THE EFFECTS OF AUTOCONTROLLING ALPHA WAVES ON TEST ANXIETY

by

Jeffrey Nels Younggren

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STATEMENT BY AUTHOR

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SIGNED: Jeffrey M. Youngren

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

W Bmoore
W. B. MOORE
Assistant Professor of Psychology

4-30-71
Date

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ABSTRACT

Recent literature would suggest that autocontrolling alpha brain waves has very pleasant experiental results. From this, the question has arisen: Is the ability to control alpha brain waves of any clinical value in lowering anxiety states? This study showed a trend in the direction of lowered anxiety states, but of equal interest was the fact that a group of naive control subjects reported pleasant states very similiar to those reported by the successful controllers of alpha. From this information, one might conclude that many of the pleasant subjective reports relating to the alpha wave state are more the result of expectancy and not that of the actual brain wave state.

INTRODUCTION

In the past decade there has been a growing interest in the area of bio-control, or more specifically, the effects of conscious or learned control over such phenomena as heart rate, blood pressure, and brain waves, normally thought to be involuntary physiological processes. For example, Dr. Barbara Brown, Chief of Experimental Physiology at the Veterans Administration Hospital in Sepulveda, California, in a popular magazine, foresees the closing of mental hospitals when the bio-control research leads to methods to cure neurosis or psychosis by placing patients in EEG feedback loops (Rorvik 1970). General researchers also feel that the autocontrolling of alpha (8 - 13 Hz.) brain wave states may be a major aspect of the pleasantness of Zen meditation since Zen meditators exhibit very high alpha rates and learn to control alpha easily (Kamiya 1968, Rorvik 1970).

The fact that brain waves can be conditioned has been known for quite some time. Early research by Jasper and Shagass (1941) showed the alpha blocking could be classically conditioned to sound by pairing sound with a light flash into a subject's eyes. The procedure usually took only ten pairings of the conditioned and unconditioned

stimuli to produce conditioning, and this procedure was shown to be successful on various conditioning paradigms. Jasper and Shagass expressed some concern about the possibility of conditioning alpha blocking using an instrumental approach. Since that time, instrumental conditioning of abnormal EEGs has been successfully demonstrated in cats (Sterman and Wyricka 1967), and also in other animals (Olds 1963).

Early research on alpha brain waves, summarized by Ellingson (1956) and Lindsley (1944), has shown that such phenomena as visual imagery, emotion, attention, and olfactory stimulation cause significant drops in alpha levels. Alpha blocking has been extensively studied and the brain stem reticular mechanisms for desynchronizing or blocking these cortical rhythms are now known. The mechanisms for increasing amplitude and frequency have not been systematically studied and since many investigators have wished to study the alpha rhythm informal techniques of increasing its amplitude have been used for the past forty years. These have consisted mostly of encouraging the subject to relax and leave his mind blank, and occasionally telling him if he has succeeded. Some workers have even listened to their own brain waves while working alone in a laboratory and trying to produce alpha (Adrian and Matthews 1934); but these informal procedures did not

employ efficient feedback in a well-controlled training situation.

There is little doubt as to the conditionability of the alpha state by making use of an operant paradigm (Kamiya 1968, 1969, Nowlis and Kamiya 1970, Stoyva and Kamiya 1968, Hart 1968, Crown 1970). The first successful research in the area was done by Kamiya (1968) and Stoyva and Kamiya (1968), who began their alpha studies by making use of a state discrimination experimental design. Subjects were to distinguish what state they were in at the sounding of a bell, with the bell sounding only upon the occurrence of an alpha burst. The first day resulted in subjects being able to distinguish alpha states only at the chance level; but by the fourth day of training, subjects were able to discriminate an alpha state at the one hundred percent level. Subjects participating in this early study reported that the alpha state was one of "not thinking," "letting the mind wander," or "feeling the heart beat" (Kamiya 1968, p. 58). Subjects who were relaxed and comfortable tended to produce more alpha waves than those who were nervous or worried about what would happen in the study.

Kamiya's research then moved to more of an operant conditioning approach with feedback being given to subjects when they were in alpha states. Feedback took

the form of a tone being administered through a set of earphones. Eighty to ninety percent of the subjects going through this training procedure demonstrated significant increases in alpha levels (Kamiya 1968), and some sustained alpha states for periods of twenty minutes (Stoyva and Kamiya 1968). Base line alpha trials were also shown to increase over trials while "alpha off" trials showed significant drops. The reason given for the increases in base line alpha was that during non-training sessions, subjects remained in the preferred state; and since the alpha state is reported as pleasurable, subjects subconsciously remained in alpha states even when not going through training (Kamiya 1968). Visual imagery was reported by subjects as the method for keeping the tone off while the method for keeping the tone on was described as an "alert nondrowsy state, devoid of concrete imagery" (Kamiya 1968, p. 58).

In a structured study done by Hart (1968), subjects were given autocontrol training for two thirty-minute sessions per week for five weeks. The design of this study was very much like that of Kamiya's later research. This study, though, incorporated a control group which did not receive feedback but was subjected to all other conditions experienced by the experimental subjects. Results showed that thirteen out of the sixteen

experimental subjects had significant increases in alpha activity. An interesting result of the study was that some of the control subjects also showed significant increases in alpha. Hart's study showed that research in this area should include a control group to avoid overestimation of the effects of the training condition.

In a recent study by Crown (1970) there was some difficulty encountered in training subjects to autocontrol using an experimental design much the same as that of Kamiya's. Out of six subjects, two learned to control percent time alpha above and below base line alpha levels, two others could reduce alpha below the base line, while the remaining two showed no significant changes in alpha activity regardless of the condition. This study also demonstrated that subjects who were successful controllers of alpha could maintain high alpha states even when receiving photic stimulation, a stumulus which would normally be considered to block alpha activity according to the review of EEG research presented by Ellingson (1956).

Kamiya (1970) has also demonstrated that his human subjects could learn to control high amplitude alpha waves for short periods of time. All subjects were given a fifteen-minute learning trial and then subjected to a two-minute session during which they were to attempt to keep

alpha on. The results showed that twenty-one out of the twenty-six subjects used had significant increases during "alpha on" periods, and nineteen of those subjects had significant decreases in alpha during "alpha off" periods. Also, there was no sex differences with regard to alpha levels nor was there any relationship between the "alpha on" state and heart rate, breathing, and blood pressure.

The subjects participating in the 1970 Kamiya study were asked to give verbal reports of what they did to produce alpha. Of the twenty-six subjects participating, twelve reported relaxation as the method, while eight reported relaxed states such as "letting go," "feeling of pleasure and security," and "sensual warmth." In other studies, the method for producing alpha has also been described as relaxation or states related to relaxation such as those just mentioned. These self-reports have led some experimenters to think that the alpha state may be a condition completely void of anxiety (Rorvik 1970). Kamiya has even suggested that "tranquility and alpha are related" and that states such as anxiousness and misery may be associated with another wave form (1968, p. 60). To date, no systematic research has been done to assess the beneficial effects of autocontrolling alpha brain wave states in relieving anxiety, or to see if the pleasant

states reported by individuals who can successfully control alpha are the result of being in the alpha state or possibly the result of exposure to an extremely relaxing experimental environment.

STATEMENT OF THE PROBLEM

The evidence from previous studies raises various questions regarding the effects and values of autocontrolling the alpha brain wave state. One important question is: Do individuals actually learn control of alpha waves or could the reported increases in alpha be the result of extremely relaxing surroundings in combination with auditory stimulation? One must also ask whether the alpha state is actually as relaxing as the previously cited literature states; and if so, whether one can teach anxious individuals to control alpha and thereby lessen their reported anxiety to any substantial degree? One final question is whether individuals who can learn to control alpha can use this technique successfully outside the experimental environment? This study will attempt to answer these questions by taking individuals who report a substantial amount of test anxiety and try to teach them to control alpha waves voluntarily. Following this, all subjects will be asked to report on how much the experimental procedure decreased their test anxiety. It is hypothesized that this study will, in general, show that the ability to control alpha waves is of clinical value in relieving reported anxiety.

METHOD

Subjects

The subjects were fourteen college students at The University of Arizona, all having completed at least one college semester. The fourteen were predominantly middle economic class students and were randomly assigned to experimental and control groups, with seven subjects in each group.

Procedure

Subjects were assessed to be test anxious by scores obtained on the Test Anxiety Scale (TAS), Appendix A. This scale is identical to the one used by Mann (1969) and is a modification of the original scale used by Emery and Krumboltz (1967). The scale is said to discriminate successfully ($P = .05$) undergraduates who are test anxious from those who are not, with the test anxious scoring significantly higher on all nineteem items.

Responses to the questions of the TAS were scored making use of a Likert-type scale. The "never" responses were scored 1, and the "always" or "almost always" responses were scored 5. A composite score of 60 or more on all nineteen items was required for subjects to be called test anxious and to participate in the study.

The questionnaire was administered to the subjects in the class rooms and no information regarding the purpose of the questionnaire was given until the questionnaires were complete. All subjects were informed that participation was totally voluntary and that the study was being done in the Psychology Department of The University of Arizona, with the information being both confidential and anonymous. Code numbers were used by the students filling out the questionnaires. The tests were then scored and those subjects with scores in the 60 or above range were asked to participate in the study. All participants were informed that the determination of their being test anxious did not imply any form of over-all anxiousness.

All volunteers were told that a study was being conducted to determine the effects of autocontrolling alpha brain wave states on test anxiety. Subjects were informed that they would be given eight one-hour sessions teaching them to control alpha in hopes that this would lower their test anxiousness. Subjects were then randomly divided into two groups, with one group being the experimental autocontrolling group and the other group functioning as a naive control.

Recording Procedures

A Beckman-type RB Dynograph, with two channel amplification and a time marker, was used for recording the electroencephalograms. A twenty-five foot, three-wire shielded cable extended from the input box of the Dynograph to the electrode input box located in an adjacent room. Subjects were seated in a Koeningkramer Reliance Opthalamic Chair, with a head support providing as much comfort as possible. (Fig. 1)

Feedback was administered manually from a Hewlett Packard Model 200 Wide Range Oscillator, operating at 205 cycles per second. The oscillator was connected to a set of Calrad RH-40 earphones, and feedback was administered by increasing the volume of the tone. In addition, the oscillator was also connected to one of the input channels of the Dynograph providing a method for recording the frequency, intensity, and duration of the feedback administrations.

Experimental and control subjects were prepared for electrorecording in the same manner. Electrode application consisted of the placement of a reference electrode on the subject's left ear (Fig. 1), a ground electrode on the mastoid, and an occipital electrode one and one half inches up and to the right of the external occipital protuberance.

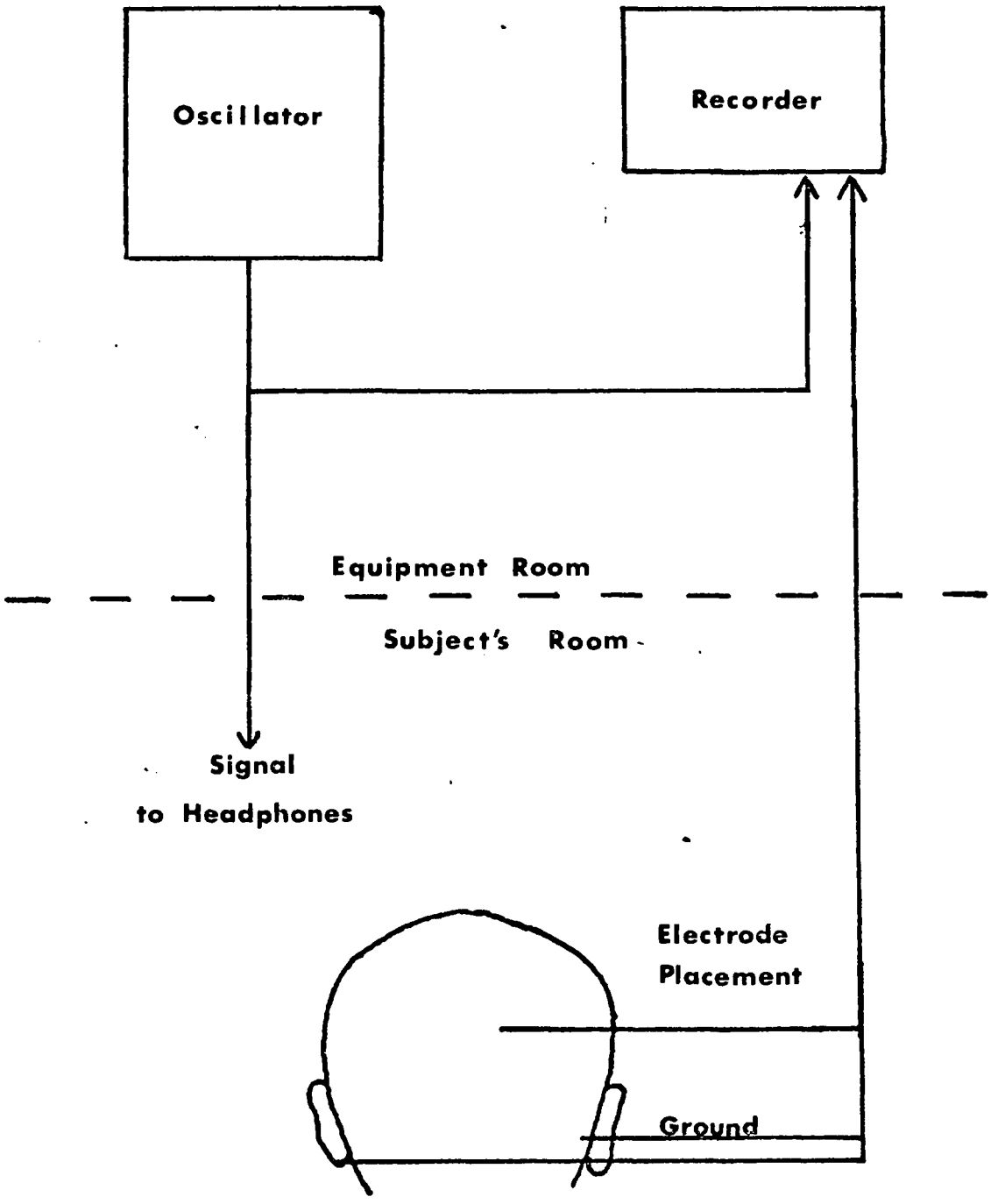

Fig. 1. Diagram of apparatus used for autocontrolling alpha brain wave states.

Recordings were therefore obtained from the occipital and from the ear as reference.

Autocontrol Methods

After the electrode application, subjects were seated comfortably in the opthalamic chair with the head rest adjusted so as to avoid fatigue. Instructions were to remain motionless with eyes closed. The door to the room in which the subjects were seated was closed and the lights turned off. Before any instructions were given to the subjects, a five-minute base line period of alpha was recorded. Subjects were instructed to keep the tone coming through the earphones as loud as possible for this would indicate that they were producing alpha waves and that they were to learn the method for keeping the tone the loudest for the longest periods of time. All subjects were given eight trials, each of which consisted of three fifteen-minute training sessions. Following the last fifteen-minute period, subjects were given an auditory signal telling them to stop attempting to control alpha, and in this manner a post-trial non-control alpha level was obtained for a period of one minute.

The experimental subjects' recordings consisted of alpha and feedback records (Fig. 2). These experimental recordings provided the feedback directions used on the

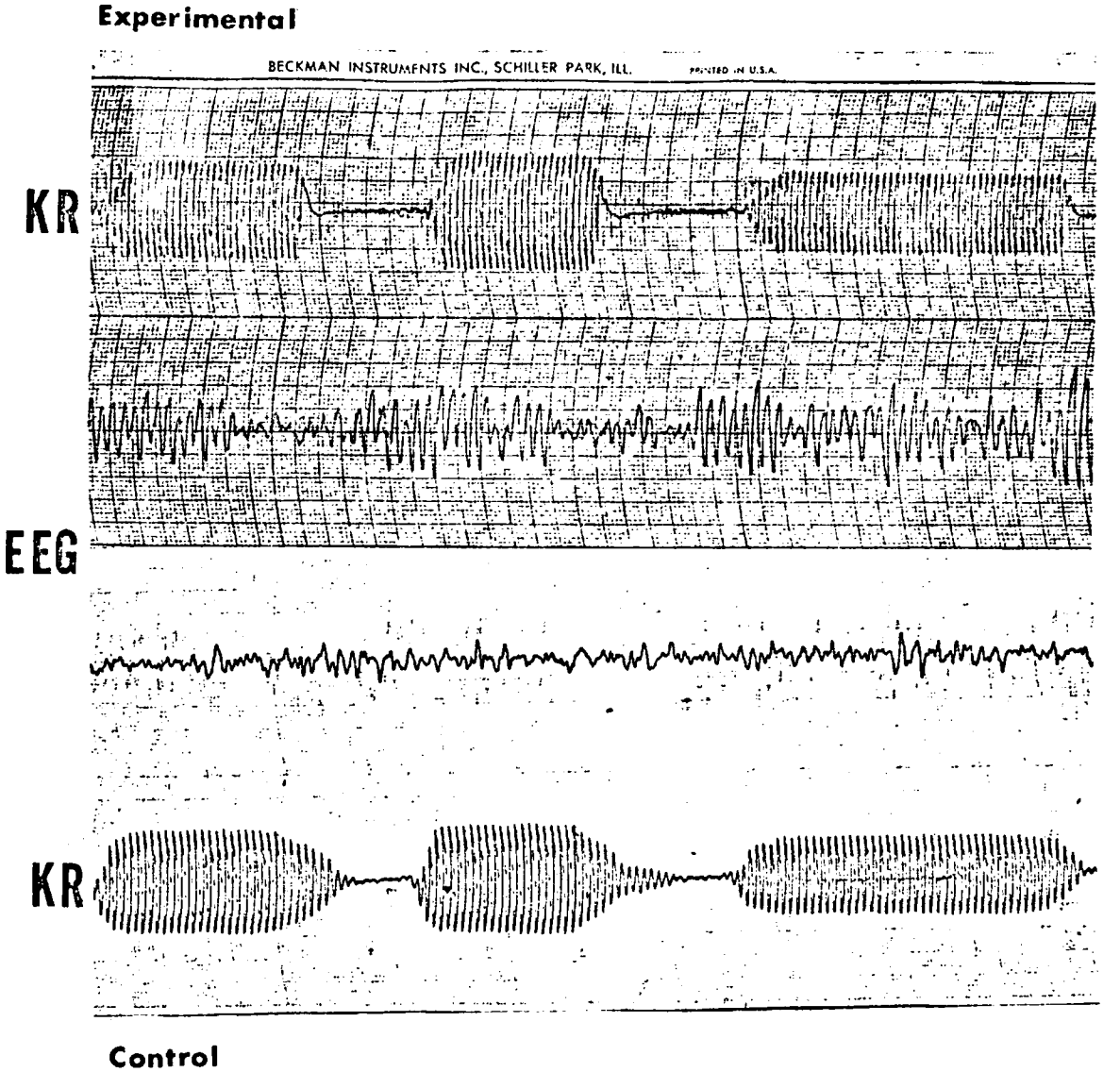

Fig. 2. EEG of Experimental and control subject with matched feedback (KR).

control subjects. The experimental recordings were turned over and control EEG recording was done on the backs of them. The feedback application for the controls became a tracking task with the experimenter giving the controls feedback identical to that previously administered to an experimental subject (Fig. 2). This provided an entirely random method for administering feedback to control subjects and also a method of matching experimental and control subjects with regards to equal feedback administration.

Following this procedure, all subjects were instructed to use the autocontrolling technique they had learned in the testing situation during a college level examination outside of the laboratory. Following the examination, subjects were to fill out the TAS again reporting what effect the autocontrolling procedure had on their test anxiety.

RESULTS

Each subject's autocontrol data was first converted into mean percentage alpha per session by measuring relative alpha levels on every fourth page of recording and converting the sums of the measured recording sheets into percentages. In this manner, eight means were obtained for each subject showing alpha production during each day. The graph showing both experimental and control groups changes in alpha levels over sessions is presented in Figure 3.

An analysis of variance was then performed on the data to determine whether the interaction of groups with treatments was significant (Table 1). An F of 1.77799 was obtained which was insignificant at an alpha level of .05. The difference approached significance with a probability of .20. This insignificance is probably due to the fact that three of the experimental subjects did not show significant increases in alpha levels while four did with values calculated on the difference of the first and last sessions exceeding a probability of .05. The respective t values using one tailed tests can be found in Appendix B.

The scores from the TAS were treated as interval data and an analysis of variance was calculated on this,

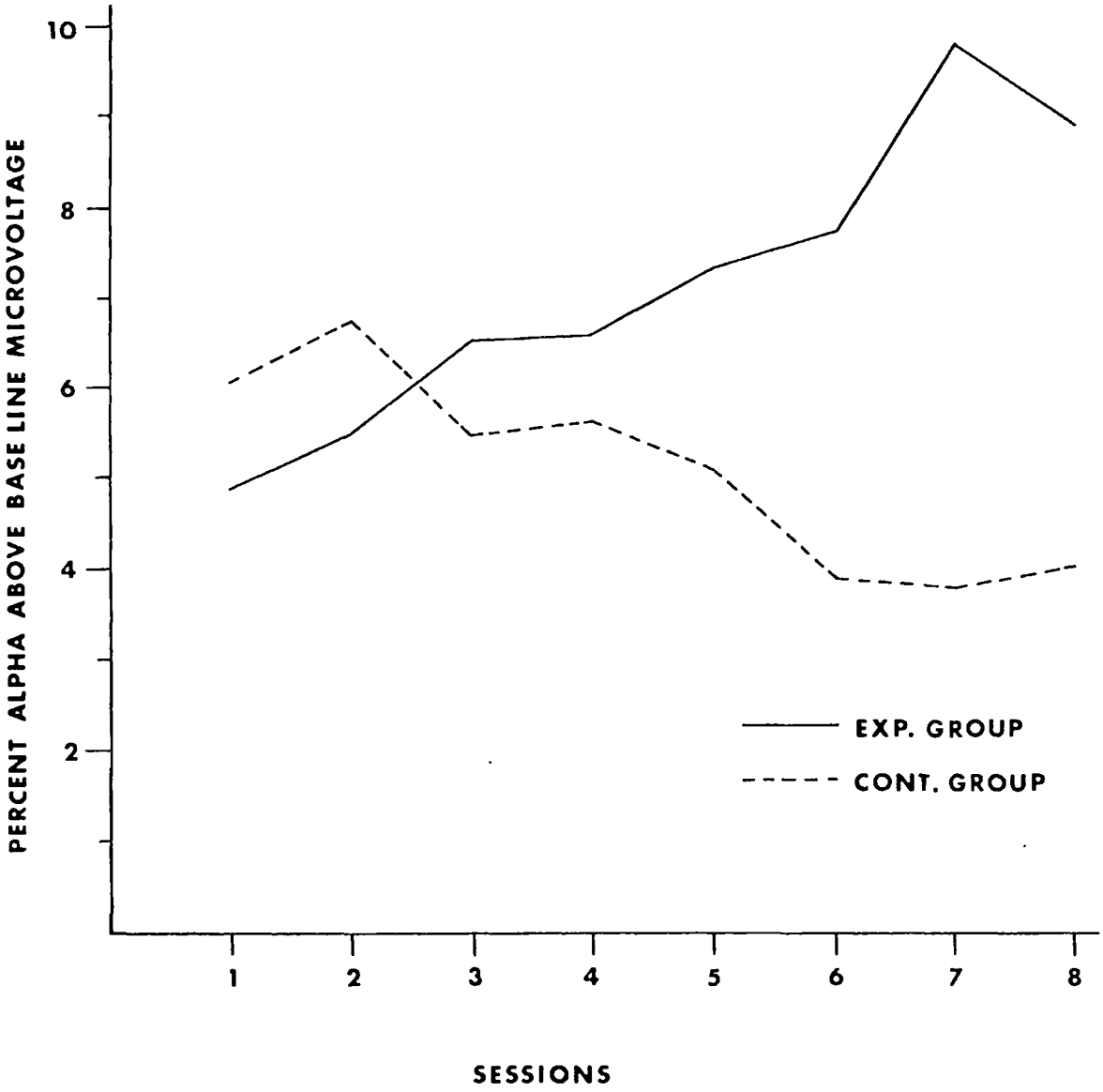

Fig. 3. Graph of relative alpha levels for experimental and control groups over sessions.

Table 1

Analysis of Variance for Experimental and Control Group's Percent Alpha Activity

Source	df	SS Num.	Mean Sq.	F	P
Within	13				
Groups	1	120.7329	120.7329		
Sub Within Groups	12	1674.5336	13.9545		
Between	98				
Treatments	7	15.5389	2.2198		
Treatments X Groups	7	176.2758	25.1823	1.779	> .2
Sub Within Groups and Treatments	84	1189.7214	14.1634		

using the same format as mentioned above. Although this use of ordinal data does not meet the criteria for the use of analysis of variance as set down by S. S. Stevens, it has been shown by Baker, Hardyck, and Petrinovich (1966) that ordinal data can be successfully treated with tests, such as the t-test, that normally demand interval or higher data.

The analysis of variance of the test scores (Table 2) showed a significant drop in test anxiety for treatments in general ($P = .001$), with the pretreatment TAS mean score of 74 for subjects in general dropping to 57 on the post-tests. The treatment by groups' interaction was insignificant with an F-test value of less than 1.

Following the analysis of the subjects by original control and experimental groups, subjects were separated into those who were successful controllers and those who were not. A t-test was then performed comparing the number of points dropped on the pre- and post-treatment scores of the TAS for each group. A t-score of .9808 was obtained with a probability exceeding .20 with a one tailed test.

One final comparison was conducted on the data. The seven individuals with highest alpha levels were compared to the seven with the low levels with regard to drop in TAS scores. A t-test was also calculated on this data and a t-score of .1481 was obtained which was insignificant.

Table 2

Analysis of Variance for TAS Change

Source	df	SS Num.	Mean Sq.	F	P
Between					
Treatments	1	1428.5714	1428.5714	12.9199	.001
Treatments X Groups	1	75.5714	75.5714		
Sub. Within Groups over Treatments	12	1236.8571	110.5714		
Within	13	1386.4285			

DISCUSSION

This study has supported the results of similar studies in that not all individuals attempting to control alpha brain wave states can successfully learn the technique. It is of interest to note that only four out of seven experimental subjects could successfully control alpha showing significant increases in their alpha levels, a number far less than the previous literature would lead one to expect. One could postulate from this data that individuals who exhibit high levels of test anxiety are more anxious in general than the rest of the population, and that this anxiety makes learning to control alpha more difficult.

Regarding the effects of autocontrolling alpha upon reported test anxiety, for experimental and control groups, one can only postulate from this data that the significant drop in test anxiety obtained for subjects in general was due to subject expectancies with regard to the experiment. This raises several important questions regarding the efficacy of the self reports obtained thus far concerning the effects of autocontrolling alpha. Since both control and experimental groups reported substantial drops in anxiety with no significant differences between

groups, possibly the information concerning the relaxing aspects of autocontrolling alpha are due only to the exposure to an extremely relaxing environment, or to expectancies.

Another aspect of the study must also be considered before one is able to accept the previous statement. The comparison of the four successful controllers with the non-controllers with regard to drop in test anxiety scores was approaching significance with a probability of .20. Two controllers reported drops of forty percent or more in test anxiety, and one of these reported using the technique before an examination and then falling asleep. This information again raises the question: Would a significant decrease in anxiety have been obtained in the experimental group if more or all individuals in it had been successful controllers? The methodology used in this study would provide a good way to further research this aspect of the study but it would require a much larger number of subjects in the experimental group so that non-controllers of alpha could be excluded.

When questioned regarding the method for controlling alpha, experimental subjects reported such techniques as "thinking about pleasant experiences," "blank out my mind," "maintain a steady deeply relaxed state," and control subjects reported "thinking of pleasant times,"

"passive acceptance," and "relaxation." As stated above, the consistency in these statements would lead one to think that the reports are less a result of the effects of autocontrolling alpha and more the result of expectancy about the effects of this study and prior information concerning the recent research results in the area.

With regards to the research techniques used in this study, it should be said that the methods used for producing the naive control subjects is very successful. Improvement could be made by avoiding manual applications of feedback. There is a possibility that some of the difficulty in obtaining significant changes in the alpha levels of the experimental groups was the result of slight delays in the administration of feedback; however, this is very unlikely because feedback administrations overlapped the alpha bursts a great deal more than the manual delays overlapped into random neural activity.

Another area of concern has been raised by this study which related to the recent rise in the sale of small devices sold for the purpose of teaching individuals to control brain waves and claiming significant experiental results for the user. With the information available from this study, one must feel that the efficacy of these devices is questionable and that the pleasant states reported

by many of the users of them are solely the result of expectancy and not the control of brain wave state.

The question concerning the use of this technique outside the experimental environment still remains unanswered. One experimental subject reported that she felt the technique was extremely relaxing but that she was unable to control alpha outside of a quiet environment void of high levels of external stimulation. If this is true and autocontrolling alpha can only be successfully achieved in a certain type of environment, one can only question the usefulness of the technique with regards to reducing high levels of anxiety.

Many of the questions raised by this study regarding the effects of bio-control of brain activity are answerable only by additional systematic research in this area. The trend obtained from comparing the test anxiety drops of successful controllers with non-controllers is interesting since the difference obtained was in the expected direction. Only with a larger number of successful controllers of alpha could one test to see if autocontrolling alpha does successfully decrease reported anxiety.

APPENDIX A

T A S

Matriculation No. _____ Sex ___ Age ___ Grade _____

Although most students experience nervousness before and during tests, some become nervous more often than others. Please indicate how often each of the following statements applies to you. Use the following scale for all questions:

Rarely or Never	Infrequently	Occasionally	Frequently	Almost Always or Always
R	I	O	F	A

Please circle the response that best describes your reactions.

1. R I O F A I do poorer on examinations because I am nervous.
2. R I O F A I feel nervous when the teacher announces the date of an examination.
3. R I O F A While taking an important examination, I perspire a great deal.
4. R I O F A When I have trouble answering a question on a test, I find it hard to concentrate on the questions that follow.
5. R I O F A I get depressed after taking a test.

6. R I O F A I feel nervous when I am studying for an examination.

7. R I O F A I get to feeling very panicky when I have to take a surprise examination.

8. R I O F A During an important examination, I experience a feeling of helplessness building up inside me.

9. R I O F A The more important the examination in determining my grade, the more nervous I am.

10. R I O F A During tests, I find myself thinking of the consequences of failing.

11. R I O F A Getting a good grade on one test doesn't seem to increase my confidence on the next test.

12. R I O F A I have trouble falling asleep the night before an important examination.

13. R I O F A When taking a test my emotional feelings interfere with my performance.

14. R I O F A I am still nervous for at least an hour after taking an examination.

15. R I O F A I feel my nervousness on tests comes from not knowing good methods of taking examinations.

16. R I O F A I feel my heart beating very fast during important examinations.

17. R I O F A I feel nervous while the test is being handed out.

18. R I O F A During a course examination, I get so nervous I forget facts I really know.

19. R I O F A I feel that I get overly nervous about taking examinations.

APPENDIX B

T VALUES FOR SIGNIFICANT EXPERIMENTAL SUBJECTS*

	t	df	P
J.D.	1.618	86	.05
V.G.	3.151	104	.001
J.M	5.626	100	.001
C.S.	9.658	67	.001

*1 tailed values

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