be useful in the treatment of hypertension in humans was Shapiro, Tursky, Gershon, and Stern's (1969) research. In this study, they developed an apparatus that would give a continuous approximation of a subject's systolic pressure on each heartbeat. Twenty, normotensive, male college students were given feedback of their own systolic pressure, and half of them were operantly reinforced for increasing and half for decreasing their blood pressure. Subjects were given 25 trials with each trial lasting 65 sec. In terms of the conditioned blood pressure changes, the up-condition group tended to maintain their baseline pressure or to decrease their pressures slightly during the session. Blood pressure decreases were consistently and significantly more marked in the group that was reinforced for lowering their pressures. A t-test (matched

pairs) of the average differences between these changes was significant at the p<.01 level. The results of this study suggested that systolic blood pressure can be changed by the use of external feedback.

There have been a number of studies that used systolic blood pressure biofeedback (Brener, Kleinman, and Goesling, 1969; Brener and Kleinman, 1970; Benson, Shapiro, Tursky, and Schwartz, 1971; Kristt and Engel, 1975; Blanchard, Young, and Haynes, 1975). These studies found significant changes after the biofeedback training.

In an attempt to determine if diastolic pressure would be more efficacious than systolic pressure, several studies have used diastolic pressure as the information feedback (Haynes, 1974; Shapiro, Schwartz, and Tursky, 1972; Elder, Ruiz, Deabler, and Dillenkoffer, 1973; Elder and Eustis, 1975). These studies indicated that diastolic blood pressure was more likely to produce the desired changes than was systolic.

A study by Schwartz (1972) used forty, normotensive males, in their twenties. The results indicated that subjects could learn to control the relation between their systolic blood pressure and heart rate when they were given blood pressure feedback and reward for the desired pattern of pressure and heart rate. They could learn to integrate these functions (increase or decrease both jointly) or to differentiate them (raise one and simultaneously lower the other).

Elder and Eustis (1975) performed a study to determine if essential hypertension could be lowered by the use of instrumental conditioning on an outpatient basis. They found that this was possible; however, the authors interpreted their results as being suggestive that treatment was more effective with hospitalized than outpatient populations.

Goldman, Kleinman, Snow, Bidus, and Korol (1975) studied the relationship between essential hypertension, the effects of systolic pressure feedback, and cognitive functioning. Subjects were given pre- and post-measures on the Wechsler Adult Intelligence Scale and the Category Test, a subtest of the Halstead-Reitan Neuropsychological Test Battery. Subjects with the largest decrements in blood pressure (both systolic and diastolic) showed the most improvement on the Category Test when it was re-administered after the biofeedback training. These results were again shown in a study by Kleinman, Goldman, Snow, and Korol (1977).

Due partly to the large equipment expense necessary to use direct feedback of blood pressure, other methods have been attempted in the treatment of hypertension. Patel (1975) used a combination of Yogic relaxation and galvanic skin response (GSR) biofeedback in an experiment. This method was found to be quite effective. Patel used this combined treatment with 20 patients who were hypertensive. Patients attended sessions individually three times a week for half an hour each for three months. By the end of this treatment period, the use of anti-hypertensive medications was stopped altogether in five patients and reduced by 33-60% in another seven patients.

Horn (1974) studied the use of alpha feedback as a mode of treatment in hypertension. The results indicated that alpha production was inversely related to blood pressure in those subjects with initially low blood pressure. Due to the small number of subjects ($\underline{N}$=12), in this study, more work needs to be done to draw adequate conclusions as to the efficacy of alpha feedback in hypertension treatment.

There is a slowly growing body of literature that indicates the use of electromyographic (EMG) biofeedback is effective in the treatment of hypertension. Various studies have shown that the relaxation of musculature can produce decrements in blood pressure, both in hypertensives and in normotensives (Fray, 1977; Orlando, 1975; Coursey, 1975; Alexander, 1975; and Montgomery, Love, and Moeller, 1974).

Shoemaker and Tasto (1974) examined the effects of muscle relaxation exercises on the blood pressure of hypertensives. The major finding in this study, according to the authors, is that a treatment program for essential hypertensives should include training in muscle relaxation bolstered by biofeedback.

There is disagreement in the literature as to the true efficacy of EMG biofeedback in lowering blood pressure, but the studies with negative results generally have had very small numbers of subjects or poor controls in the experimental conditions (Fray, 1977; Shoemaker and Tasto, 1974; Alexander, 1975). Another aspect of the present study was an examination of personality variables that may affect EMG biofeedback results.

In an unpublished dissertation, Zigrang (1978) found, upon reviewing the literature, that only three personality variables seemed to have a consistent effect upon how well people respond to EMG and GSR biofeedback training. These were locus of control, autonomic perception, and anxiety.

Apparently, subjects who have an internal locus of control are better able to produce desired changes through the use of EMG and GSR biofeedback than are subjects who are said to have an external locus of control.

Autonomic perception is the degree to which individuals feel that they are aware of their internal, autonomic activity. The literature is conflicting on this subject, but seems to indicate that low or middle scorers on the Autonomic Perception Questionnaire, devised by Mandler, Mandler, and Uviller (1958), may be more accurate in their perception of internal states than are high scorers.

A final factor in the present study involves the possibility of cultural differences in terms of response to biofeedback training. There is a complete lack of published studies using American-Indian subjects in the area of biofeedback. There is, at the same time, a paucity of data on American-Indians concerning the personality variables that are seen as affecting performance on biofeedback tasks.

Tyler and Holsinger (1975) examined locus of control differences in fourth, seventh, ninth, and eleventh grade American-Indian children. These children, with the exception of the eleventh graders, scored in a significantly more external direction than a matched group of Caucasian children. Jessor, Graves, Hanson, and Jessor (1968) found, that within a tri-ethnic community, the American-Indians scored in a more external direction than a Spanish-American (Hispanic) group or a group of Caucasians.

The literature on field-dependency includes a small number of studies with minorities and even fewer with American-Indians specifically. However, Berry and Annis (1974) compared "traditional" Canadian Indians with acculturated Indians and urban Canadian Caucasians. The "traditional" Indians and the Caucasians were found to be highly field-independent. The authors concluded that the acculturation process in some way had led to the field-dependency of the acculturated Indian

group. Bowd (1977) also found evidence, using the Children's Embedded Figures Test, that suggested that Indians may be more field-dependent than Caucasians.

The Present Study

The present study examines the relationship among two biofeedback treatment methods and the learned control of blood pressure. One treatment method consists of visual feedback of GSR levels presented simultaneously with auditory feedback of EMG levels. The literature suggests that maximizing the information available to the subject, in terms of the information fed back to the subject, will increase the ability of the subject to produce any desired changes. The literature has also shown EMG biofeedback to be effective in learned control of blood pressure. The major focus of the present study is the determination of whether the addition of a second biofeedback mode, in this case GSR, improves or interferes with learning control of blood pressure.

GSR was chosen as the additional biofeedback mode for various reasons. GSR was used in Patel's (1975) study, and the results of that study are among the most impressive in the literature. One of the personality measures to be used in the present study is the Autonomic Perception Questionnaire devised by Mandler, et al. (1958). Part of the rationale for the development of this questionnaire was an examination of anxiety states. GSR has been shown to be correlated with anxiety, and this may provide a useful link between the personality and physiological measures of the present study. A final reason for the inclusion of GSR in the present study, is that the combination

of EMG and GSR biofeedback modes has not been used in any of the published studies.

All subjects were administered the Autonomic Perception Questionnaire devised by Mandler, et al. (1958), Rotter's (1966) External vs. Internal Control of Reinforcement Scale, and the Group Embedded Figures Test developed by Witkin (1950). These were given so that an examination of the relationships among locus of control, autonomic perception, field-dependency vs. field-independency, and the ability to use biofeedback to lower blood pressure can be made.

Finally, there is a cross-cultural aspect to the present study. The literature suggests that there are differences between American-Indians and Caucasians on the personality measures used in this study. Furthermore, the scores obtained by American-Indians on these measures have been shown to be in the very directions that are associated with less success on EMG and GSR biofeedback tasks. The present study examines American-Indian college students' scores on the above personality measures and their abilities to produce desired changes on biofeedback tasks. A similar examination is made of the personality measures scores and performance on biofeedback tasks of a group of Caucasian college students, and a comparison between the two groups is performed.

Hypotheses

It is hypothesized that subjects will be able to produce statistically significant decrements from baseline levels in blood pressure, both systolic and diastolic, through the use of both treatment methods.

The second hypothesis is that the subjects in the EMG and GSR treatment group will produce greater decrements in blood pressure than the subjects in the EMG only treatment group.

The third hypothesis is that Caucasian subjects will produce greater decrements from baseline levels than the American-Indian subjects.

The fourth hypothesis is that there will be a positive correlation between the degree of internal locus of control and ability to produce decrements from baseline levels in blood pressure.

The fifth hypothesis is that there will be a negative correlation between higher scores on the Autonomic Perception Questionnaire and the size of decrements from baseline levels in blood pressure.

The sixth hypothesis is that there is a positive correlation between the degree of field-independency and the ability to produce decrements from baseline levels in blood pressure.

CHAPTER II

METHOD

Subjects

Twenty Caucasian subjects, twelve females and eight males, were chosen from introductory psychology courses taught at Oklahoma State University. These subjects were randomly selected from a pool of volunteers. Twenty American-Indian subjects, twelve females and eight males, were chosen from the Native-American Student Association at Oklahoma State University.

The Caucasian subjects were recruited by means of class present-ations and were offered extra credit points for participation. The American-Indian subjects were recruited by a presentation given during a meeting of the Native-American Student Association. The experimenter offered to present the results of the study at another meeting as incentive for participation. All subjects, both Caucasian and American-Indian were within the age range of undergraduate college students; that is, approximately 18 to 23 years old.

Instruments

The Autonomic Perception Questionnaire (Mandler, et al., 1958) was given to all subjects in the experiment. This instrument has three sections. The first section requires free response descriptions by the subjects of their states of feeling and reactions when (a) in a

state of anxiety and apprehension and (b) in a state of pleasure. The second section consists of thirty self-rating scales. Of the 30 scales, 21 relate to feelings when in a state of anxiety, and 9 relate to the state of pleasure. The third section consists of 70 MMPI items. Fifty of these are from the Manifest Anxiety Scale; and an additional twenty were selected from the MMPI as dealing with reports of internal bodily stimulation.

The questionnaire was given to 166 Harvard College students. All of the intercorrelations for the parts of the questionnaire were significant at the .01 level or better. The results showed positive correlations between scores on this questionnaire and other paper-and-pencil tests of anxiety such as the Taylor Manifest Anxiety Scale.

All subjects were given the Group Embedded Figures Test (Witkin, 1950). This test is a perceptual test. The subject's task on each trial is to locate a previously seen simple figure within a larger complex figure which has been so organized as to obscure or embed the simple figure. The test consists of 24 trials, on each of which a different figure is employed.

This test is given to 51 men and 51 women, all Brooklyn College students, by Witkin (1950). The test has a fairly high reliability as shown by odd-even correlations of .87 for men and .74 for women. This test also correlates highly with the Kohs Test (r= .57) for field-independency vs. field-dependency.

All subjects were also given Rotter's (1966) External vs. Internal Control of Reinforcement Scale. This scale was designed to test whether a person perceives reinforcement for behavior as being under internal or external control. This scale has been used in a large

number of studies and reports of internal consistency show correlations in the .70's and test-retest reliabilities in the .60's for a one month period.

Apparatus

Electromyographic (EMG) measures were recorded from an Autogen 1700 Feedback Myograph using standard forearm and cervical placements. Galvanic skin response (GSR) measures were obtained from an Autogen 3400 Feedback Dermograph. Two active silver/silver chloride electrodes were placed on the second and third fingertips of the non-dominant hand. The ground electrode was placed on the index finger of the non-dominant hand, and was held in place by the use of velcro fasteners.

The subjects received auditory feedback of the levels of muscle tension. The feedback consisted of clicks which were logarithmically proportional to the level of muscle tension. Some subjects also received visual feedback of their GSR levels. This was provided by the use of a "Level" meter visible on the front panel of the Autogen 3400.

Blood pressure levels, both systolic and diastolic, were recorded. These readings were taken manually with a Clayton sphygmomanometer.

Training for Experimenters

The experimenters were two female undergraduate psychology students and one male graduate student. These students were trained in carrying out the procedures for applying EMG and GSR electrodes, using a sphygmomanometer, conducting the baseline and training trials, and in giving instructions to the subjects. The experimenters received practice on mock subjects until they could apply the apparatus quickly and

smoothly. Experimenters observed at least one complete session per-
formed by an experienced experimenter. Each experimenter was then
observed for at least one session by the experienced experimenter.
When the observer judged the novice experimenter to be competent in all
phases of the sessions, the novice experimenter was allowed to conduct
further sessions without supervision.

<div align="center">Procedure</div>

Phase I

Initially the subjects, who were selected from a larger group of
volunteers, were brought together for an orientation session.

At this session, the subjects were informed orally that the
experiment would be in the area of biofeedback; that the experiment
would involve their possibly gaining more control over aspects of their
physiological pattern; that the experiment would require a time
commitment from them of about three hours total; and that further
information would be given during the experiment itself.

Each subject was then given a card. These cards were assigned to
subjects randomly, and each card had a unique number on it. The
subjects were instructed to write their names on the backs of the cards.
That number served as their "identification" on the paper-and-pencil
tests that they were given.

All subjects were then given the Autonomic Perception Questionnaire,
Rotter's External vs. Internal Control of Reinforcement Scale, and the
Group Embedded Figures Test, in that order. Each subject was told to

write the unique number, of their card, in the space where their name would normally be written on the test. In this way, the tests could be scored by the experimenter without his gaining knowledge of individual subjects' names and scores together. After the training trials were complete, the names of the subjects were matched with their test scores by the use of the identifying numbers. The subjects, upon completion of the three tests, passed the tests in to be collected in an envelope. The cards with numbers and names were turned in and collected in a separate envelope. The subjects were then scheduled as to the times of their training trials and were dismissed. All subjects were scheduled for the biofeedback training within 15 days of the administration of the personality tests.

Phase II

The second phase of the experiment consisted of the collection of baseline and training trials data for each subject. The subjects arrived individually at their scheduled times, and were seated in a semi-reclining position in a reclining chair. The electrodes were attached at the locations chosen for the experiment.

At that point, the subject was given the following instructions:

> The purpose of this part of the sessions is to collect some data necessary for the experiment. I would like for you to make yourself as comfortable as possible. Please make no unncessary movements.

After these instructions were given, the subject's blood pressure, both systolic and diastolic, was taken using a standard bulb-and-cuff sphygmomanometer. Following the recording of the blood pressure, there was a five min. "rest period" for the subject. During this time, the

Autogen 5100 Digital Integrator was used for two min. to give the average EMG levels for the subject. The integrator combined the cervical and forearm flexor EMG levels and displayed the average of these. This average was recorded by the experimenter. Following the recording of the EMG levels, the next two min. were spent in recording the subject's GSR levels. The average GSR level over the two min. period was recorded by the experimenter. This combination of blood pressure, EMG, and GSR recordings was repeated until a total of three blood pressure and three EMG and GSR recordings had been taken. This procedure resulted in baseline levels for the three measures.

The next portion of this phase consisted of the actual training trials. Subjects were randomly assigned to one of two treatment conditions: EMG and GSR feedback with relaxation instructions (Group 1), and EMG only feedback with relaxation instructions (Group 2). The experimenter was given only the subject's name and group number. Treatment groups one and two consisted of equal numbers of Caucasians and American Indians, and each group consisted of 12 males and 8 females.

During the actual training trials, the subject was seated in a semi-reclining position in a chair. The recorded instructions were played for them. The instructions were as follows:

> This is an experiment on the effects of biofeedback upon an individual's physiological pattern of responses. What we are interested in is whether or not a person can lower their blood pressure by becoming very relaxed and calm. Through the headphones, you will hear a series of clicks. As you relax, the number of clicks you hear should decrease. On the instrument panel before you, there is a meter that will also give you information about how relaxed you are. Just above and to one side of the meter is a label that says "more relaxed". As you become more relaxed, the meter's needle should move in the direction of that label. Your task is to decrease the number of clicks you hear and move the needle in the direction of the label. These can both be accomplished by your simply relaxing. We have found that there are ways that help a

person relax such as: Make yourself as comfortable as possible. Try to breathe deeply and evenly. Try to move as little as possible. Let yourself think about how it feels to be very warm and sleepy. Let relaxing images come into your mind. From time to time, there will be silent periods when we are recording measures. At the end of a few minutes, we will stop and take your pressures; and then we will begin again letting you become more relaxed. The whole session will last about one hour. Remember, listen to the clicks, watch the meter, and just try to become very, very relaxed. We will now begin.

The sequence for the training trials began with the experimenter setting up the equipment for the group in which the scheduled subject belonged. Group one received auditory feedback of their EMG levels and visual feedback of their GSR levels. For this group, the experimenter arranged the equipment so that the meter of the Autogen 3400 Feedback Dermograph was visible to the subject. This meter was labeled as to the direction the subject was to try to deflect the needle.

For group two, the subjects received both auditory and visual feedback of their EMG levels only. The experimenter arranged the equipment so that the meter of the Autogen 1700 Feedback Myograph was visible to the subject. This meter was also appropriately labeled. These equipment arrangements could be made easily and quickly. After the instructions had been played and the headphones placed on the subject, each subject then received four eight-min. periods of feedback with their blood pressure taken after each trial. The average EMG readings and the GSR readings were recorded twice during the eight-min. feedback periods.

Following the completion of the session, the subjects were informed as to the nature of the experiment, and any questions they had were answered as fully as possible. The subjects were further instructed as to how they could obtain information concerning the results of the study.

Design

Independent Variables

The independent between-subject variable is treatment group. The EMG and GSR feedback plus relaxation instructions are the first condition. The EMG only feedback and relaxation instructions are the second condition.

The four trials within each session constitute a within-subject independent variable. A classification variable is the race of the subject; that is, American-Indian or Caucasian.

Dependent Variables

Dependent variables in the present study included: EMG levels, GSR levels, and decrements in blood pressure levels. Scores on three paper-and-pencil tests were correlated with the physiological measures.

CHAPTER III

RESULTS

Introduction

Results will be presented in three separate sections. The first

section will examine the comparability of the four groups of subjects

in terms of their baseline physiological measures. The second section

will examine the training trials data on EMG, GSR, systolic BP levels,

and diastolic BP levels. This second section will be an analysis of

evidence of learning. The third section will report the nature of the

interrelationships among personality and physiological measures for

the four groups.

Comparability of the Treatment and Cultural Groups

To ensure that any obtained differences in learning among the

four groups are a result of differences in responses to training and

not a result of some confounding variable, an ANOVA on Treatments

(2) X Groups (2) was performed on the average of the three baseline

levels for the four physiological measures. For example, the average

was obtained for the three baseline trials EMG levels on each subject;

and a 2 X 2 ANOVA was run on this measure.

No differences were found for EMG, GSR, or diastolic blood

pressures. Thus, any differences in learning among the groups on these

measures will not be a reflection of differences in initial baseline values. The analyses of variance for these three measures are shown in Appendix D.

The results of systolic blood pressure baseline levels differed from the other measures. No differences between the two treatment groups were found; however, there was a Group difference on systolic BP baseline levels, $F(1,37)= 16.43$, $p < .0002$ (see Table I). An examination of the means for the two Cultural groups showed that the American-Indian group, mean of 122.80 mm Hg, had signficantly higher baseline systolic BP levels than did the Caucasian group whose mean systolic BP equaled 113.92 mm Hg (see Appendix E).

Evidence of Learning

A difference score, which reflected a decrement from baseline levels on each of the physiological measures, was used in the initial ANOVAS shown in Appendix F. To obtain these difference scores, the training trial four (the final training trial) measurements were subtracted from the average baseline levels. For example, the training trial four EMG measurements were subtracted from the average baseline EMG level for each subject. The ANOVA performed on the systolic BP difference scores showed a significant Treatment effect, $F(1,36)= 5.36$, $p < .02$. A significant Group effect was also shown, $F(1,36)= 5.71$, $p < .02$. The mean difference score for the EMG and GSR group (Trt. Group 1) equaled 3.73 mm Hg, and the mean difference score for the EMG only group (Trt. Group 2) equaled 5.78 mm Hg (see Appendix G). Thus, the EMG only treatment group attained significantly larger decrements in systolic BP levels. The mean difference score for the Caucasian group equaled

TABLE I

ANALYSIS OF VARIANCE SUMMARY TABLE FOR AVERAGE
BASELINE SYSTOLIC BLOOD PRESSURE LEVELS

Source	df	S.S.	F	PR F
Model	2	816.3611	8.50	.0009
Error	37	1776.8361		
Treatment Group	1	27.2250	.57	.4562
Cultural Group	1	789.1361	16.43	.0002

5.82 mm Hg, and for the American-Indian group the mean difference score equaled 3.70 mm Hg. Thus, the Caucasian subjects attained a significantly larger mean decrement than did the American-Indian subjects.

The ANOVA performed on the diastolic BP difference scores showed only a significant Treatment effect, $F(1,36) = 6.69$, $p < .01$. The mean difference score for the EMG and GSR treatment group equaled 2.33 mm Hg, and the mean difference score for the EMG only treatment group equaled 4.97 mm Hg. Thus, the diastolic BP data paralleled the systolic BP data in that the EMG only treatment group attained statistically significantly larger mean decrements in blood pressure levels than the EMG and GSR treatment group. There was no significant Group or Treatment X Group effect indicated by the ANOVA on the diastolic BP difference scores.

No significant Group, Treatment, or Group X Treatment effects were found in ANOVA performed on the EMG and GSR level differences scores. It appears that, on these two measures, the groups did not differ significantly.

In order to determine if the actual size of the difference scores was statistically significant, t-tests were performed on these scores for each Treatment group (see Table II). The t-test on the systolic BP data, for the EMG and GSR treatment group, indicated that the size of the decrements was statistically significant $t(19) = 6.039$, $p < .0005$. For the systolic data on the EMG only treatment group, the t-test also indicated significantly large decrements in systolic BP levels, $t(19) = 8.340$, $p < .0005$.

TABLE II

T-TEST ON CORRELATED MEANS FOR THE FOUR PHYSIOLOGICAL
MEASURES DIFFERENCE SCORES BY TREATMENT GROUPS

	EMG only		EMG and GSR	
Measures	t value	p value	t value	p value
EMG	1.3649	NS	1.6544	NS
GSR	2.0064	p<.05	1.1141	NS
Systolic BP	8.3400	p<.0005	6.0390	p<.0005
Diastolic BP	6.4374	p<.0005	3.3900	p<.005

The t-tests performed on the diastolic data for both treatment groups also indicated statistically significantly large decrements. On the EMG and GSR group, the result was t(19)= 3.390, p<.0005; and for the EMG only group, the result was t(19)= 6.4374, p<.0005. The t-tests performed on the EMG decrements failed to reach significance on both of the Treatment groups. The result for the EMG and GSR group was t(19)= 1.654, p= NS; and for the EMG only group, t(19)= 1.3649, p= NS. The t-test on the GSR decrements for the EMG and GSR treatment group also failed to reach significance, t(19)= 1.114, p= NS; however, the t-test on GSR decrements did reach significance for the EMG only group, t(19)= 2.0064, p<.05.

Four separate mixed ANOVAS on Groups (2) X Treatments (2) X Trials (4) were performed on the training trials data. These ANOVAS are shown in Appendix H. The between subjects variables were the cultural groups and treatment groups, and the within subjects variable was trials. The mixed ANOVA on the systolic data showed a significant main group effect, F(1,36)= 23.97, p<.0001; and a significant trials effect, F(3,108)= 36.00, p<.0001. No other main effects nor interactions reached significance. Apparently the only differences in the systolic blood pressure difference scores were between the two cultural groups and among the four training trials.

An examination of the systolic data means showed that the American-Indian group, with a mean of 120.65 mm Hg. had significantly higher systolic blood pressure levels than did the Caucasian group. The Caucasian group had a mean systolic blood pressure level of 109.15 mm Hg during the training trials. The means of the four trials, on systolic blood pressure, are shown in Appendix I. The trial means indicate a

decreasing trend in systolic blood pressure levels across the four

trials. The mixed ANOVA performed on the diastolic blood pressure

levels paralleled the systolic data. There were significant main group

and trials effects. The result for groups was $F(1,36)= 4.15$, $p<.05$;

and the result for trials was $F(3,108)= 16.56$, $p<.0001$. The American-

Indian group had a significantly higher mean diastolic blood pressure

level than did the Caucasian group. The mean diastolic blood pressure

level for the American-Indian group equaled 75.48 mm Hg, and the

Caucasian group's mean equaled 71.75 mm Hg. The trial means showed a

decreasing trend across trials; and the largest decrement occurred in

trial two. No other main effects nor interactions reached significance

in the diastolic data analysis. The mixed ANOVA performed on the EMG

data indicated a significant main group effect only, $F(1.36)= 5.41$,

$p<.026$. The American-Indian group's mean EMG level of 2.77 microvolts

was significantly higher than the Caucasian group's mean of 2.02

microvolts. No other main effects nor any interactions reached

significance. The mixed ANOVA performed on the GSR data indicated a

significant trials effect only, $F(3,108)= 3.73$, $p<.01$. The trial means

indicate a decreasing trend across trials. The largest decrement

occurred in trial two, and the next largest decrement occurred in trial

four. The groups X trials effect only approached significance,

$F(3,108)= 2.39$, $p<.07$. No other main effect nor any other interactions

even approached significance.

Interrelationships Among the Personality and

Physiological Measures

A seven X seven matrix of Pearson product moment correlations on

the Autonomic Perception Questionnaire Score, the Rotter External vs. Internal Control of Reinforcement Questionnaire Score, the Rotter External vs. Internal Control of Reinforcement Scale Score, the Embedded Figures Test Score, and the physiological measures difference scores (on systolic BP, diastolic BP, EMG, and GSR) is shown in Appendix J. This matrix indicated two significant correlations. One out of the 21 correlations would be expected to be significant at the .05 level by chance alone. The Rotter External vs. Internal Control of Reinforcement Scale Score was not significantly related to any of the other measures. The Group Embedded Figures Test Score correlated significantly with the GSR level difference scores $r(40)=+.28$, $p<.039$. The Autonomic Perception Questionnaire Score correlated significantly with the GSR level difference scores $r(40)=-.29$, $p<.037$. None of the physiological measures correlated significantly with any of the other physiological measures.

It appears that if a subject was less autonomically perceptive, he or she would produce decrements in GSR levels. It would also seem that if a subject had a higher degree of internal locus of control, he or she would produce decrements in GSR levels. The Autonomic Perception Questionnaire Scores and the Group Embedded Figures Test Scores did correlate negatively with each other, but not significantly so. T-tests were performed on the Treatment and Cultural groups in terms of the three personality test scores, and none of the groups differed significantly.

CHAPTER IV

DISCUSSION

The general question considered in the present study was whether

or not subjects could use EMG only or EMG and GSR biofeedback to

lower their blood pressures. The results indicate that subjects can.

Both treatment groups data show decreasing trends across trials on both

systolic and diastolic blood pressure. The actual size of the decre-

ments in blood pressure was found to be statistically signifcantly

large for both groups. These results agree with other studies using

EMG to train subjects to lower their blood pressures (Fray, 1977;

Orlando, 1975).

In the present study, it was hypothesized that subjects in the

EMG and GSR treatment group would produce greater decrements in blood

pressure from baseline levels than the subjects in the EMG only group.

The results did not support this hypothesis. An analysis of the

results showed that the EMG only group produced significantly larger

decrements from baseline levels in both systolic and diastolic blood

pressures. The two treatment groups' data showed similar trends across

the four training trials. Both groups obtained their largest

decrements in trial two. A possible explanation of these trends may

be found in the experimental procedure. The subjects were instructed

to merely relax during the baseline trials with no external feedback

being given them. At the onset of training trial one, feedback was

begun; and the subjects had to begin the tasks of reducing the number of clicks heard through the headphones and attempting to deflect a meter's needle in a given direction. These tasks required the development of cognitive strategies on the subjects' parts. This development may have involved the subjects during the entire first trial and may not have allowed any real progress on the biofeedback task until trial two. Since no questions were asked in the present study concerning the subjects' subjective impressions of trials one and two; the above explanation is purely speculative. The area of cognitive strategies and the trends found in the EMG and GSR data offer an explanation of the differential performances of the two groups. The GSR data trend across trials paralleled the systolic and diastolic data. There was a decreasing trend across trials; with the largest and smallest decrements found in trials two and four respectively. The EMG data trend was different. The EMG levels dropped in trial two, rose in trial three, and the largest drop occurred in trial four. The EMG and GSR treatment group listened to EMG feedback and watched the GSR meter for feedback. Due to the differing trends, this group received conflicting feedback. This could have made the task for the EMG and GSR combined treatment group more difficult. An implication of this finding and possible explanation is that, if more than one mode of biofeedback (e.g. EMG and GSR) or mode of presentation (e.g. visual and auditory) is to be used, feedback should be somehow integrated. For example, the EMG and GSR signals could be integrated into one, time-averaged feedback signal and presented to the subject. This would keep the subjects' task from becoming too difficult due to conflicting feedback.

The two treatment groups consisted of equal numbers of Caucasian and American-Indian subjects. It was hypothesized that the Caucasian subjects would produce greater decrements from baseline levels in blood pressure than the American-Indian subjects. The results suggested support for this hypothesis. The Caucasian group performed better on systolic blood pressure, and obtained significantly larger mean decrements in systolic blood pressure. Support for this hypothesis is only suggested since the American-Indian subjects had significantly higher baseline systolic pressures. The American-Indian group began the study with higher systolic pressures and obtained smaller decrements than the Caucasian group of subjects. An examination of the mean baseline systolic pressure for the American-Indian group, whose mean equaled 120.65 mm Hg, showed that this was not so high as to be clinically significant. This suggests that the smaller decrements obtained by this group were not necessarily due to cardiovascular problems that would preclude success in lowering blood pressure. One would not posit dietary differences as reasons for the differential performances of the two cultural groups; since the diastolic pressure baselines of the two groups did not differ. An alternative explanation for the differential performances might be that the American-Indian subjects found the experimental situation more aversive. This is speculative and is based upon the reports of the subjective impressions of the experimenter. The American-Indian subjects appeared to be much less at ease with the equipment, especially the electrodes. This was reflected in the data through higher baseline levels on all four physiological measures; though only the systolic blood pressures were significantly higher. Further research would be needed to determine if

aversion to the experimental situation truly explained the performance of the American-Indian group.

Other questions considered in the present study concerned three personality variables. The literature suggested that these variables affected performance on EMG and GSR biofeedback tasks (Zigrang, 1978). It was hypothesized that there would be a positive correlation between the degree of internal locus of control and ability to produce decrements from baseline levels in blood pressure. The results did not support this hypothesis. Scores in the direction of higher internal locus of control correlated negatively with the size of both systolic and diastolic blood pressure decrements. This correlation was not significant.

Higher scores on autonomic perception were hypothesized to correlate negatively with larger decrements in blood pressure. This hypothesis was not supported by the results. Higher autonomic perception scores did correlate negatively with larger blood pressure decrements, but not significantly.

It was hypothesized that there would be a positive correlation between the degree of field-independency of subjects and the ability to produce decrements from baseline levels in blood pressure. This hypothesis was not supported by the results. The degree of field-independency did not correlate significantly with the size of either systolic or diastolic blood pressure decrements. The correlation between the degree of field-independency and the size of systolic blood pressure decrements was in a positive direction, but was in a negative direction in terms of the diastolic blood pressure decrements.

The only significant correlations found among the personality measures and the physiological measures involved GSR decrements, autonomic perception, and the degree of field-independency. Larger decrements in GSR levels were found to be associated with lower autonomic perception scores and higher field-independency scores.

An interesting finding in the present study was that no group differences were found in the personality variables. The American-Indian college students scored very similarly to the Caucasian college students. This result agrees with the literature on acculturation. One implication of this for future cross-cultural biofeedback research is that researchers should attempt to use more traditional, that is less acculturated, American-Indians. It may be that American-Indians that are acculturated to the degree that they would accept a college degree as a goal are not very dissimilar from Caucasian college students on some personality variables. It could be that the similarity on these or other variables, between American-Indian and Caucasian college students, contributed to the lack of cultural group differences in the present study.

The final portion of this discussion will be an attempt to place the results of the present study within the framework of the existing biofeedback and blood pressure research. Various feedback modalities have been effectively used in studies of learned blood pressure control. The literature review (see Appendix A) contains many studies that utilized external feedback of either diastolic or systolic blood pressure. Some researchers have used EMG feedback to reduce their subjects blood pressures (Orlando, 1975; Montgomery, et al., 1974). Steptoe (1976) used pulsewave velocity feedback successfully.

Horn (1974) studied alpha wave production and blood pressure changes.
Finally, Patel's 1975 study used a combination of Yoga relaxation
instructions and galvanic skin response (GSR) feedback.

For comparison purposes, the pertinent aspects of the present study
will be summarized. The subjects were normotensive college students.
Subjects were given one session consisting of four baseline trials
of five min. duration each and four training trials of ten min.
duration each. Two treatment groups, of equal size, were used. One
group received EMG feedback, both auditory and visual, and the second
group received auditory EMG feedback and visual GSR feedback. The mean
decrements from baseline levels of the EMG only group's systolic and
diastolic blood pressures equaled 5.78 mm Hg and 4.97 mm Hg respectively.
The EMG and GSR group obtained a mean systolic decrement of 3.73 mm Hg
and a mean diastolic decrement of 2.33 mm Hg.

By comparison Orlando, in her 1975 study, used two groups of
hypertensive subjects. One group received four 30 min. EMG biofeedback
sessions per week, and a second group received one 30 min. EMG session
per week. Both groups received daily autogenic relaxation training.
The biofeedback sessions were given for six weeks. The four sessions
per week group obtained a mean systolic decrement from baseline levels
of 4.2 mm Hg and a mean diastolic decrement of 1.5 mm Hg. The one
session per week group had mean systolic and diastolic decrements of
6.33 mm Hg and 9.5 mm Hg respectively. The EMG feedback was given
auditorally. The results of the present study compare quite favorably
with Orlando's results. It is interesting to note that the mean
systolic decrements were larger than the mean diastolic decrements in
both groups of the present study and the four sessions per week group

in Orlando's study. The comparison of results is even more striking

given that the subjects in the present study received 40 min. total

feedback time, and Orlando's subjects received 12 hrs. of feedback in

one group and 3 hrs. in the other. Her subjects also received auto-

genic relaxation training during the study. On the other hand,

Orlando's (1975) study used chronic essential hypertensive subjects;

and it is typically more difficult to lower blood pressures in this

type of subjects than in normotensive subjects.

Another study that used auditory EMG feedback and relaxation

training was the Montgomery, et al.'s (1974) study. In this study,

hypertensive subjects were given 30 min. sessions twice weekly for

a period of 16 wks. The subjects showed mean decrements from

baseline levels of 14.74 mm Hg systolic and 12.70 mm Hg diastolic.

The results of the present study compare favorably with the results of

Montgomery, et al.'s study. Although the Montgomery, et al.

study used hypertensive subjects, the cognitive task may have been

simpler. Their subjects had only to process auditory feedback rather

than auditory and visual feedback as in the present study. While

Montgomery, et al.'s subjects received approximately 16 times as

much training time as the present study's subjects; they showed

blood pressure decrements only three times larger approximately.

The pattern of larger systolic than diastolic decrements was present

also.

Goldman, et al. (1975) used heartbeat-by-heartbeat feedback

of systolic blood pressure rather than EMG feedback. They

gave seven male, essential hypertensive subjects weekly two

hr. training sessions for a period of nine wks. Feedback

consisted of a brief light and a moderate intensity tone that were

contingent upon decreases in systolic blood pressure. From the

beginning of the first session to the beginning of the ninth session,

the experimental subjects showed mean decrements of 14.7 mm Hg diastolic

and 6.3 mm Hg systolic. The authors offered no explanation for the

larger diastolic than systolic decrements. Within training sessions,

subjects obtained mean decrements of 7.0 mm Hg systolic; and diastolic

blood pressure increased an average of .2 mm Hg. Their subjects

obtained larger blood pressure decrements than the subjects in the

present study, but their subjects received 18 hrs. of biofeedback

training. The subjects in the present study received only 40 min. of

biofeedback training.

A series of experiments by Shapiro and his colleagues all involved

systolic blood pressure feedback, both auditory and visual feedback,

25 trials each of which lasted approximately one min. in duration.

For the subjects trained to decrease their blood pressures, decrements

in systolic blood pressure ranging from .5 mm Hg to 4.8 mm Hg were

found. Other studies using direct feedback of systolic blood pressure

have found decrements within the same range.

One other type of biofeedback study should be compared to the

present study. This is Patel's (1975) work on yoga and biofeedback

in the management of hypertension. This comparison will be made

because the biofeedback that Patel used was GSR. The subjects were

20 hypertensive patients, and their ages varied from 39 to 78 yrs.

All but one of the subjects were taking anti-hypertensive medications

of some kind. Each of the subjects were seen individually and a yogic

relaxation method was explained to them. Subjects attended three

sessions per wk. for half an hour each for three months. At each

session, subjects lay on an examination couch with their eyes closed.

They received audio feedback of their GSR levels, and they were to use

the yogic relaxation method to lower their GSR levels. The results of

Patel's (1975) study are very impressive. The average blood pressure

of 121 mm Hg at the beginning of the trial was reduced to 101 mm Hg.

Anti-hypertensive medications were stopped altogether for five subjects

and were reduced by 33 to 60 percent in seven other subjects. There

were four subjects whose drug regimen was unchanged, but their blood

pressure levels were lowered. Another four patients did not lower

their blood pressures. Both systolic and diastolic blood pressures

were reduced for the group of subjects on the average. Their average

systolic pressure fell from 160 to 134 mm Hg, and their average

diastolic pressure was reduced from 102 to 86 mm Hg. There were no

significant changes in pulse rate, rate of respiration, or body weight

among the subjects during the study. Patel did a follow-up on these

subjects one year after the study. Statistically significant reduc-

tions in blood pressure and anti-hypertensive drug requirements were

satisfactorily maintained in the treatment group.

The rationale for the addition of GSR to EMG feedback, in one of

the present study's treatment groups, grew out of Patel's success with

GSR feedback. It was hypothesized in the present study that the GSR

and EMG treatment group would produce larger decrements than the EMG

only group. This hypothesis was not supported by the results of the

present study. The EMG only group's results compare well with the

results of Patel's work. With only one session and 40 min. of feedback

training, the blood pressure decrements in the present study were

one-fourth the size of the blood pressure decrements that Patel found.

The pattern of larger systolic decrements than diastolic decrements

was shown in both the present study and Patel's. The EMG and GSR group

did not fare as well. Patel's (1975) study produced blood pressure

decrements approximately nine times larger than the EMG and GSR

group of the present study. A possible explanation for this discrep-

ancy lies not in a single versus multiple modality feedback problem.

The explanation is more a question of task complexity. The EMG only

group's task was to reduce levels of concordant feedback; while the EMG

and GSR group's task was to reduce levels of conflicting feedback.

In conclusion, the results of the present study are, for the most

part, comparable to the results of other studies in the literature. The

EMG only group of the present study obtained blood pressure decrements

from baseline levels that were larger than some studies that had much

longer training times. Other studies showed larger decrements in blood

pressure; but if the number of sessions and amount of time spent in

training were increased in the present study, one could predict that the

decrements found would be comparable to the more successful studies.

The results of the data analysis concerning the EMG and GSR

decrements are very problematic. While the blood pressure decrements

were found to be significantly large; the EMG and GSR decrements were

not found to be significantly large. The problems lie in the fact that

the subjects were being trained to lower their EMG and GSR levels. It

was theorized that reduced muscle tension and galvanic skin response

would bring about reductions in blood pressure. The blood pressure

reductions occurred; but the EMG and GSR levels reductions did not, at

least not to a statistically significant degree. There were reductions

in EMG and GSR levels in both treatment groups, and these reductions did follow the trends described in the results section. There is no obvious explanation for these results, but one could speculate that the production of significant blood pressure reductions does not require the production of significant reductions in EMG or GSR levels. A second possible explanation for these results might posit that the change scores in blood pressure were due to habituation, postural changes, or lack of stimulation. The care taken to obtain stable baselines under conditions similar to training makes this rather unlikely. Another alternative explanation for these problematic findings is that some physiological process, that was not measured in the present study, was a mediating agent. This mediator could be anything from skin temperature to vascular musculature. It is even possible that simply increasing the number or length of the trials would produce the desired significant reductions in EMG and GSR levels. This could be examined in future research.

The present study's results suggest that a possible extension might involve a comparison of three groups with the present study's groups. One group would receive both auditory and visual feedback of their GSR levels; this would parallel the EMG only group of the present study. A second group would receive an integrated auditory feedback signal of both GSR and EMG levels. The third group would receive an integrated visual feedback signal of both GSR and EMG. With appropriate experimental controls, the results of these groups could be compared with the results of the present study to determine whether the task complexity or visual versus auditory feedback were problematic on this type of task. It would also be interesting to give these groups more training trials

and more training time to examine the blood pressure reduction trends over a longer period than the present study.

REFERENCES

Alexander, A. B. An experimental test of assumptions relating to the use of electromyographic biofeedback as a general relaxation technique. Psychophysiology, 1975, 12(6), 656-662.

Benson, H., Shapiro, D., Tursky, B., & Schwartz, G. E. Decreased systolic blood pressure through operant conditioning techniques in patients with essential hypertension. Science, August 1971, 173(3998), 740-741.

Berry, J. W., & Annis, R.C. Ecology, culture and psychological differentiation. International Journal of Psychology, 1974, 9, 173-193.

Blanchard, E. B., Young, L. D., & Haynes, M. R. A simple feedback system for the treatment of elevated blood pressure. Behavior Therapy, March 1975, 6(2), 241-245.

Bowd, A. D. Field dependence and performance of Piagetian invariance tasks: A cross-cultural comparison. The Journal of Genetic Psychology, 1977, 130, 157-158.

Brener, J. M., & Kleinman, R. A. Learned control of decreases in systolic blood pressure. Nature, June 1970, 226, 1063-1064.

Brener, J. M., Kleinman, R. A., & Goesling, W. J. The affect of different exposures to augmented sensory feedback on the control of heart rate. Psychophysiology, 1969, 5(5), 510-516.

Brown, B. B. New mind, new body. New York: Harper & Row, 1974.

Brown, B. B. Stress and the art of biofeedback. New York: Harper & Row, 1977.

Coursey, R. D. Electromyographic feedback as a relaxation technique. Journal of Consulting and Clinical Psychology, 1975, 43, 825-834.

Elder, S. T., & Eustis, N. K. Instrumental blood pressure conditioning in out-patient hypertensives. Behavior Research and Therapy, 1975, 13, 185-188.

Elder, S. T., Longacre, A., Welsh, D. M., McAfee, R. D. Apparatus and procedure for training subjects to control their blood pressure. Psychophysiology, January 1977, 14(1), 68-72.

Elder, S. T., Ruiz, Z. R., Deabler, H. L., & Dillenkoffer, R. L. Instrumental conditioning of diastolic blood pressure in essential hypertensive patients. Journal of Applied Behavior Analysis, 1973, 6(3), 377-382.

Fray, J. M. Implications of electromyographic feedback for essential hypertensive patients (Doctoral dissertation, Texas Tech University, 1975). Dissertation Abstracts International, 1977, 58, 1584. (University Microfilms No. 75-26, 839)

Goldman, H., Kleinman, K. M., Snow, M. Y., Bidus, D. R., & Korol, B. Relationship between essential hypertension and cognitive functioning: Effects of biofeedback. Psychophysiology, September 1975, 12(5), 569-573.

Haynes, S. N. Application of operant feedback techniques in the control of diastolic blood pressure of essential hypertensives (Doctoral dissertation, University of Colorado, 1971). Dissertation Abstracts International, 1974, 34(10-B), 5169. (University Microfilms No. 72-17, 265)

Horn, M. B. Investigation of the relationship of blood pressure to alpha feedback stimulation (Doctoral dissertation, United States International University, 1974). Dissertation Abstracts International, 1974, 34(10-B), 5169. (University Microfilms No. 74-8913, 131)

Jessor, R., Graves, T. D., Hanson, R. C., & Jessor, S. I. Society, personality, and deviant behavior: A study of a tri-ethnic community. New York: Holt Rinehart and Winston, Inc., 1968.

Kleinman, K. M., Goldman, H., Snow, M. Y., & Korol, B. Relationship between essential hypertension and cognitive functioning: II. Effects of biofeedback training generalize to nonlaboratory environment. Psychophysiology, March 1977, 14(2), 192-197.

Kristt, D. A., & Engel, B. T. Learned control of blood pressure in patients with high blood pressure. Circulation, 1975, 51, 370-378.

Luckmann, J., & Sorenson, K. C. Medical-surgical nursing - A psychophysiologic approach. Philadelphia: W. B. Saunders Company, 1974.

Mandler, G., Mandler, J. M., & Uviller, E. T. Autonomic feedback: The perception of autonomic activity. Journal of Abnormal and Social Psychology, 1958, 56, 367-373.

Montgomery, D., Love, W. A., Jr., & Moeller, T. Effects of electromyographic feedback and relaxation training on blood pressure in essential hypertensives. Biofeedback Research Society Meeting Abstracts, 1974. (Abstract)

Orlando, J. Z. Learned self-regulation of arterial hypertension utilizing biofeedback and relaxation training (Doctoral dissertation, University of Florida, 1974). Dissertation Abstracts International, 1975, 36(2-B), 894. (University Microfilms No. 75-16, 430)

Paskewitz, D. A. Biofeedback instrumentation: Soldering closed the loop. American Psychologist, March 1975, 30(3), 371-378.

Patel, C. Yoga and biofeedback in the management of hypertension. Journal of Psychosomatic Research, 1975, 19(5-6), 355-360.

Rasmussen, W. A. Instrumental control of systolic blood pressure in hypertensive subjects (Doctoral dissertation, University of Massachusetts, 1972). Dissertation Abstracts International, 1973, 33(6-B), 2819-2820. (University Microfilms No. 72-32, 994)

Rotter, J. B. Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 1966, 80 (1, Whole No. 609).

Sawyer, J. E. The effects of muscle relaxation and biofeedback on blood pressure for essential hypertensives (Doctoral dissertation, University of Mississippi, 1976). Dissertation Abstracts International, 1977, 37(8-B), 4164. (University Microfilms No. 77-1432, 119)

Schwartz, G. E. Biofeedback as therapy: Some theoretical and practical issues. American Psychologist, August 1973, 663-673.

Schwartz, G. E. Voluntary control of human cardiovascular integration and differentiation through feedback and reward. Science, January 1972, 175(4017), 90-93.

Shapiro, D., Schwartz, G. E., & Tursky, B. Control of diastolic blood pressure in man by feedback and reinforcement. Psychophysiology, May 1972, 9(3), 296-304.

Shapiro, D., Tursky, B., Gershon, E., & Stern, M. Effects of feedback and reinforcement on the control of human systolic blood pressure. Science, February 1969, 163(3867), 588-590.

Shoemaker, J. E., & Tasto, D. L. The effects of muscle relaxation on blood pressure of essential hypertensives. Behaviour Research and Therapy, 1974, 13, 29-43.

Steptoe, A. Blood pressure control: A comparison of feedback and instructions using pulse wave velocity measurements. Psychophysiology, 1976, 13(6), 528-535.

Tyler, J. D. & Holsinger, D. N. Locus of control differences between rural American Indian and white children. The Journal of Social Psychology, 1975, 95, 149-155.

Witkin, H. A.   Individual differences in ease of perception of embedded
    figures. Journal of Personality, 1950-51, 19, 1-15.

Zigrang, P. A.   The effects of individual differences in physiological
    reactivity on learning control of EMG and GSR responses through
    biofeedback training. Unpublished doctoral dissertation, 1978.
    (Available from Psychology Department, Oklahoma State University,
    Stillwater, Oklahoma, 74078)

APPENDIXES

APPENDIX A

LITERATURE REVIEW

One of the first studies that suggested that biofeedback might be useful in the treatment of hypertension in humans was Shapiro, et al.'s (1969) research. In this study, they developed an apparatus that would give a continuous approximation of a subject's systolic pressure on each heartbeat. Twenty, normotensive, male college students were given feedback of their own systolic pressure, and half were operantly reinforced for increasing and half for decreasing their pressure. The subjects were seated in a semi-reclining position in a sound-and-light controlled room and were told that the experiment was concerned with the ability of individuals to control certain physiological responses. They were asked not to tense their muscles or move about, and to keep their breathing as regular as possible during the sessions. Subjects were given 25 trials; each trial lasting 65 seconds. The apparatus fed back the heartbeat-by-heartbeat systolic pressure to the subject using a 100 msec. flash of red light and a simultaneous 100 msec. tone for each success. The reinforcer was a slide of a nude from Playboy magazine that was projected for 5 sec. after every 20 flashes of light. Pairs of subjects were matched on their baseline levels and randomly assigned to each experimental condition. Measures of breathing patterns were taken by means of a strain gauge belt fastened around the waist, and the breathing patterns were indistinguishable in the two conditions. Measures of heartrate were taken, and no systematic relationship between heartrate and blood pressure was found. In terms of the conditioned blood pressure changes, the up condition group tended to maintain their baseline pressures or decrease them slightly during the session. The decrease was consistently and significantly more marked

in the group reinforced for lowering their pressures. A $\underline{t}$-test (matched pairs) of the average differences between these changes was significant at the $\underline{p}<.01$ level. The results of this study suggested that systolic blood pressure can be changed by the use of external feedback.

In an unpublished dissertation, Haynes (1974) examined the use of diastolic blood pressure feedback in a population of essential hypertensive patients in an attempt to lower their blood pressure. Each subject was exposed to stress and adaptation periods before and after one of three treatment conditions: augmented sensory feedback of diastolic blood pressure, no feedback of diastolic blood pressure, and non-contingent (random) feedback. Measures of skin conductance, heartrate, blood volume pulse, and blood volume were taken throughout each session. The results indicated that diastolic blood pressure feedback was significantly more effective in lowering blood pressure (diastolic) than was non-contingent feedback, but insignificantly different from no feedback. The various other physiological measures taken remained unchanged and unrelated to treatment effectiveness. The effectiveness of diastolic blood pressure as a function of feedback was related to diastolic blood pressure response to stress and vasodilation during treatment.

Following the finding in the Brener, et al. (1969) article that the degree of cardiovascular control is a direct function of the amount of augmented sensory feedback provided during training; Brener and Kleinman (1970) attempted to maximize the amount of blood pressure information fed back to subjects. In this study, systolic blood pressure was monitored from the finger rather than the upper arm in an

attempt to reduce the ischemic pain associated with that method. The apparatus provided feedback as to the systolic blood pressure every 2 to 3 heartbeats. Two groups of five normotensive college students each were run two sessions each group; and a session consisted of twenty trials of fifty-second duration separated by an intertrial interval of about thirty seconds. Subjects were told that the experiment was investigating whether or not they could decrease their blood pressures and were instructed fully as to the significance of the feedback display. They were told to use "mental processes" only, and were not to use somatic changes such as respiration or muscle tension. The control subjects were told that the experiment was to investigate their cardiovascular processes, and that they were only to pay close attention to the display during the sessions. The control subjects were also told not to change their breathing rates or muscle tension during the trials. The heartrates of the two groups were decreased within and between sessions; but were not significantly different between the two groups nor were they systematically related to the blood pressure changes. Because of the overlap in blood pressure between groups at the beginning of each session, there was not a significant group effect, and both groups' pressures were lower on the second session than the first. However, the experimental group did display substantially greater decreases in blood pressure as a function of trials over each session than did the control group. These results did suggest a degree of learned blood pressure control as a function of systolic blood pressure feedback.

Another study, involving systolic blood pressure feedback, was the Benson, et al. (1971) experiment. The subjects

used were ambulatory and attending the Hypertension Clinic of the
Boston City Hospital. There were five males and two females. Their
average age was 47.9 years. Six of the seven were taking antihyper-
tensive medications, and these medications were not altered during the
sessions. Median systolic blood pressure was recorded by use of an
automated, constant cuff-pressure system. During each trial, the cuff
was inflated for fifty consecutive heartbeats (recorded automatically
by an electrocardiogram) and then deflated. The subjects were given
thirty trials each session: with an intertrial interval of thirty to
forty-five seconds. There were five to sixteen control sessions for
each subject during which the median systolic blood pressure was
recorded with no feedback or reinforcement given. Following the
control sessions, subjects were given twenty-five conditioning trials
during which lowered systolic blood pressure, as indicated by the
absence of a Korotkoff sound, was fed back to the subject by means of
a 100 msec. flash of light and a simultaneous 100 msec. tone of moder-
ate intensity. The subjects were told that the tone and light were
desirable and they should attempt to make them appear, and after each
twenty tones and lights a slide was projected for five seconds. These
slides were of scenic pictures and were worth five cents each to the
subjects as a reward. The conditioning trials were discontinued after
five consecutive trials in which blood pressure did not lower. The
results showed that the subjects' blood pressures did not change within
the first five control sessions; however, it did lower an average of
4.8 mm Hg ($p < .001$) within each conditioning session. No consistent
changes in heartate were observed in the subjects concomitantly with
blood pressure changes.

In contrast to the above articles, Shapiro, et al. (1972) found that, in twenty normotensive college males, when diastolic blood pressure is conditoned; heartrate is also reinforced in the same direction although to a lesser degree. The apparatus used was similar to that in Shapiro's et al. (1969) study. Ten subjects trained their diastolic pressures up and ten down. Then there were extinction trials for both groups. Reductions in diastolic pressures ranged from two to ten mm Hg and persisted in a set of trials without feedback after the initial conditioning trials. This was after only thirty-five conditioning trials of brief duration.

A study by Schwartz (1972) used forty, normotensive males, in their twenties. The study found that subjects could learn to control the relation between their systolic blood pressure and heartrate when they were given blood pressure feedback and reward for the desired pattern of blood pressure and heartrate. They could learn to integrate these functions (increase or decrease both jointly) or to differentiate them (raise one and simultaneously lower the other).

Schwartz (1973) discussed the use of biofeedback as a therapeutic tool. He supported biofeedback's use in the treatment of hypertension, but not in the absence of other therapeutic procedures. He suggested further research in the area.

Elder, et al. (1973) studied eighteen male essential hypertensive subjects in an experiment designed to compare two different strategies for controlling high blood pressure. There were three treatment groups: control (no feedback), a group in which a 3 sec. red light was given to the subject contingent on a reduction in his diastolic pressure, and a group in which verbal approval was paired

with the signal given to group two. The apparatus obtained an indirect measure of systolic and diastolic blood pressures once every two minutes over an extended interval. The results suggested that diastolic pressure is a more suitable dependent variable than systolic pressure, and that the most effective strategy for controlling blood pressure seems to consist of substantial and immediate positive stimulus feedback indicating correct and error responses.

In an unpublished dissertation, Rasmussen (1973) found that mildly hypertensive subjects were able to significantly decrease systolic but not diastolic pressure given immediate, correct feedback about their blood pressure after each heartbeat. A control group that was given unreliable feedback as to their blood pressure showed no significant changes in diastolic blood pressure, systolic pressure, or heartrate.

Kristt and Engel (1975) gave five hypertensive subjects a three-phase conditioning program consisting of: a seven-week period of self-determination of systolic and diastolic blood pressure at home, a three-week period of training in lowering and raising systolic blood pressure in the laboratory using the treatment method Shapiro, et al. (1972) used, and a three-month period during which the subjects again took their blood pressures at home and mailed them in. The results suggested that subjects can significantly lower their blood pressure in the laboratory, and that these skills persist for at least three months. It also indicated that various relaxation criteria (brain alpha-wave activity, breathing rate, and triceps brachii muscle tension) did not change during systolic blood pressure control periods.

The authors stated that the learning techniques used in the study and relaxation procedures are not mutually exclusive, but do seem to be different.

Blanchard, et al. (1975) used a relatively simple feedback system consisting of a once per minute determination of systolic blood pressure which was presented to four hospitalized patients, with high blood pressure, over a Sony television camera which was focused on a sheet of graph paper. Each subject was informed that the experiment was designed to see how well they could learn to control their blood pressure through "mental means." They were asked not to use breathing patterns nor muscle tension, and these were monitored. The results showed that the feedback condition consistently led to decreases in systolic blood pressure with mean decreases ranging from nine to fifty-five mm Hg. The return to baseline conditions led to cessation of improvement in all subjects; however, re-introduction of feedback in two cases led to further decreases in systolic blood pressure.

Elder and Eustis (1975) performed a study designed to determine if essential hypertension could be lowered by the use of instrumental conditioning on an out-patient basis without a concurrent effort to alter the patient's normal daily environment. There were fourteen males and eight females ranging in age from 23 to 80 years old. Generally, the training procedure conformed to strategy two of the Elder, et al. (1973) study. The results indicated that essential hypertensive subjects can lower their blood pressures, and that massed training seems to be superior to spaced. In addition, the authors felt that their study showed that the conditioning of hypertension is more effective with hospitalized than out-patient populations.

Steptoe's (1976) study was designed to make a comparison between blood pressure changes with exteroceptive feedback and simple instructions. A difference in this study from others was that pulse wave velocity was used both as an index of pressure change, and as the feedback medium. Using this method, it is possible to give subjects continuous analog feedback of blood pressure, while monitoring between trials so that adjustments in the basal level may be assessed. Forty subjects, sixteen women and twenty-four men, were assigned to four groups: two groups were given instructions only, either to raise or lower blood pressure, the other two groups were also to either raise or lower pressure, but were given feedback as well as the instructions. Four sessions were given with nine 4 min. trials each. The data were expressed in terms of transit time, variations of which have been found to be related inversely to mean arterial pressure. The results indicated that subjects can modify transit time, therefore blood pressure, on instruction alone, without any exteroceptive feedback. The comparison between instructional control and feedback with instructions was compromised, in this study, by discrepancies in the analysis done. Overall trial scores showed that the feedback groups enhanced increased only, and the decrease groups (both the instructions only and the feedback group) produced similar decreases in blood pressure.

Goldman, et al. (1975) investigated the relationship between essential hypertension and cognitive functioning and the effects of systolic pressure biofeedback. Fourteen male hypertensives were given the Wechsler Adult Intelligence Scale and the Category Test,

a subtest of the Halstead-Reitan Neuropsychological Test Battery, prior to biofeedback training. They were then given nine, weekly two hour sessions, with feedback contingent upon decreases in systolic blood pressure. The apparatus was similar to that used in the Shapiro, et al. (1969) study. Four, male hypertensives were a control group, and were given the WAIS and Category Test before undergoing three, weekly two-hour sessions of blood pressure monitoring. The results suggested a significant, positive correlation between systolic blood pressure and the number of errors made on the Category Test. Biofeedback training produced decreases in systolic pressure within sessions, and decreases in diastolic pressure between sessions. Subjects with the largest decrements in blood pressure (both systolic and diastolic) showed the most improvement on the Category Test when it was re-administered after the biofeedback training. These results suggest a relationship between essential hypertension and reversible cognitive impairment.

In an unpublished dissertation, Horn (1974) studied the use of alpha feedback, instead of blood pressure feedback, upon changes in blood pressure. Horn gave twelve subjects, in high, normal, and low blood pressure categories, autogenic alpha training. During this training, simultaneous blood pressure readings were taken, and then the statistical significance of the changes in the two functions were examined. The results indicated that alpha production was inversely related to blood pressure in those subjects with high blood pressure, and directly related to blood pressure in those subjects with initially

low blood pressure. Alpha production appeared to be unrelated to blood pressure in subjects with normal blood pressure.

Increasing technological sophistication has led to the development of several methods and types of biofeedback instrumentation that can be used in blood pressure studies. A fairly new method is described in Elder, et al. (1977) article. Earlier instrumentation is reviewed and discussed in Paskewitz's (1975) article.

The Kleinman, et al. (1977) article is a follow-up to their earlier study on the effects of biofeedback and the relationship between essential hypertension and cognitive functioning in 1975. The 1977 article extends this relationship to the non-laboratory environment. Eight, male hypertensives were given nine, weekly two-hour biofeedback training sessions during which the feedback was made contingent upon decreases in systolic blood pressure. There were three, weekly control sessions, with no feedback given, before this training began. The subjects were given the Category Test sub-test of the Halstead-Reitan Neuropsychological Test Battery prior to and subsequent to the nine weeks of biofeedback training. In addition, the subjects monitored their blood pressure five times daily at home and work during the training, and continued this for a period of four months after the termination of the training sessions. The biofeedback training resulted in significant decreases in blood pressure both within the laboratory and outside it. This reduction in outside the laboratory pressures persisted during the four month follow-up period. A significant, positive correlation was found between systolic blood pressure and number of errors on the Category Test given before the treatment, and

between the size of the systolic pressure decrements during training

and the improvement in Category Test performance after the training.

Other methods have been attempted in the treatment of hypertension.

Patel's (1975) study used Yogic relaxation and biofeedback in the

treatment of eleven female and nine male hypertensives. Nineteen of

the twenty were on anti-hypertension medications. The results showed

that the medications were stopped altogether in five subjects and

reduced by thirty-three to sixty percent in seven more. Blood pressure

control was better in four other patients and four more showed no

changes in control. The biofeedback was a continuous display of

galvanic skin response used as a measure of relaxation. The Yogic

relaxation in combination with the continuous biofeedback were inferred

to be responsible for the reductions in blood pressure.

Fray's (1977) unpublished dissertation attempted to determine the

implications of electromyographic feedback in the management of

hypertension. The biofeedback therapy was compared to autogenic therapy

in terms of effectiveness, and the suggestibility of the subjects was

also investigated to determine if such a factor affected the final

outcome. Thirty essential hypertensives were assigned to three groups

of ten each: EMG biofeedback, autogenic training, and no-treatment

control group. Each treatment lasted ten days with thirty, sixty, and

ninety-day follow-ups. Suggestibility was determined by the Hypnotic

Induction Profile; this was scored after the subject completed the

treatment phase. The results indicated that EMG and autogenic training

both resulted in decreased diastolic blood pressure at the end of the

treatment period. These were both significantly different from the no-

treatment group. The results of the follow-up suggested that the

autogenic training had the most lasting effects and that suggestibility did not prove to be a significant factor.

Another unpublished dissertation by Sawyer (1977) studied two female and two male hypertensives. The treatment method was recorded muscle relaxation instructions combined with feedback of trial-by-trial changes in the subjects' systolic blood pressure. The reductions in blood pressure were all clinically significant, and the effects appeared to be greater than any previously recorded. Only six treatment sessions were given and the apparatus was simpler than other studies.

Orlando's (1975) unpublished dissertation investigated the effects of electromyographic (EMG) feedback and relaxation training on the blood pressures of thirty essential hypertensives. Three groups were used: one with four biofeedback sessions per week, one with one biofeedback session per week, and a control group that received neither biofeedback nor relaxation training. The study investigated any differences due to treatment schedules, and personality characteristics associated with increased self-regulation, and explored a possibly useful clinical treatment method. The experimental groups received autogenic relaxation training each day in addition to the biofeedback. The results, as evaluated by three licensed physicians, showed that only the group that received one biofeedback session per week had clinically significant reductions in blood pressure. The results failed to show any personality changes that were statistically significant at the .05 level.

Shoemaker and Tasto (1974) examined the effects of muscle relaxation on the blood pressure of essential hypertensives. The subjects were fifteen volunteers and were assigned to three groups:

group one received muscle tension relaxation exercises, group two received noncontinuous biofeedback of blood pressure, group three was a control group that underwent six sessions of blood pressure measurements only. The subjects in all three groups were pre-measured every other day for three days. The results supported the hypothesis that muscle relaxation training brings about reductions in systolic and diastolic blood pressures. Results also showed that the biofeedback subjects could significantly lower diastolic blood pressure; however, this reduction was smaller than the relaxation group, and systolic pressure was not significantly reduced. The major statement in this study, according to the authors, is that a treatment program for essential hypertensives ought to include training in muscle relaxation bolstered by biofeedback.

Coursey's (1975) article compared a group of ten male subjects who received electromyographic (EMG) biofeedback and two control groups. One control group, of ten subjects, was told to relax but given no specific instructions nor feedback. The other control group of ten was given instructions about relaxation, but no feedback. The feedback group received variable-tone feedback from the frontalis muscle. Each of the subjects had one baseline session and seven sessions of twenty-one minutes each, over a two-week period. The results showed that the EMG feedback group obtained significantly lower EMG scores than the two control groups. The two control groups did not differ significantly from each other. These results suggested that EMG feedback is more effective in muscle relaxation of a specific muscle group than either simple verbal instructions or the reductions obtained by a subject's unaided efforts. Although the EMG feedback group did much better than

the two control groups, it was not shown to be a very powerful technique by itself.

In a study by Alexander (1975), twenty-eight normal adults took part in a test of two assumptions concerning the use of electromyographic biofeedback as a relaxation technique: that EMG training to reduce tension in one muscle will generalize to untrained muscles, and that subjective feelings of relaxation are related to EMG reductions. A treatment group of fourteen subjects underwent five sessions; three of which involved EMG training on the frontalis muscle. During all sessions, EMG readings were also obtained from the forearm and lower leg. Ratings of subjective feelings of relaxation were given at regular intervals by the subjects. The control group, of fourteen subjects who were matched with the treatment group for baseline frontalis EMG, received five sessions similar to the treatment group except that no feedback was given. The results of this study gave little or no evidence of generalization of EMG reduction from the trained muscles to the untrained, nor any evidence that subjective feelings of relaxation were increased through the use of biofeedback over the no feedback condition. Some possible reasons for these results may be the small number of sessions (3); the use of very unrelated secondary muscles, unrelated physiologically; and the motivation of the subjects to perform.

Montgomery, et al. (1974) studied the relationship found between relaxation training (progressive relaxation and autogenic training) and the reduction of blood pressure. They then used an electromyographic frontalis feedback procedure sometimes augmented with a cassette tape series for home training. The control group showed

little change in pressures, but the trained subjects (N=32) showed decrements of an average of 14.74 mm Hg systolic and 12.70 diastolic. At a follow-up session one year later, 23 of the original 32 trainees produced a mean decrease from the original baseline of 27.52 and 17.70 mm Hg systolic and diastolic respectively. Thus, it was suggested that a residual effect had continued.

Another aspect, of the use of any mode of biofeedback as a therapeutic tool, is the assessment of candidates for this type of treatment. In an attempt to find factors that might enhance the possibilities of a successful therapeutic outcome, investigators have examined various personality factors.

In an unpublished doctoral dissertation, Zigrang (1978) reviewed this literature and found that three personality variables seemed to consistently affect learned autonomic control. These were locus of control, autonomic perception, and anxiety. Her conclusions were that subjects with an internal locus of control are better learners in a biofeedback setting; and that low anxiety individuals are also better learners; that the literature is mixed with regard to autonomic perception and overall low or middle scorers on an Autonomic Perception Questionnaire may be better subjects for biofeedback experimentation.

Rotter (1966) examined the role of reinforcement of behavior as it is affected by whether the person perceives the reinforcement to be contingent upon skill or chance. He discussed several experiments that led to and used what is now known as Rotter's External versus Internal Control of Reinforcement Scale. This scale, consisting of 29 items, has been so widely used that little discussion of it is really necessary here. It should suffice to say that it is a paper-and-pencil test that

deals with the subjects' belief about the nature of the world. That is, how the subject sees reinforcement as being controlled; either internally of externally.

Mandler, et al.'s (1958) article explains the development and validation of their Autonomic Perception Questionnaire. This work grew out of a search for specificity in the study of anxiety and for objective variables that affect anxiety. This questionnaire was administered to 166 subjects, then the 19 highest scorers and the 13 lowest scorers were exposed to an intellectual stress situation. The stress situation consisted of three, very difficult cognitive tasks that were described to the subjects as being rather easy. During the stress situation, GSR, heartrate, respiration, temperature, and blood volume were recorded. These measures were then intercorrelated and rank ordered for intrachannel consistency. The Autonomic Perception Questionnare contains questions related to the five channels that were tested above. The subjects' perceptions of their autonomic reactivity were then compared with the physiological measures of their reactivity. the authors found positive correlations between the questionnaire and paper-and-pencil tests of anxiety; high perceivers showed significantly greater autonomic reactivity than did low perceivers; and high perceivers tended to overestimate their autonomic responses, while low perceivers tended to underestimate theirs.

Another variable of interest in the present study is that of field-independence versus field-dependence. This variable has also been extensively studied, and the only article that has a direct bearing on the present study is Witkin's (1950) article. This article describes the development of the Embedded Figures Test. This test is highly

correlated with other measures of cognitive style and is described

fully in the methods section of the present study. The link between

this variable and the present study is that it has been examined for

its' effects upon biofeedback training, with mixed results; and this

variable is one of the few that has been studied in an American-

Indian population.

There is a tremendous paucity of psychological data concerning

American-Indians. As far as published studies, none were found using

biofeedback of any kind and Indians.

Jessor, et al. (1968) studied a population consisting of

Caucasian American, American-Indian, and Spanish-American

subjects. This study involved the use of the locus of control variable.

They found the American-Indians to be the most external, and they were

followed by the Spanish Americans in degree of externality. The

Caucasians appeared to be the most internal of the three groups. The

authors' theorized that their results could be interpreted in terms of

a fatalistic attitude. One could find circumstantial, historical

evidence for this attitude in terms of federal maintenance of all

services from reservations to mental and medical health services.

As mentioned earlier, field-dependency has been studied in an

American-Indian population. This was done with a Canadian study.

Berry and Annis (1974) studied what they felt was a group of traditional

Indians and a group of "acculturated" Indians. The traditional group

was found to be highly field-independent while the "acculturated" group

was found to be field-dependent. A Caucasian group, who were also

examined, was found to be more field-independent. The authors concluded

that the process of acculturation inhibited the differentiation skills for the acculturated group.

Bowd (1977) hypothesized a relationship between field-independence and the ability to demonstrate conservation on Piagetian egocentrism tasks. He used these tasks and the Children's Embedded Figures Test to compare Indian children from a Manitoba reserve in Canada with Caucasian children. The results suggested that the correlations between these measures for both groups supported his hypothesis. The Indian group's correlations were not as strong, and the author concluded that this indicated a greater degree of field-dependency in the Indian group.

APPENDIX B

LIST OF ITEMS ON THE ROTTER EXTERNAL VS

INTERNAL CONTROL OF REINFORCEMENT SCALE

LIST OF ITEMS ON THE ROTTER EXTERNAL VS

INTERNAL CONTROL OF REINFORCEMENT SCALE

1.a.   Children get into trouble because their parents punish them
        too much.
  b.   The trouble with most children nowadays is that their parents
        are too easy with them.

2.a.   Many of the unhappy things in people's lives are partly due to
        bad luck.
  b.   People's misfortunes result from the mistakes they make.

3.a.   One of the major reasons why we have wars is because people
        don't take enough interest in politics.
  b.   There will always be wars, no matter how hard people try to
        prevent them.

4.a.   In the long run people get the respect they deserve in this
        world.
  b.   Unfortunately, an individual's worth often passes unrecognized
        no matter how hard he tries.

5.a.   The idea that teachers are unfair to students is nonsense.
  b.   Most students don't realize the extent to which their grades
        are influenced by accidental happenings.

6.a.   Without the right breaks one cannot be an effective leader.
  b.   Capable people who fail to become leaders have not taken
        advantage of their opportunities.

7.a.   No matter how hard you try some people just don't like you.
  b.   People who can't get others to like them don't understand
        how to get along with others.

8.a.   Heredity plays the major role in determining one's personality.
  b.   It is one's experiences in life which determine what they're
        like.

9.a.   I have often found that what is going to happen will happen.
  b.   Trusting to fate has never turned out as well for me as making
        a decision to take a definite course of action.

10.a. In the case of the well prepared student there is rarely if ever such a thing as an unfair test.
  b. Many times exam questions tend to be so unrelated to course work that studying is really useless.

11.a. Becoming a success is a matter of hard work, luck has little or nothing to do with it.
  b. Getting a good job depends mainly on being in the right place at the right time.

12.a. The average citizen can have an influence in government decisions.
  b. This world is run by the few people in power, and there is not much the little guy can do about it.

13.a. When I make plans, I am almost certain that I can make them work.
  b. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyhow.

14.a. There are certain people who are just no good.
  b. There is some good in everybody.

15.a. In my case getting what I want has little or nothing to do with luck.
  b. Many times we might just as well decide what to do by flipping a coin.

16.a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.
  b. Getting people to do the right thing depends upon ability, luck has little or nothing to do with it.

17.a. As far as world affairs are concerned, most of us are the victims of forces we can neither understand, nor control.
  b. By taking an active part in political and social affairs the people can control world events.

18.a. Most people don't realize the extent to which their lives are controlled by accidental happenings.
  b. There really is no such thing as "luck."

19.a. One should always be willing to admit mistakes.
  b. It is usually best to cover up one's mistakes.

20.a. It is hard to know whether or not a person really likes you.
  b. How many friends you have depends upon how nice a person you are.

21.a. In the long run the bad things that happen to us are balanced by the good ones.
  b. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

22.a. With enough effort we can wipe out political corruption.
   b. It is difficult for people to have much control over the things politicians do in office.

23.a. Sometimes I can't understand how teachers arrive at the grades they give.
   b. There is a direct connection between how hard I study and the grades I get.

24.a. A good leader expects people to decide for themselves what they should do.
   b. A good leader makes it clear to everybody what their jobs are.

25.a. Many times I feel that I have little influence over the things that happen to me.
   b. It is impossible for me to believe that chance or luck plays an important role in my life.

26.a. People are lonely because they don't try to be friendly.
   b. There's not much use in trying too hard to please people, if they like you, they like you.

27.a. There is too much emphasis on athletics in high school.
   b. Team sports are an excellent way to build character.

28.a. What happens to me is my own doing.
   b. Sometimes I feel that I don't have enough control over the direction my life is taking.

29.a. Most of the time I can't understand why politicians behave the way they do.
   b. In the long run the people are responsible for bad government on a national as well as on a local level.

APPENDIX C

LIST OF ITEMS USED IN THE PRESENT STUDY FROM

THE AUTONOMIC PERCEPTION QUESTIONNAIRE

LIST OF ITEMS USED IN THE PRESENT STUDY FROM

THE AUTONOMIC PERCEPTION QUESTIONNAIRE

1.   When you feel anxious, are you aware of many bodily reactions?

_____

Aware of very many   Aware of very few

2.   When you feel anxious, how often are you aware of your bodily
     reactions?

_____

Always   Never

3.   When you feel anxious, does your face become hot?

_____

Does not change   Becomes very hot

4.   When you feel anxious, do your hands become cold?

_____

No change   Very cold

5.   When you feel anxious, do you perspire?

_____

A great deal   Not at all

6.   When you feel anxious, does your mouth become dry?

_____

Always   Never

7.   When you feel anxious, are you aware of increased muscle tension?

_____

No increased tension   A great deal of tension

8. When you feel anxious, do you get a headache?

_____
Always   Never

9. When you feel anxious, how often are you aware of any change in your heart action?

_____
Never   Always

10. When you feel anxious, do you experience accelerated heart beat?

_____
No change   Great acceleration

11. When you feel anxious, does the intensity of your heart beat increase?

_____
Does not change   Increases to
                                                 extreme pounding

12. When you feel anxious, how often are you aware of change in your breathing?

_____
Always   .   Never

13. When you feel anxious, does your breathing become more rapid?

_____
No change   Very rapid

14. When you feel anxious, do you breathe more deeply?

_____
Much more deeply   No change

15. When you feel anxious, do you breathe more shallowly?

_____
Much more shallowly   No change

16. When you feel anxious, do you feel as if blood rushes to your head?

_____
Always   Never

17. When you feel anxious, do you get a lump in your throat or a choked-up feeling?

Always .... Never

18. When you feel anxious, does your stomach get upset?

Not at all .... Very upset

19. When you feel anxious, do you get a sinking or heavy feeling in your stomach?

Never .... Always

20. When you feel anxious, do you have any difficulty talking?

Never .... Always

21. When you feel anxious, are you bothered by your bodily reactions?

Bothered very much .... Not bothered at all

APPENDIX D

ANALYSES OF VARIANCE TABLES ON BASELINE DATA

D.1

ANALYSIS OF VARIANCE SUMMARY TABLE FOR

AVERAGE BASELINE DIASTOLIC

BLOOD PRESSURE LEVELS

Source	df	S.S.	F	PR>F
Model	2	87.2222	1.30	.2854
Error	37	1243.7889		
Treatment Group	1	10.6778	.32	.5764
Cultural Group	1	76.5444	2.28	.1398

D.2

ANALYSIS OF VARIANCE SUMMARY TABLE FOR

AVERAGE BASELINE ELECTROMYOGRAPHIC

LEVELS

Source	df	S.S.	F	PR$>$F
Model	2	52662.1389	2.55	.0920
Error	37	382505.4139		
Treatment Group	1	8594.6694	.83	.3678
Cultural Group	1	44067.4694	4.26	.0660

D.3

ANALYSIS OF VARIANCE SUMMARY TABLE FOR

AVERAGE BASELINE GALVANIC SKIN

RESPONSE LEVELS

Source	df	S.S.	F	PR>F
Model	2	2875.1111	.30	.7427
Error	37	177414.9333		
Treatment Group	1	2538.7111	.53	.4714
Cultural Group	1	336.4000	.07	.7926

APPENDIX E

TABLE OF MEAN BASELINE LEVELS OF EMG,

GSR, SYSTOLIC BLOOD PRESSURE,

AND DIASTOLIC BLOOD

PRESSURE

E.1

TABLE OF MEAN BASELINE LEVELS OF EMG,

GSR, SYSTOLIC BLOOD PRESSURE,

AND DIASTOLIC BLOOD

PRESSURE

	GROUPS			
Measures	EMG only	EMG and GSR	American Indian	Caucasian
EMG	2.4451	2.7383	2.9236	2.2598
GSR	1.0413	1.2006	1.1500	1.0920
Systolic BP	119.1834	117.5333	122.8000	113.9167
Diastolic BP	76.5667	75.5334	77.4334	74.6667

APPENDIX F

ANALYSIS OF VARIANCE SUMMARY TABLES ON

DECREMENT FROM BASELINE LEVELS

DIFFERENCE SCORES

F.1

ANALYSIS OF VARIANCE SUMMARY TABLES ON

DECREMENT FROM BASELINE LEVELS

DIFFERENCE SCORES

Source	df	S.S.	F	PR>F
Model	3	87.6306	3.72	.0198
Error	36	282.3667		
Treatment Group	1	42.0250	5.36	.0264
Cultural Group	1	44.8028	5.71	.0222
Treatment Group X Cultural Group	1	.8028	.10	.7509

F.2

ANALYSIS OF VARIANCE SUMMARY TABLE FOR

DIASTOLIC BLOOD PRESSURE

DIFFERENT SCORES

Source	df	S.S.	F	PR>F
Model	3	102.2556	3.29	.0316
Error	36	373.2889		
Treatment Group	1	69.3444	6.69	.0139
Cultural Group	1	4.0111	.39	.5379
Treatment Group X Cultural Group	1	28.9000	2.79	.1037

F.3

ANALYSIS OF VARIANCE SUMMARY

TABLE FOR EMG DIFFERENCE

SCORES

Source	df	S.S.	F	PR>F
Model	3	23432.3000	.97	.4160
Error	36	288912.0444		
Treatment Group	1	49.8778	.01	.9376
Cultural Group	1	5092.5444	.63	.4309
Treatment Group X Cultural Group	1	81289.8778	2.28	.1399

F.4

ANALYSIS OF VARIANCE SUMMARY TABLE

FOR GSR DIFFERENCE SCORES

Source	df	S.S.	F	PR>F
Model	3	2249.4306	.39	.7586
Error	36	68642.6556		
Treatment Group	1	813.0028	.43	.5179
Cultural Group	1	140.6250	.07	.7875
Treatment Group X Cultural Group	1	1295.8028	.68	.4152

APPENDIX G

TABLE OF MEAN DECREMENT FROM BASELINE

LEVELS DIFFERENCE SCORES BY GROUPS

G.1

TABLE OF MEAN DECREMENT FROM BASELINE

LEVELS DIFFERENCE SCORES BY GROUPS

	GROUPS			
Measures	EMG only	EMG and GSR	American Indian	Caucasian
EMG	.3106	.2883	.1866	.4123
GSR	.1828	.0926	.1565	.1165
Systolic BP	5.7833	3.7333	3.7000	5.8167
Diastolic BP	4.9667	2.3333	3.3333	3.9667

APPENDIX H

MIXED ANALYSES OF VARIANCE TABLES

H.1

MIXED ANALYSIS OF VARIANCE SUMMARY TABLE

ON ACTUAL TRAINING TRIALS SYSTOLIC

BLOOD PRESSURE LEVELS

Source	df	S.S.	F	PR>F
Cultural Group	1	5290.0000	23.97	.0001
Treatment Group	1	4.9000	.02	.8824
Cultural Group X Treatment Group	1	184.9000	.84	.3661
Trial	3	265.000	36.00	.0001
Cultural Group X Trial	3	5.4000	.73	.5375
Treatment Group X Trial	3	11.3000	1.54	.2082
Cultural Group X Treatment Group X Trial	3	3.3000	.45	.7227

H.2

MIXED ANALYSIS OF VARIANCE SUMMARY TABLE

ON ACTUAL TRAINING TRIALS DIASTOLIC

BLOOD PRESSURE LEVELS

Source	df	S.S.	F	PR>F
Cultural Group	1	555.0250	4.15	.0491
Treatment Group	1	46.2250	.35	.5604
Cultural Group X Treatment Group	1	50.6250	.38	.5424
Trial	3	149.6750	16.56	.0001
Cultural Group X Trial	3	1.4750	.16	.9181
Treatment Group X Trial	3	5.0750	.56	.6456
Cultural Group X Treatment Group X Trial	3	3.4750	.38	.7674

H.3

MIXED ANALYSIS OF VARIANCE SUMMARY TABLE

ON ACTUAL TRAINING TRIALS

EMG LEVELS

Source	df	S.S.	F	PR>F
Cultural Group	1	225150.0250	5.41	.0257
Treatment Group	1	7209.2250	.17	.6797
Cultural Group X Treatment Group	1	30691.6000	.74	.3961
Trial	3	6580.3500	.83	.4853
Cultural Group X Trial	3	3281.1250	.41	.7484
Treatment Group X Trial	3	5347.9250	.67	.5755
Cultural Group X Treatment Group X Trial	3	382.9500	.05	.9806

H.4

MIXED ANALYSIS OF VARIANCE SUMMARY TABLE

ON ACTUAL TRAINING TRIALS

GSR LEVELS

Source	df	S.S.	F	PR>F
Cultural Group	1	2714.2563	.10	.7515
Treatment Group	1	17284.8063	.65	.4260
Cultural Group X Treatment Group	1	7826.0063	.29	.5913
Trial	3	2713.5188	3.73	.0134
Cultural Group X Trial	3	1735.4188	2.39	.0718
Treatment Group X Trial	3	699.1688	.96	.4150
Cultural Group X Treatment Group X Trial	3	472.4688	.65	.5884

APPENDIX I

TABLES OF TRAINING TRIALS MEANS FOR

ALL SUBJECTS ON THE FOUR

PHYSIOLOGICAL MEASURES

I.1

TABLE OF MEAN PHYSIOLOGICAL LEVELS

BY TRIALS FOR ALL SUBJECTS

	PHYSIOLOGICAL MEASURES			
Trials	EMG	GSR	Systolic BP	Diastolic BP
1	2.4580	1.0847	116.9500	75.0500
2	2.3892	.9947	115.0000	73.8000
3	2.4385	.9925	114.0500	73.2000
4	2.2922	.9832	113.6000	72.4000

I.2

TABLE OF MEAN PHYSIOLOGICAL LEVELS

DURING TRAINING TRIALS

BY GROUPS

	PHYSIOLOGICAL MEASURES			
Groups	EMG	GSR	Systolic BP	Diastolic BP
EMG and GSR	2.4616	1.1177	114.7250	74.1500
EMG only	2.3274	.9099	115.0750	73.0750
Caucasian	2.0194	.9726	109.1500	71.7500
American Indian	2.7696	1.0550	120.6500	75.4750

APPENDIX J

CORRELATION MATRIX FOR THE PERSONALITY

MEASURES AND THE PHYSIOLOGICAL

MEASURES DIFFERENCE SCORES

J.1

CORRELATION MATRIX FOR THE PERSONALITY

MEASURES AND THE PHYSIOLOGICAL

MEASURES DIFFERENCE SCORES

	Sys-tolic	Dias-tolic	EMG	GSR	GEFT	APQ	ROT
Sys-tolic		0.00465 S=0.489	0.08415 S=0.303	0.17173 S=0.145	0.16518 S=0.154	-0.15483 S=0.170	-0.09108 S=0.288
Dias-tolic			0.14406 S=0.188	-0.11322 S=0.487	-0.17461 S=0.281	-0.16205 S=0.159	-0.22010 S=0.086
EMG				0.4382 S=0.394	0.13186 S=0.209	0.02886 S=0.860	0.03489 S=0.831
GSR					0.28274 S=0.039	-0.28617 S=0.037	0.21343 S=0.186
GEFT						-0.15688 S=0.334	0.10710 S=0.511
ROT							0.03668 S=0.822

VITA ^{2}

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