The Effectiveness of Biofeedback

Augmented by a Respiration Technique

In Reducing Heart Rate

by

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ABSTRACT

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This experiment was designed to illustrate the effects of biofeedback training augmented by a modified Furedy and Poulos respiration technique in reducing heart rate. One hundred and thirty-five undergraduates were screened for the experiment. Of these, 75 met the health requirements and demonstrated an interest in the experiment. From these 75 individuals, 36 were chosen at random to participate. Subjects were randomly assigned to one of two groups - Group B and Group P. Each group consisted of eighteen individuals, nine of which were males and nine of which were females. All subjects received four 30-minute training sessions, one on each of four consecutive days. On the day following the fourth session, all subjects were tested across four three-minute trials for their ability to reduce heart rate with no special aids or instructions. During the training sessions Group B received biofeedback training augmented with a modified Furedy and Poulos respiration technique and Group P received training in a modified progressive muscle relaxation technique. It was hypothesized that the biofeedback group (Group B) would be superior to the progressive muscle relaxation group (Group P) in reducing heart rate during the fifth day. Data accumulated in this research supports this hypothesis. Group B was significantly superior in reducing heart rate to Group P during day five ($\underline{p}$ < .01). Magnitude of the Furedy and Poulos respiration technique as an indicator of candidacy for biofeedback training is discussed as well as sex differences with regard to ability to utilize biofeedback to reduce heart rate. Implications for future research are also discussed.

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DEDICATION

To Truett Fields for inspiring my interest in this fascinating field of study.

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INTRODUCTION

Although it is not a very old topic of study, biofeedback research has shown much promise for its utility in treating various physiological problems. The voluntary control of autonomic processes has been investigated to the extent that conclusive evidence exists that demonstrates that it is possible to control, voluntarily, some autonomic functions. Instrumental conditioning of heart rate (HR) in animal subjects has been demonstrated (Engel and Gottlieb, 1970) as well as instrumental conditioning of HR in humans (Brener, Kleinman and Goesling, 1969; Engel and Chism, 1967). Biofeedback, in the form of viewing a beat-to-beat HR, has been demonstrated as effective in reducing HR variability by Hnatiow and Lang (1965).

Many different forms of biofeedback exist today. Feedback information may be provided in the form of tones of varying frequency (Schwartz, 1972), lights (Levene, Engel and Pearson, 1968), positive verbal reinforcement (Ascough and Sipprelle, 1968) and various other forms. Whatever the form, the function of biofeedback is to monitor an autonomically controlled function and to relay the readout of the monitor to the subject via mechanical/electrical means in order to allow the subject to be aware of the status of the autonomic function. In the case of HR, a cardiotachometer could monitor the HR and a graphic readout could be relayed to the subject to provide the biofeedback.

One of the goals of biofeedback is to provide a non-aversive stimulus conducive to allowing the subject to learn to control some autonomic

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Psychophysiology was used as a pattern for style and format.

function. Furedy and Poulos (1975) used a breath-holding technique and a downward head tilt action to reflexively induce a HR deceleration. This technique proved to be quite successful in achieving its goal.

The present experiment is designed to demonstrate the utility of biofeedback training augmented by a modified Furedy and Poulos respiration technique to reduce HR. HR deceleration is of obvious clinical utility to individuals with tachycardia. Very similar in several ways to the experiment of Furedy and Poulos, subjects are asked to attend cognitive and proprioceptive cues associated with HR deceleration induced by the reflexive technique.

BACKGROUND

Various studies have been done demonstrating the effectiveness of biofeedback. However, many critics attacked these studies on the basis that perhaps the change in autonomic function was due, not to feedback, but to some other physiological or psychological variable. One of the most conclusive studies done in the field of biofeedback refuted these criticisms and paved the way for biofeedback research to take place out of the light of skepticism. In the late 1960's, a man by the name of N. E. Miller conducted a series of biofeedback studies on rats (DiCara and Miller, 1969; Miller and Banvazzi, 1968; Miller and DiCara, 1967). By providing positive reinforcement via electrical stimulation to a reward area in the brain of the rats, Miller demonstrated once again that biofeedback is possible. The novelty of Miller's research, however, was that each of the rats were curarized-that is they were placed under the influence of the dried aqueous extract of Strychnos toxifera which paralyzed the animal so that no skeletal movement was possible. Critics that had previously claimed that biofeedback was not a conceivable means of learning to control autonomic functions and that data to indicate such a plausibility was due to skeletal muscle mediation were disproven. Biofeedback research was on its way to widespread acceptance.

Since Miller's research, much has been learned about biofeedback and its applicability. Although biofeedback training has many possibilities for clinical utility, it also has various limitations as to its use. For the treatment of borderline essential hypertension it has been shown that the long term effects of biofeedback training to reduce bloodpressure are insignificant (Surwit, Shapiro and Good, 1978). It has also been shown, however, that reliable decreases in systolic blood pressure can be achieved (Fey and Lindholm, 1978). These two studies indicate that a great deal of variability can be found in biofeedback research results. As is the problem with any new science, research is oriented toward finding new facts and establishing basic guidelines for more exacting findings. Biofeedback research is in an era of uncertainty and doubt as to the techniques that produce the most significant results. Future research will hopefully enable the investigators to clear up previous doubt and delineate the problems with biofeedback techniques to achieve more consistent results.

With regard to HR, many studies have demonstrated that it is possible to manipulate HR via biofeedback training in order to achieve a more favorable physiological and/or psychological state. It has been demonstrated that learned control of HR deceleration is an effective self-control skill for coping with anxiety (Gatchel, 1977). It has also been suggested that biofeedback can be used to reduce a patient's general level of arousal (Marcus and Levin, 1977). Biofeedback of HR has shown some utility in treating premature ventricular contractions as well as sinus tachycardia (Blanchard and Miller, 1977). The treatment of certain physiological disorders with biofeedback has certain advantages over medication. It is useful to note that indeed biofeedback training does work and will perhaps someday be used for the treatment of such said clinical problems.

Perhaps the most applicable method of using biofeedback is with some other source of mediation. It has been demonstrated that biofeedback paired with instructions is superior to biofeedback alone (Nunes and Marks, 1975). As previously mentioned, Furedy and Poulos found that biofeedback with a respiration technique provided for significant HR decreases. Another improvement of biofeedback training has been shown by Holmes, Frost and Bennett (1977). A short adaptation period preceeding biofeedback training seems useful to biofeedback training sessions; however, it was demonstrated that a long adaptation period might hinder HR deceleration.

A great deal has been found with respect to HR deceleration due to learned autonomic control of HR. The basis of this research is to further establish the utility of the Furedy and Poulos respiration technique with biofeedback training as well as investigate some of the properties of the respiration technique with regard to the ability to reduce HR.

Thus, it is hypothesized that biofeedback training augmented by a modified Furedy and Poulos respiration technique will be superior to progressive muscle relaxation training in reducing HR. The individuals taught a modified progressive muscle relaxation technique, which is a modified version of a technique developed by Lazarus (1966), will serve as a control group.

METHOD

Subjects

One hundred and thirty-five male and female undergraduates were interviewed for the experiment. In order to qualify for the experiment, the subjects were required to fill out a health information sheet (see Appendix B) and meet the specified health requirements as well as demonstrate a genuine interest in the experiment. Of the 135 undergraduates, seventy-five individuals met the health requirements and demonstrated a genuine interest. From these seventy-five individuals eighteen males and eighteen females were randomly chosen and then males and females, respectively, were assigned randomly to one of two experimental groups.

Apparatus

A Stoelting pneumographic recorder was placed around each subject's chest in order to monitor respiratory activity. Three electrodes were attached to the subject's chest and connected to a Narco Biosystems BT 1200 cardiotachometer in order to monitor heart rate. Respiratory and cardiac output were recorded on a Stoelting Multigraph. A Sony video camera relayed the HR recordings of the cardiotachometer to a TV monitor positioned five feet in front of the subject. Taped instructions were played to each subject on a cassette player (Appendix A).

Procedure

All subjects were given the same set of pre-experimental instructions Appendix B). Male subjects were randomly assigned to one of two groups, as were female subjects. Sub-Group MB (Male Biofeedback) and Sub-Group

FB (Female Biofeedback) both consisted of nine subjects each. Group B (Biofeedback) included both Sub-Groups MB and FB. Group B was instructed to reduce HR by employing a modified Furedy and Poulos breath-holding technique while viewing a graphic readout of their beat-to-beat HR. Sub-Group MP (Male PMR) and Sub-Group FP (Female PMR) both consisted of nine subjects each. Group P (PMR) included both Sub-Groups MP and FP. Group P was instructed to reduce HR by employing a modified progressive muscle relaxation technique similar to the technique developed by Lazarus (1966). No Biofeedback was given to Group P.

Each subject completed five thirty minute sessions, one session on each of five consecutive days. The first four sessions comprised the training period in which the subject was instructed in the respective technique given to his group and attempted to learn to reduce HR. The fifth day Group B was asked to reduce HR without any special instructions or aids, i.e. without any biofeedback, breath-holding techniques, etc.... On day five Group P was given the same taped instructions as Group B but was allowed to use the PMR technique that they had been instructed in to reduce HR.

Each group was given the same schedule of instructions for attempting to reduce HR on day five (see Appendix A). During the training period, Group B and Group P were given instructions that were conducive to the learning of the respective techniques.

All subjects were run under the same experimental test conditions. The lighting was dimmed a constant amount for each subject and the room was virtually void of external noise at all times. All subjects remained in the room a constant amount of time during each session. During each session, all subjects were instructed to breath normally unless otherwise instructed.

Group B: Biofeedback Augmented by a Respiratory Technique

Each individual in this group was provided with video feedback of beat-to-beat HR during the training period. All subjects were instructed to attend cognitive and proprioceptive cues associated with HR deceleration. During each training session each subject was instructed to use a modified Furedy and Poulos respiration technique for the first five of six total trials. This modified respiration technique is as follows:

3 seconds of even exhalation
3 seconds of even and very deep inhalation
20 seconds of breath holding
140 seconds of attempted HR deceleration with normal respirations.

On the sixth trial of each session, the subjects were instructed to reduce their HR without any special respiration techniques but were still allowed visual feedback.

Each subject in Group B was given the same taped instructions during the training period (see Appendix A for instructions). Between each of the six trials there was a one minute resting period during which subjects were instructed to stop reducing HR and relax. A two minute adaptation period preceded the first trial.

Group P: Progressive Muscle Relaxation

Each individual in this group was given a modified version of Lazarus' Progressive Muscle Relaxation Technique (see Appendix A) on each of the first four days. A short adaptation period was followed by the instructions on relaxation. Toward the end of the PMR session, the subjects were instructed to lower their HR during each of two 140 second trials with a one minute rest interval between trials. Group P served as a control group to Group B. It is thought that Group P will allow for the control of any HR decrease that occurs due to the decrease state of bodily movement and sitting quietly in the experiment room.

DATA QUANTIFICATION AND ANALYSES

On the fifth session of the experiment data was taken across four three minute trials for all subjects. HR was measured at four second intervals for the entire three minute duration of each trial. A mean baseline HR was established at the beginning of the session following a two minute adaptation period by taking four second interval readings across a two minute period. A mean beats per minute (bpm) value was established for baseline HR and for each of the four consecutive trials for each subject.

For each trial, a percent change from the baseline HR was established in order to account for the variability due to initial values of HR. An overall percent decrease across all trials was calculated by averaging the mean percent change in HR across each trial. Mean overall HR percent change was calculated for Sub-Groups MB, FB, MP, and FP as well as Group B and Group P.

A Winer Case II (Winer, 1971) three factor repeated measures analysis of variance was performed using the mean percent change in HR. In order to account for excessive variability due to positive and negative values of percent change, a constant (k = 20) was added to each value to establish a set of data consistent for an overall decrease in HR. The constant was subtracted from all values reported as mean percent HR increase or decrease. The main effects that were tested were biofeedback training, progressive muscle relaxation training, sex differences, and trials.

The Furedy and Poulos respiration reflexive technique was studied also. The magnitude of the percent change due to the reflexive technique was established by averaging the overall percent HR decrease across the first and second trials of session one and session four. An average HR percent decrease due to the reflexive technique alone was calculated for each trial used as follows:

> Five two second interval readings were taken to establish the HR just before the reflexive technique was instigated via instructions to the subject. This ten second interval is defined as that ten second period prior to the very beginning of the instructions to exhale very deeply (see Appendix A). Five two second interval readings were taken for the first ten second period that HR decreased and remained consistently low for at least ten seconds following the initiation of the reflex. The difference in the two readings divided by the reading taken prior to the technique constituted the percent decrease.

A Winer (1971) two factor unequal cell frequency analysis of variance was performed on the data accumulated on the reflexive technique percent decrease across all subjects in Group B. Subjects were divided into High Reflex (HI) and Low Reflex (LO) Groups based upon the overall magnitude of the percent decrease the reflexive technique induced. Subjects with the highest percent decreases due to the reflexive technique only were placed in Group HI. Subjects with the lowest percent decrease were placed in Group LO. HI males and LO males as well as HI females and LO females were also separated and reported. A comparison of the HI Group to the LO Group in terms of ability to decrease HR across trials during the fifth day was established. The main effects tested in the Winer two factor unequal cell frequency analysis of variance were sex differences and reflex magnitude.

RESULTS

The findings of the Winer Case II three factor repeated measures analysis of variance of day five data are reported in Table I (Winer, 1971). Individuals in Group B were found to have statistically significant percent changes in HR from those individuals in Group P ($p < .01$). The overall percent decrease across all four trials for Group B was 5.52%. For Group P it was found that there was a net overall 0.44% increase in HR across all four trials. It is therefore evident that the individuals that used biofeedback decreased their HR quite significantly overall whereas the individuals that were taught progressive muscle relaxation showed no apparent control in reducing their HR.

The main effect of sex differences with respect to ability to decrease HR was demonstrated to approach significance ($p < .10$). Sub-Group MB lowered their HR a net overall 8.74% whereas Sub-Group FB lowered their HR only 2.29%. Males were therefore superior to females in demonstrating an overall decrease in HR. With respect to bpm, Sub-Group MB lowered their HR an average of 6.42 bpm across all four trials with a range of 17.94 bpm decrease to 1.92 bpm decrease. On the other hand, Sub-Group FB demonstrated an overall net decrease of only 1.68 bpm across all four trials with a range of 5.21 bpm decrease to 1.17 bpm increase in HR. Three of the nine individuals in Sub-Group FB demonstrated an overall increase in HR across all four trials in day five; however, these were minor increases in HR.

The individuals in Sub-Group MP decreased their HR a mean of 0.02% from baseline HR in day five across all four trials. Those individuals in Sub-Group FP increased their HR from baseline an average of 0.90%

across all four trials. There was no marked or dynamic difference in the performance of Sub-Groups MP and FP. The data indicates that there is very little difference in males and females with their ability to decrease HR using the modified progressive muscle relaxation technique. The sex difference that approached significance ($p < .10$) in the Winer Case II ANOVA calculation is therefore largely due to the differences in Sub-Groups MB and FB. With respect to change in HR in bpm, Sub-Group MP showed an average increase of 0.09 bpm with a range of 6.28 bpm decrease to 6.47 bpm increase across all four trials. Sub-Group FP demonstrated an average increase in HR of 0.21 bpm with a range of 8.34 bpm increase to 7.77 bpm decrease. Eight of the subjects in Group P showed a mean decrease in HR. The range of Group P was comparable to that of those individuals in Group B. This fact seems to further support the notion that biofeedback augmented by the Furedy and Poulos respiration technique is a more effective tool in reducing HR than PMR. A summary of the overall percent changes in HR in Groups B and P, as well as Sub-Groups MB, FB, MP, and FP can be seen in Figure 1.

Across trials in day five there was no significant difference in performance within subjects although the difference between Groups B and P approached statistical significance across the four trials ($p < .25$). Figure II illustrates graphically the percentage change in HR across all four trials between Groups B and P. There seems to be an indication that there is some difference in performance across trials. Figure III illustrates graphically the percentage change in HR across all four trials between Sub-Groups MB, FB, MP, and FP. Table II summarizes the percent change in HR across all trials for Groups B and P as well as Sub-Groups MB, FB, MP, and FP.

The Winer two factor unequal cell frequency analysis of variance (Winer, 1971) is summarized in Table III. The main effects tests were sex differences with respect to Furedy and Poulos modified reflexive technique as well as the difference between HI and LO reflex groups. There was a significant difference demonstrated between the HI and LO Reflex groups ($p < .01$). No significant result was found with respect to sex. A summary of Group HI and Group LO as well as HI males, HI females, LO males, and LO females is given in Table IV along with total average percent HR decrease across all four trials for each respective group. It is interesting to note that Group HI decreased their mean HR across trials a greater percentage than did Group LO. HI males and HI females also decreased their mean HR across trials to a greater magnitude than did LO males and LO females, respectively. The data seems to indicate that individuals with a good modified Furedy and Poulos reflex decrease their HR to a greater extent than to individuals with a low reflex.

Individuals were also separated on the basis of the type of Furedy and Poulos reflex illustrated. The author will henceforth refer to these types of reflex as a Type I reflex and a Type II reflex. A Type I reflex can be defined as follows:

> Upon deep inhalation and breath holding directly following complete exhalation, the Type I reflex is characterized by an immediate and consistent deceleration in HR during breath holding followed by continued cardiac deceleration for a short period of time once normal breathing is initiated.

A Type II reflex is defined as follows:

> Upon deep inhalation and breath holding directly following complete exhalation, the Type II reflex is characterized by an insignificant change in HR until subsequent exhalation following breath holding at which time cardiac deceleration is

> immediate and usually consistent for at least
> ten seconds.

The data indicate that 69% of the males in Group B had a Type II reflex and 80% of the females in Group B had a Type I reflex during the trials used for the calculation of the cardiac reflex of Group HI and of Group LO. Although some individuals demonstrated both type of reflexes, the author finds it significant to note the sex differences with respect to Type I and Type II cardiac reflexes in general. No statistically significant findings between individuals with Type I and Type II reflexes were found; however, the difference between the reflexes and the differences between sexes with respect to the Type of reflex elicited might provide for some physiological explanation as to the differences between males and females with respect to the ability to utilize biofeedback to reduce HR in future research.

During the collection of data, respirations were noted carefully. Any unusually large breath or coughing caused unusually high fluctuations in HR. Changes in respiration have been shown to be parallel to changes in HR (Carrol, Janet, and Preston, 1979). Therefore, it seemed essential to carefully note any unusual breathing patterns so that that segment of the data taken during unusually fluctuating respirations could be ignored. It is significant to mention that most all subjects refrained from any unusually inconsistent respiration patterns.

TABLE I

Winer Case II
Summary of
Analysis of Variance

Source of Variation	SS	df	MS	F
Between Subjects	6863.25	35		
A	1279.79	1	1279.79	8.497***
B	489.48	1	489.48	3.250**
AB	274.43	1	274.43	1.82*
Error Between	4819.56	32	150.61	
Within Subjects	2549.10	108		
C	78.39	3	26.13	1.05
AC	147.12	3	49.04	1.98*
BC	50.23	3	16.74	0.68
ABC	16.34	3	5.45	0.22
Error Within	2378.67	96	24.78	

A = Biofeedback/PMR *** ($p < .01$)

B = Male/Female ** ($p < .10$)

C = Trials * ($p < .25$)

TABLE II

Summary of % Decrease in HR
For All Subjects Across All Trials
(Data in Parenthesis Indicates an Increase in HR)

Group/ Sub-Group	C_1	C_2	C_3	C_4	Total
MB	10.44	7.88	8.68	7.99	8.74
FB	2.75	1.06	1.46	3.91	2.29
MP	0.64	(2.30)	1.50	0.25	0.02
FP	(1.46)	(1.48)	(0.80)	0.21	(0.90)
B	6.60	4.47	5.07	5.95	5.52
P	(0.41)	(1.89)	0.35	0.19	(0.44)

TABLE III

Winer Two Factor Unequal
Cell Frequency Analysis
of Variance
(Least Squares)

Source of Variation	SS	df	MS	F
A	545.97	1	545.97	28.48*
B	8.24	1	8.24	0.43
AB	9.33	1	9.33	0.49
Error	268.31	14	19.17	

A = High and Low Reflex Groups

B = Sex

* ($p < .01$)

TABLE IV

Induced Cardiac Reflex Magnitude

GROUP	A	B	C
GROUP HI-MALES	18.07	2.02	10.21
GROUP LO-MALES	8.43	2.55	6.91
GROUP HI-FEMALES	20.88	8.01	3.15
GROUP LO-FEMALES	8.36	3.16	1.62
GROUP HI	19.32	5.32	7.07
GROUP LO	8.39	2.73	3.97

A = Furedy and Poulos reflex magnitude (%)

B = Standard Deviation of Reflex

C = Total % HR decrease across all trials

FIGURE I

Summary of HR % Change Across Trials For All Groups

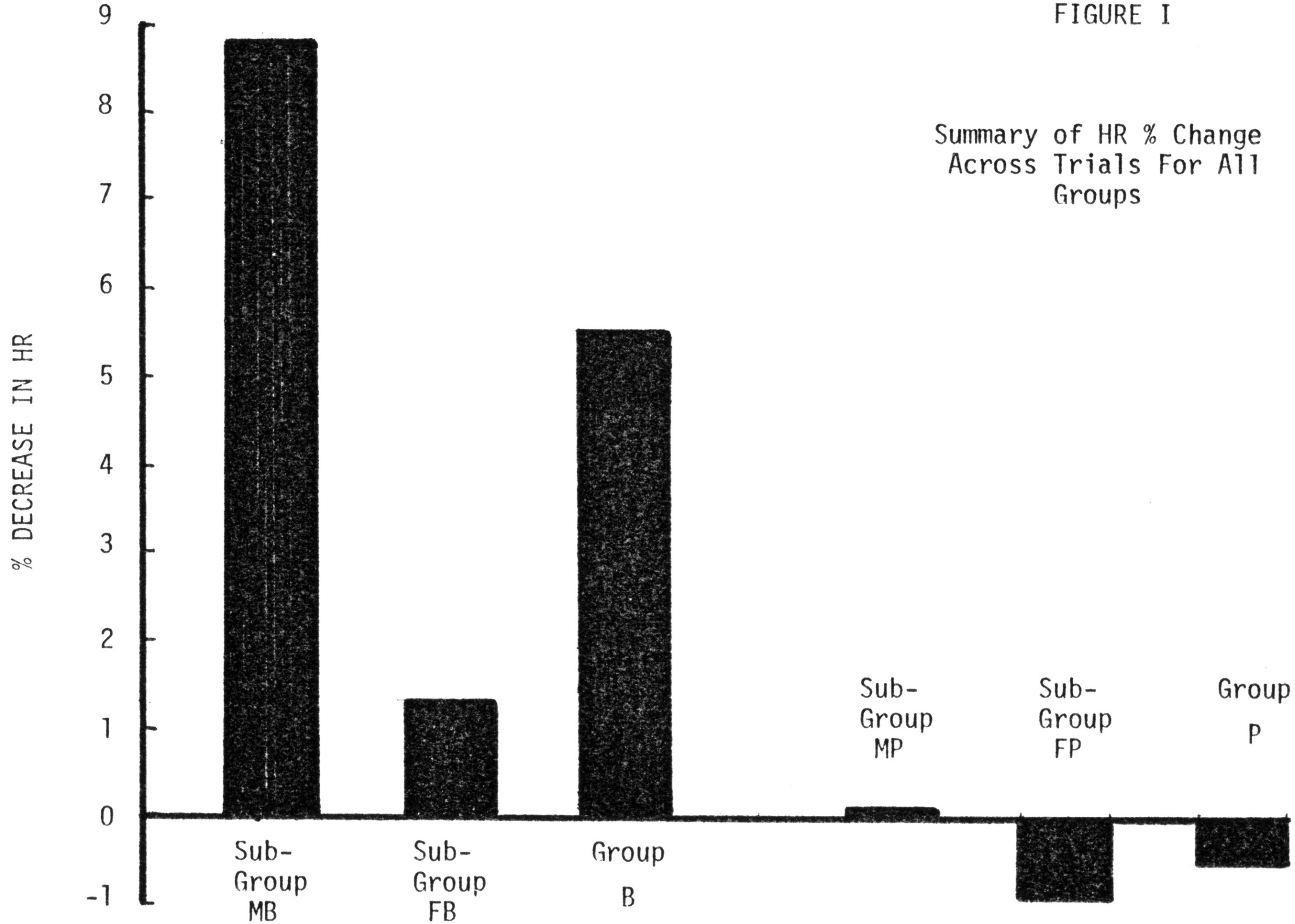


FIGURE II

Trials VS. % Change
in HR for Group B
and Group P

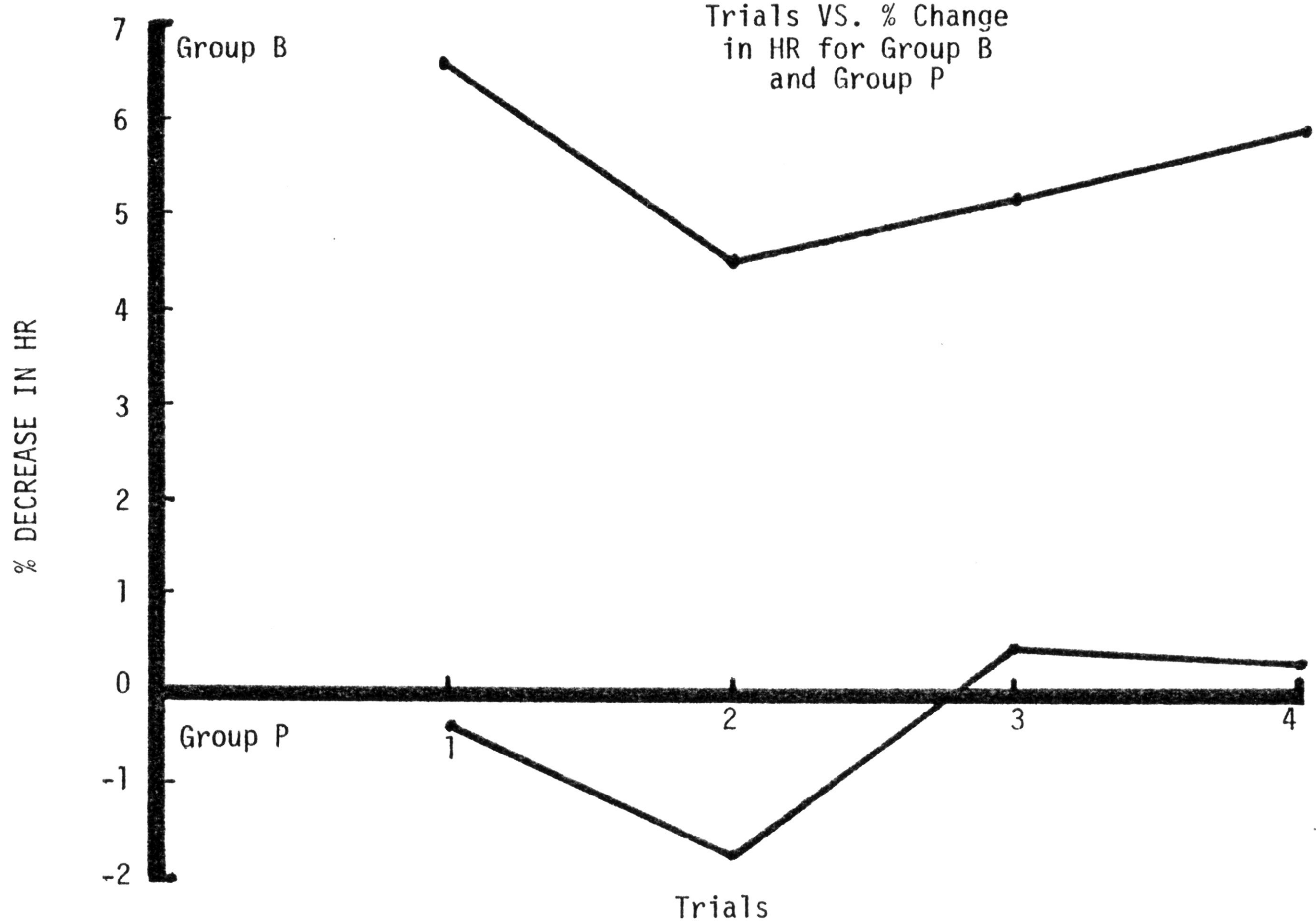
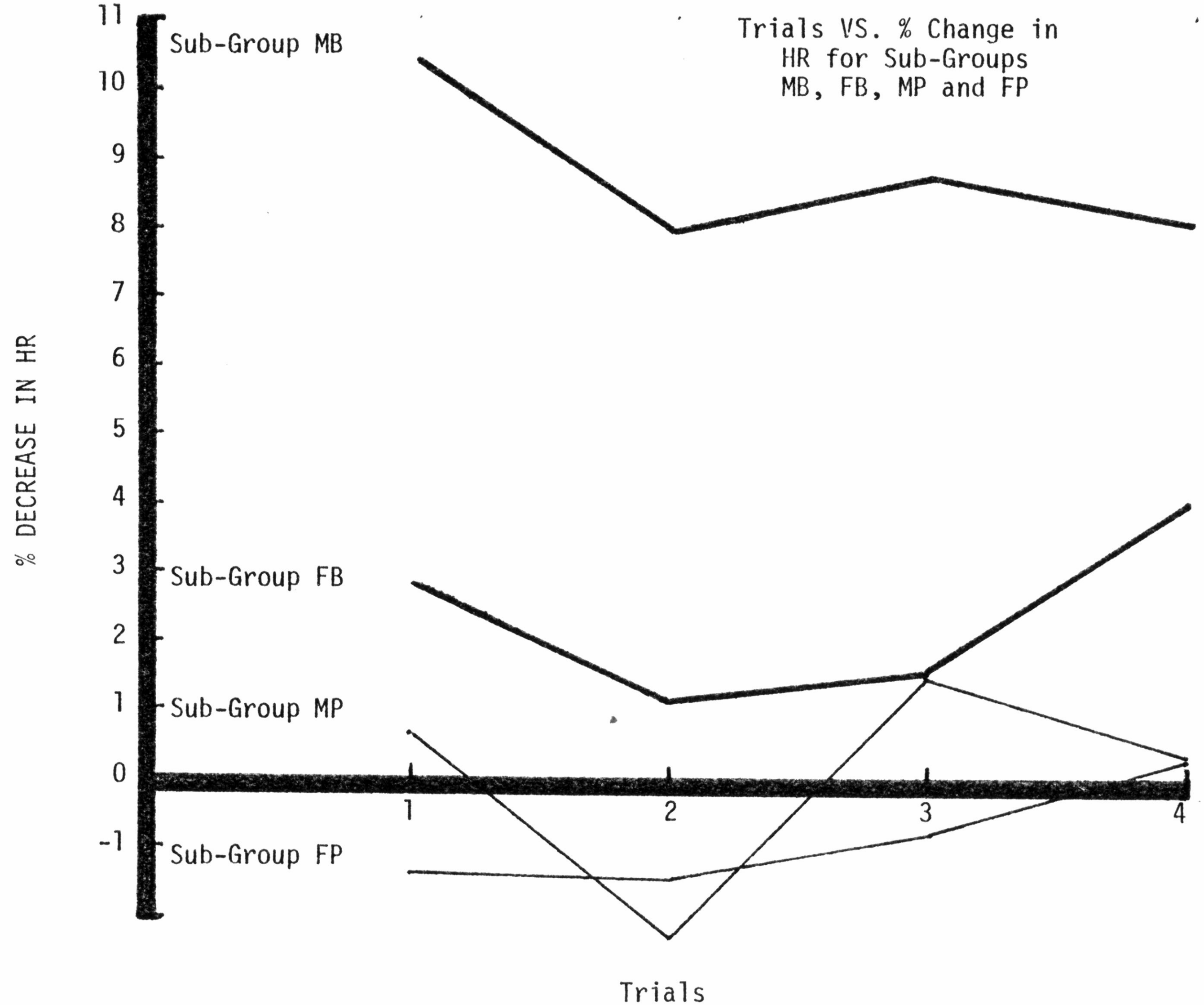


FIGURE III

Trials VS. % Change in
HR for Sub-Groups
MB, FB, MP and FP



DISCUSSION

The findings of this research clearly indicate that biofeedback training augmented by the Furedy and Poulos respiration technique enhances the ability to decrease HR following a four day training period. Learning a progressive muscle relaxation technique apparently has no real effect upon the ability to decrease HR to any significance under the same experimental test conditions. It is important to mention that other experimenters have raised serious questions regarding the effectiveness of the biofeedback component of biofeedback training for altering HR (White, Holmes and Bennett, 1977). The effectiveness of only the biofeedback component was not investigated in this research. The major factor of interest is the effectiveness of an overall method in reducing HR. The author contends that the clinical utility of biofeedback training might prove more dynamic when augmented by the Furedy and Poulos respiration technique. The significant difference between Group B and Group P demonstrates the effectiveness of the method used by Group B to reduce HR.

The difference between the performance of males and females in Group B seemed quite unusual. Several studies have investigated the role of sex differences upon biofeedback training. It has been demonstrated that females shift to a greater right cerebral hemisphere activation when biofeedback is introduced from a self-control of HR (Davidson and Schwartz, 1976). Davidson and Schwartz also demonstrated that males showed no such shift in neural activation to the right cerebral hemisphere. These experimenters concluded that there might be different underlying patterns of neurophysiological processes demonstrated during HR regulation in males and females.

It has been shown that subjects given right-ear feedback are more effective in producing HR changes than subjects given left-ear feedback (Greenstadt, Schuman and Shapiro, 1978). Perhaps this research can further support the idea posed by the author that the neurophysiological process involved in biofeedback training is activated more in the left cerebral hemisphere than the right. This would be a possible explanation for the apparent difference in males and females with regard to the research of Davidson and Schwartz. It was noted that the right cerebral hemisphere displayed similar neural activity during biofeedback introduction and during instructions to think emotional thoughts in females but not males (Davidson and Schwartz, 1976). Perhaps females are more apt to develop some emotional state conducive to right cerebral activity during biofeedback training whereas males are not thus allowing for greater left cerebral activity in males. The author realizes that this can only be a hypothetical explanation for the sex difference illustrated by the data; however, further research might prove useful if directed toward this line of thought.

Individual differences have also been shown to affect the ability to alter HR. Based upon Rotter's Internal-External Control Scale, it was found that internal control subjects performed better on the increase and external control subjects performed better on the decrease of HR (Ray and Lamb, 1974). Other research indicates that internals are not superior in reducing HR, but that extended biofeedback training is required to demonstrate that internals are superior in reducing HR (Blankstein and Egner, 1977). It is clear from the research that much is yet to be discovered about the individual differences with regard to ability to alter HR. However, it is important to realize that there is apparently some difference in males and females in using biofeedback training to reduce HR. Further research should be directed toward delineating these differences in order to understand which individuals would be good candidates for biofeedback training.

From the data found in this research, it is apparent that some individuals are better at reducing HR than others. Some indicator of which individuals would be good candidates for biofeedback training would be useful. The magnitude of the cardiac reflex elicited by the Furedy and Poulos respiration technique seems to demonstrate some indication as to the ability of an individual to decrease HR. Females and males in Group HI both demonstrated a superior ability to reduce HR than females and males in Group LO, respectively. This data seems to indicate that the magnitude of the Furedy and Poulos reflex might be a useful tool in selecting candidates for biofeedback training augmented by the Furedy and Poulos respiration technique. Clearly, the clinical applicability of biofeedback training has not yet been totally established; however, research directed toward understanding which individuals would benefit from biofeedback training would serve a great advantage in the formation of guidelines for clinical utility. It has been demonstrated that individuals that score high on a test of ability to perceive heart activity are superior in altering HR than individuals that have a lower score (McFarland, 1975). Once a set of guidelines can be delineated as to which individuals will best be able to utilize biofeedback training, the clinical applicability of biofeedback used in reducing HR will be easier to assess.

The Furedy and Poulos respiration technique provides for two different types of cardiac reflex. The Type I reflex is seen to be present most often in females and the Type II reflex is seen to be present most often in males. Perhaps some physiological explanation for this phenomena exists which can further explain the sex difference seen in the data collected. The author feels it is important to delineate these minor differences in order to provide for as many plausible explanations for sex difference as possible.

Data taken from the fifth day demonstrated that across all individuals in Group B, an initially good HR decrease was seen in the first trial and then a slightly less favorable HR decrease during the second trial was observed. Following the second trial, subjects tended to improve as the session progressed. A slightly similar effect was found by Levenson (1976).

During the fifth session subjects were instructed not to use the Furedy and Poulos respiration technique. Data was carefully inspected to make sure that subjects were not using the reflexive technique to lower HR. It is noted that cardiac deceleration was not spontaneous in nature, as was seen in the Type I and Type II cardiac reflex induced by respiratory control, but a gradual deceleration in HR which is more characteristic of learned autonomic control. It is possible that some other physiological or psychological state of the subjects became associated with the reflex during the training period and carried over to the testing day.

CONCLUSION

As was hypothesized, the individuals instructed to use biofeedback augmented by the Furedy and Poulos respiration technique performed significantly better ($p < .01$) in reducing HR than individuals taught to use a modified progressive muscle relaxation technique. A difference in males and females in their respective ability to utilize the biofeedback and respiratory training was noted. Several explanations as to the reason for this sex difference were given; however, no absolute rationale for the sex difference is clear. Further research is necessary to establish the explanations for not only sex difference, but the difference in the Type I and Type II cardiac reflex. Once these and other questions are answered in future research, it will be possible to assess the overall clinical utility of biofeedback training in reducing HR. It is evident that such training would be applicable in the treatment of various forms of tachycardia.

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APPENDIX A:

Taped Instructions

TAPED INSTRUCTIONS FOR
TRAINING SESSIONS FOR GROUP B

Sit back and relax (adaptation period)

Exhale completely
Inhale very deeply
Hold your breath (20 sec.)
Breath normally and lower your heart rate (140 sec.)
Stop decreasing HR
Rest 1 min
(Repeat cycle five times, then)

Lower your HR while breathing normally (100 sec.)

[end session]

TAPED INSTRUCTIONS FOR DAY FIVE
FOR ALL SUBJECTS

Lower HR (3 min.)
Stop decreasing your HR
(Rest 1-2 min.)

(Repeat cycle 4 times)

[end session]

TAPED INSTRUCTION FOR GROUP P DURING TRAIING SESSIONS

[Progressive Muscle Relaxation Instructions] Lazarus (1966)

The following modifications were made: Toward the end of the PMR instructions, subjects were instructed to keep relaxing and attempt to lower their HR. One hundred and forty seconds of attempted HR deceleration was followed by a one minute rest period. Subjects were then asked once again to lower their HR for a 140 second duration. No other modifications to Lazarus' technique were made.

APPENDIX B:

Informed Consent Form

Informed Consent Form

This study will be concerned with measuring certain physiological processes. In order to eliminate as many sources of variation as possible I need some information from you. You need not fill out this form, but if you do not you will not be considered for this experiment.

List any medical problems you have had (for example diabetes, chronic bronchitis, high blood pressure).

Are you presently under a doctor's care? Yes No (circle one)

Do you use any drugs or medication regularly? Yes No

Is transcendental meditation, yoga, or any practice involving altered states of consciousness a major part of your life? Yes No

This study will demand more of a committment from you than some of the other experiments, but we think it will be a rewarding experience for you. To participate in this experiment you must be willing to agree to the following conditions:

1. You will be required to participate in the entire sessions to receive credit.
2. No excessive smoking immediately before the session.
3. No excessive drinking of alcohol or coffee immediately before the session.
4. No eating excessively immediately before the session.
5. Get a reasonable amount of sleep (at least six hours if possible) the night before the session.

All measurements will be made and recorded with as much anonymity as possible. You may resign at any time from the experiment but you will not receive credit. A session will be held after the experiment is over to answer any questions you may have and to provide you with the results of the experiment.

I understand the information stated above and agree to participate in this experiment.

____
(Name)

____
(Date)