LATERAL EYE-MOVEMENTS AS AN INDEX OF ALPHA ENHANCEMENT WITH AUDITORY FEEDBACK

by

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B. Sc., Columbia University, 1968

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in the Department

of

Psychology

SIMON FRASER UNIVERSITY

September, 1970

APPROVAL

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Degree: Master of Arts

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Abstract

The purpose of this research was to investigate relationships among reflective lateral eye-movements (LEM), resting level of EEG alpha activity, and degree of alpha rhythm enhancement during training with an auditory feedback loop.

In an initial study, 60 Ss were tested for LEM and basal alpha activity. Analysis of variance of the basal scores showed a significant interaction between sex and LEM. Male left-movers and female right-movers had consistently higher alpha indices. In the second stage of this study, 24 Ss selected on the basis of sex and basal level of alpha were asked to return for feedback training. Analysis of performance during training showed that low basal Ss significantly increased their level of alpha activity, while high basal Ss showed no significant change.

The second study, which was designed to determine the relationship of LEM to the degree of alpha enhancement with contingent feedback training, employed a yoked-control procedure. Forty Ss were selected on the basis of sex and LEM. Each of the 20 Ss assigned to the experimental group was matched for sex, LEM, and basal alpha with one of the 20 Ss in the yoked-control group. Analysis of pre-training basal scores replicated the initial findings of the first study. Male left-movers and female

right-movers again had consistently higher alpha indices. Analysis of performance during training with alpha contingent feedback showed no significant difference between experimental and yoked-control Ss. However, these groups did differ significantly in their explanation of what produced the tone. Experimental Ss offered explanations of how they controlled the tone, while yoked-control Ss more often insisted that they had no control over the production of the tone.

The lack of a significant difference between alpha activity in yoked-control and experimental Ss precludes an operant interpretation of the feedback training technique. However, that Ss could distinguish between contingent and non-contingent feedback suggests the possible use of the feedback techinque as a method for training perception, rather than control, of internal events.

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Acknowledgements

I would like to express my gratitude to Dr. Paul Bakan for his continued assistance during the preparation of this thesis, and to Dr. M. E. Bitterman for his incisive suggestions concerning experimental design. I would also like to thank Dr. Harold Weinberg and Dr. A. R. Blackman for their helpful criticism in the preparation of the final manuscript.

Introduction

Experimental Enhancement of the Alpha Rhythm

Much work in the field of electroencephalography has focused upon the investigation of synchronous brain activity within the range of eight to twelve cycles per second -- a range commonly referred to as the alpha rhythm. A recent, and potentially important, aspect of this work is the development of experimental procedures for the enhancement of alpha activity. Kreitmen and Shaw (1965) attempted to assess the effect of four different types of tasks upon the amount of alpha activity produced by eight subjects. They reported that tasks in visual brightness-matching and in mental arithmetic led to severe decrements in the amount of alpha activity. Tasks for determining auditory thresholds had little effect upon the amount of alpha, while a two-point tactile discrimination task led to alpha enhancement. Another procedure which has been used to increase alpha activity was developed by Kamiya (1968, 1969). While training subjects to identify their own alpha and beta activity, Kamiya discovered that some subjects, usually those who excelled at the identification task, also learned to produce alpha activity upon request. By refining the procedure used in the indentification study, Kamiya developed a training procedure which has subsequently been called the alpha feedback-loop. A similar apparatus had been designed earlier by Mulholland (Mulholland & Runnals, 1963), but was used to study cortical activation rather than to enhance alpha activity. Generally this procedure is arranged so that the electroencephalographic (EEG) output controls the onset and offset of some stimulus (usually a pure tone) in such a way that the presence of the stimulus is contingent upon the production of alpha activity.

Kamiya (1968, 1969) reported that most subjects who were trained with the feedback-loop learned to both increase and decrease the amount of alpha activity that occurred within a specified time interval. Kamiya's report on the effectiveness of the feedback-loop as a technique for learning to control alpha activity was partially corroborated in an independent study by Hart (1968). Hart gave extensive alpha enhancement training with the feedback-loop to 16 experimental subjects. He found that 13 subjects significantly increased their alpha indices within ten half-hour sessions administered over a period of five weeks. In addition, Hart used five control subjects who did not receive feedback. Since some of these controls also showed increased alpha activity in later sessions, Hart advised future researchers to include this control in order to prevent an overestimation of the effectiveness of the feedback training procedure. Kamiya (1969) reported a study in which each subject was used as his own control. This experiment, which attempted to gather more information about conditioned alpha suppression, employed a more elaborate training procedure. For the first five 30 second trials, subjects were instructed to produce a tone which was contingent upon alpha activity. During the following five trials the tone was disconnected, and subjects were told explicitly not to try to produce the tone, but simply to rest. For the next five trials the tone was reconnected, but subjects were instructed to try to turn it off. By repeating this sequence, Kamiya was able to determine enhancement, basal, and suppression scores for each subject at different times in the experimental session. His results showed significant differences between suppression and enhancement functions, as well as between suppression and basal functions. However, he failed to find a significant difference between enhancement and basal functions. Kamiya suggested that the similarity between basal and enhancement functions indicated that after enhancement training the alpha state became a preferred mode of waiting for the next set of suppression trials. This interpretation was strengthened by his subjects' reports that they much preferred producing the tone.

Although other researchers (Brown. 1968, 1970; Nowlis & Kamiya, 1970; and Spilker, Kamiya, Callaway, & Yeager, 1969) have also reported successful enhancement of alpha activity using the feedback-loop technique, little effort has been directed toward a systematic investigation of other variables which might contribute to an understanding of the alpha acquisition process. Instead, the procedure has been conceptualized as a somewhat special extension of operant conditioning to neurophysiological activities. Consequently, the alpha feedback procedure has become an accepted, but poorly examined, operant technique used in the investigation of other psychological and psycho-physiological problems (Spilker, _et_. _al_., 1969).

Some researchers, following the advice of Stoyva and Kamiya (1968) that physiological measures in conjunction with verbal reports be used as converging operations for the scientific study of consciousness, have begun to investigate the experienced correlates of alpha activity. Brown (1970) reported that subjects who showed greatest enhancement of eyes-open alpha activity during training with contingent visual feedback more often reported a "narrowing of perceptual attention" and "pleasant feeling states." In addition, she reported that subjects with initially low basal levels of resting alpha activity showed the greatest degree of alpha enhancement during this eyes-open training. Nowlis and Kamiya (1970) conducted a similar study using auditory feedback with eyes-open and eyes-closed training. Subjects were given up to 15 minutes to discover how they controlled the feedback tone. They then were tested to determine their ability to produce and suppress the tone. An analysis of the verbal reports in a post-experimental interview showed that relaxation and attention to breathing were the dominant methods for producing alpha, whereas vigilance, tension, and agitation tended to suppress it in the eyes-closed condition. In the eyes-open training, subjects reported relaxation and not focusing as methods for alpha production, and visual attentiveness as the best method for alpha suppression. In another study, Brown (1968) provided visual feedback varying in hue for the production of alpha, beta, and theta activity. She reported that subjects found alpha activity to be associated with increased inner awareness, and tranquility. Beta activity was associated more frequently with unpleasant types of thoughts and feelings. She added that verbal reports describing theta activity were more difficult to analyze since this activity occurred less often. However, since general agreement occurred among subjects who offered descriptions of the various EEG states, Brown optimistically concluded that the feedback procedure provides a new, and unique method for the investigation of private, or subjective experience.

Although the use of the feedback training technique in the search for experiential correlates of EEG activity is a provocative, and potentially fruitful enterprise, this use seems to have fostered a general disinterest in the more detailed study of the alpha feedback training *per se*. Researchers have reported substantial differences between subjects in both enhancement and suppression abilities, and it seems that some subjects simply do not benefit from the feedback experience. However, few reports have attempted to account for this between-subjects variance. In view of the reported activities which were associated with alpha enhancement and suppression, a recently discovered lateral eye-movement phenomenon (LEM) might provide a useful index of the differences found among subjects trained with the alpha feedback-loop.

The Lateral Eye-Movement Phenomenon

The LEM phenomenon is a behavioral response that usually occurs whenever a subject is asked a direct question requiring reflection. Prior to giving his answer, the subject will typically shift his eyes to the right or left immediately after the question has been asked. In repeated observations, the direction of the eye-movement is characteristic for a given subject.

Since the discovery of the LEM phenomenon (Day, 1964), most of the research on this behavioral response has attempted to relate it to some underlying psychological or physiological process. In his initial report of the phenomenon, Day (1964) suggested that LEM was related to shifts in attention which occur as the subject pauses to reflect on the answer to a question. He also suggested that LEM was related to the individual's personal method of coping with anxiety. In later papers, Day (1967, 1968) claimed that differences in the direction of LEM divide people into two distinct groups who, from clinical observations, seem to have basically different cognitive and perceptual styles. Day suggested that these differences were best viewed as the result of differences in the temporal distribution of attention. Day contrasted left- and right-movers by their statements about the locus of their feeling of anxiety; the right-mover spoke of an external source of anxiety, while the left-mover was more inclined to seek some internal source. Day added that differences in the direction of LEM might also be revealed in early language acquisition; the right-mover would more readily acquire and use words referring to actions, while the left-mover would be more prone to learning descriptive language, especially language referring to private experience.

The response of experimental psychologists to the LEM phenomenon has been scant. Duke (1968) replicated Day's initial findings in an experimental setting. He found that the LEM response occurred more often to questions requiring reflection, as opposed to more factual questions; that the direction of LEM was consistent within a given individual, and more consistent for males than for females; and that the LEM phenomenon was unrelated to eye-dominance. In a later study, Kaushall (1970) replicated Duke's finding for eye-dominance using a sighting method, but found a high correlation between LEM and eye-dominance for brightness-matching. Bakan and Shotland (1969) conducted a study which showed that right-movers were less influenced by color-work interference during the administration of the Stroop

Test. They suggested that this difference between left- and right-movers may be due to the right-movers' superiority in visual attention, which enabled them to make the covert word response sooner, and then to proceed to process the requisite color name.

In another study, Bakan (1969) tested subjects for LEM and susceptibility to hypnosis. He found a significant correlation between left eye-movements and high susceptibility. From additional data collected on the same subjects, Bakan reported that left-movers tended to select more humanistic fields of study at the university, had better verbal than mathematical scores on the Scholastic Aptitude Test, and had clearer visual imagery. Other studies in electroencephalography (London, Hart, & Leibovitz, 1968; and Nowlis & Rhead, 1968) had demonstrated a correlation among susceptibility to hypnosis, clarity of visual images, and resting EEG alpha rhythm. Thus Bakan and Svorad (1969) compared left- and right-movers in terms of percentage alpha in their resting EEG activity. They reported that left-movers had consistently more resting alpha rhythm than right-movers.

Rationale for the Present Investigation

The purpose of the present study is to investigate the relationship between LEM and alpha enhancement in the feedback training procedure. In view of the report by Brown (1970) that the degree of enhancement in the eyes-open training condition was greater for subjects with initially lower basal levels of resting alpha, right-movers might be expected to benefit more from feedback training. However, examination of the verbal reports from subjects who successfully altered their alpha indices (Brown, 1968, 1970; and Nowlis & Kamiya, 1970) leads to a different expectation. The reported narrowing of attention, increased inner awareness, and decreased visual attention are descriptive of behavior which fits well with the emerging stereotype of the left-mover. In addition, Day's suggestion that left-movers are more attentive to internal experience leads to the expectation that left-movers would have less difficulty making the internal discriminations which might facilitate learning to alter the amount of alpha activity. However, if the left-movers' basal level of alpha were too high, their performance during enhancement training might be limited by a ceiling effect. Without more detailed information about the alpha training procedure, as well as about the relationship between amount of resting alpha and LEM, it is difficult to predict how performance of left- and right-movers might differ during the alpha feedback training.

In order to provide additional information on the feedback training technique, and on the relation of LEM to basal alpha, an initial study was designed to examine performance during feedback training as a function of sex and basal level of alpha activity. All training was limited to the eyes-closed condition. In addition, LEM scores were collected for each subject in an attempt to replicate the finding that LEM and basal alpha are correlated. Since alpha enhancement might be limited by a ceiling effect for high basal subjects, two additional indices of learning were included in the design. Tests were given midway through, and at the end of feedback training to detect changes in the ability to produce alpha without feedback. Finally, ability to control alpha activity was assessed by including post-training enhancement and suppression tests.

Since subjects who received feedback training in the first study were not selected on the basis of LEM, a second experiment was designed to test directly the hypothesis that left-movers would benefit more from the feedback experience. In order to provide an accurate estimate of the relative effectiveness of the feedback training procedure, the second study included a control group which received feedback that was not contingent upon alpha activity.

Experiment 1

Method

Subjects: Sixty subjects (Ss), 30 females and 30 males, were recruited from the Simon Fraser University community as prospective participants in an experiment on language and private experience. Ss were selected on the basis of LEM scores so that there were an equal number of left- and right-movers of each sex. Ss ranged in age from 18 to 32 years, and were either students or staff at the university.

Apparatus: A list of twelve proverbs was used to determine LEM scores (See Appendix A). The basic components of the alpha feedback system were a Grass Polygraph, Model 7W-c16PA; a Grass Driver Amplifier, Model 7DAC; a Grass Wide-Band AC EEG Preamplifier, Model 7P5A; an alpha trigger designed to trigger with inputs in the range of 8.0 to 12.2 cycles per second (See Appendix B); a Heathkit Audio-generator, Model 1G-72, set at 240 cycles per second; a Monarch Solid State Amplifier, Model SA-616; a Hunter Model 120-A KlockKounter, Series D; a small accessory speaker; and an assortment of Grason-Stadler modular equipment. All EEG recording was done with S in an IAC Model 11170 sound-proof booth, equipped with an Eden six-channel intercom. A Uher 1400 tape-recorder was used to record all verbal responses during the administration of the proverb scale, and during a post-experimental interview.

Procedure: When S reported to the experimental room, he was asked to be seated in a chair directly opposite, and facing the experimenter (E). S was told that E was conducting exploratory research on the relation of language to EEG recordings, and thus it was necessary to collect some information about how S used and interpreted words. This was to be done by tape-recording S's interpretations of a list of ambiguous proverbs. E stressed that there were no correct or incorrect answers, but that it was important for S to think carefully about each proverb, and to respond only if he found it meaningful. E then read one proverb at a time, and waited for S to respond. By looking up at S just as he finished reading the proverb, E was able to see and record the direction of S's LEM.

After S had finished interpreting the proverbs, he was escorted into the sound-proof booth, and asked to be seated in a reclining chair. The EEG recording was made using three electrodes: a ground electrode attached to the forehead above the left eye-brow; an indifferent electrode attached to the right mastoid; and a reading electrode attached to the occipital midline approximately three centimeters above the inion. Time constants were set to filter 0.3 for low frequency, and 35.0 for high frequency. After attaching the electrodes so that impedence was below two kilo-ohms, E adjusted the chair so that S was in a semi-supine position, and asked S to relax for about ten minutes with his eyes closed. E then left the experimental chamber, turning off the lights. S was given about three minutes to adapt to the darkened booth, and then a five minute recording was made to determine basal level of alpha activity without feedback.

The alpha feedback training part of the experiment was designed to investigate the effect of training upon males and females with high and low basal levels of alpha. Low basal level was operationally defined as ten to 140 seconds of alpha during the five minute test period. High basal was defined as 150 to 280 seconds of alpha during the same five minute period. The experimental design of the training study required 24 Ss distributed evenly for sex and basal level. All Ss who could be placed tentatively into one of the four experimental groups were asked to return at a later time for the training session. Two dollars per hour was offered as an incentive to encourage Ss to return.

The previous procedure was repeated at the start of the second session in order to provide a means of estimating the reliability of the basal alpha and LEM data. If the second basal measure for any S was not within the range of the group to which he tentatively had been assigned, he was eliminated from the experiment. If the second basal measure was within the stipulated range, then the feedback training was begun.

The training procedure in the second session consisted of 18 five minute trials (Figure 1). Immediately after verification of the first day's basal measure, the amplified output of the audio-generator was connected to the speaker inside the sound-proof booth via the alpha filter and trial relays. The sound level of feedback was constant for all Ss. S was then asked to signal as soon as he was ready for E to take another EEG recording. When S was ready, E started the first trial (T1), and for the first time S received auditory feedback contingent upon alpha activity. At the end of the first trial, E explained that the tone was produced by something that S was doing, and asked S to try to keep the tone on as much as possible in the next few trials. (Verbatim instructions are shown in Appendix C.) S then was given 6 five minute trials (T2 to T7) to practice producing the tone. Each trial began as soon as S signaled that he was ready for it. After the sixth practice trial, E disconnected the tone, and asked S to continue doing whatever he thought caused the tone to come on, even though he would not hear the tone in this next trial (T8). Following this, S was given six more five minute trials (T9 to T14) of practice at producing the tone. Then once again the tone was disconnected, and S was asked to continue doing whatever he thought caused the tone to come on. After this second test (T15) without the tone, S was given one additional practice trial (T16) with the tone connected. During the final two trials, S was first asked to turn the tone off (T17 -- alpha suppression test) and then to attempt to produce it (T18 -- alpha enhancement test). Throughout the training session, amount of alpha was recorded at the end of each trial from the Hunter timer.

At the end of training, E entered the sound-proof booth, removed the electrodes, and asked S the following questions:

1. What was your initial reaction to the tone? And later?
2. What types of things did you do to produce the tone?
3. What did you do to turn it off?

All verbal reports were tape-recorded, and later categorized by a naive judge who was unfamiliar with the alpha feedback literature, and with the verbal reports about experiences associated with alpha activity.

Results

LEM and Basal Alpha

Mean basal levels of alpha were calculated separately for left- and right-movers of each sex (Table 1). Male right-movers tended to have consistently lower amounts of resting alpha activity. Six male right-movers produced less than ten seconds of alpha during the five minute basal period. Male left-movers had higher amounts of resting alpha, even though almost half were classified in the low-basal group. For females the relationship between LEM and basal alpha was reversed. Female left-movers produced consistently lower amounts of resting alpha; four females produced less than ten seconds of alpha during the basal period. Female right-movers had higher amounts of alpha; all but three were classified in the high-basal group. Analysis of variance (See Appendix D) showed a significant interaction between LEM and sex which accounted for a majority of the variance in basal scores ($F=18.33$, $df=1,56$, $p<0.001$). Neither the main effect for sex, nor for LEM approached significance.

Reliability Data

Thirty-four Ss returned for alpha feedback training at least 24 hours after the first basal test. Initial data collected on these Ss provided checks for reliability of LEM and basal measures. The test-retest reliability coefficient for LEM, calculated from 34 repeated measures, was 0.78 ($p<0.001$). Reliability coefficients calculated separately for each sex were not significantly different. The test-retest reliability coefficient for basal alpha, calculated from 33 repeated measures, was 0.72 ($p<0.001$). Separate analyses by sex showed that male basal measures were significantly less reliable than female basal measures ($p<0.05$).

Of the 34 Ss who returned for the feedback training only 24 completed the entire alpha feedback procedure. Seven Ss were eliminated because of technical difficulties with the apparatus. Three Ss were disqualified because the second basal measure of their alpha activity was not within the specified range of the group to which they had been assigned. Two Ss initially classified in the low basal group increased their amount of alpha during the second measure; while one S initially classified in the high-basal group, decreased his amount during the second measure. The remaining 24 Ss were distributed among the four experimental groups so that sex and basal level were balanced. However, these groups were not balanced for LEM scores.

Feedback Training

Alpha enhancement scores were computed by averaging performance in blocks of three trials. These scores provided indices of early and late performance in the first series (T2 to T7) and the second series (T9 to T14) of practice with alpha contingent feedback (Figure 1). Analysis of variance of these enhancement scores with respect to sex, basal group, and blocks (See Appendix E) revealed a significant main effect for blocks ($F=6.39$, $df=3,60$, $p<0.01$); a significant main effect for groups ($F=70.53$, $df=1,20$, $p<0.001$); a significant sex by basal group interaction ($F=10.04$, $df=1,20$, $p<0.01$); and a significant blocks by group interaction ($F=2.98$, $df=3,60$, $p<0.05$). The blocks effect (Figure 2) indicated the tendency for Ss to increase their amount of alpha activity with successive practice trials. The basal group main effect (Figure 3) showed that low-basal Ss tended to produce less alpha activity throughout the experimental trials with alpha contingent feedback. The sex by basal group interaction (Figure 4) indicated that low-basal males produced more alpha activity during practice than low-basal females, while high-basal males produced less alpha than high-basal females. This performance during training corresponds to performance which occurred during pre-training basal tests. The basal by blocks interaction showed that low-basal Ss increased their amount of alpha to a greater degree than high-basal Ss as a function of practice with contingent feedback (Figure 3).

The amount of alpha produced in trials T8 and T15 (without feedback) was analyzed to determine if training increased Ss' ability to produce alpha when the tone was not available. Analysis of variance of these scores with reference to sex and basal group (See Appendix F) revealed only two significant sources of variance. A significant basal group main effect ($F=64.48$, $df=1,20$, $p<0.001$) indicated that the low-basal group produced less alpha in tests without feedback than the high-basal group (Figure 5). A significant basal by sex interaction ($F=6.98$, $df=1,20$, $p<0.05$) showed that low-basal males produced more alpha than low-basal females, while high-basal males produced less alpha than high-basal females (Figure 6). This difference again corresponds to differences which were found in the pre-training basal tests.

Alpha control indices were calculated for each S by subtracting the amount of alpha during the alpha suppression test (T17) from the amount of alpha produced during the last alpha enhancement test (T18).

Group means for control indices are shown in Table 2. Analysis of variance of control data with respect to sex and basal groups (See Appendix G) revealed only one significant source of variance -- a main effect for sex ($F=4.61$, $df=1,20$, $p<0.05$). This effect indicated that males showed a greater ability to control the presence of the tone than did females.

Verbal Reports

An analysis of verbal reports from the post-training interview showed that 12 *Ss* were initially indifferent to the tone, nine claimed that at first they found it unpleasant, and only three found it pleasant from the beginning. However, 21 *Ss* reported finding the tone pleasant at the end of training, while two were still indifferent to the tone, though they enjoyed the experience of producing it, and only one *S* (a high-basal male who successively decreased his amount of alpha activity with practice) still felt that the tone was unpleasant. The methods which *Ss* reported using to produce and suppress the tone are shown in Table 3. Any comment which occurred more than twice and was not subsumed in a larger category was included as a response item. An inspection of the different responses showed no substantial differences in the techniques of control between high and low-basal *Ss*. Although no sex differences were apparent in techniques for alpha production, male Ss reported more attention to thoughts and use of emotional arousal as methods for suppressing alpha. Use of visual images, and relaxation without thoughts were the most frequently reported methods for producing alpha, while active thinking and attention to body sensations were more frequently reported as methods of alpha suppression. No Ss reported the use of visual imagery during the alpha suppression test.

Experiment 2

The result of the first experiment only partially replicated the finding of Bakan and Svorad (1969) that left-movers tended to have more resting alpha activity. For males the expected relation was found, but for females the reverse relation held. Results from the feedback training procedure confirmed the report by Brown (1970) that low-basal subjects show a greater degree of alpha enhancement as a function of practice with feedback. However, the lack of a direct relation between LEM and basal alpha weakened the argument that right-movers might increase the amount of alpha more than left-movers as a result of feedback training. This result encouraged a direct test of the hypothesis that left-movers should perform better under the feedback conditions.

In order to provide a means of estimating the differential effects of the feedback training prodedure, the second study, following the advice of Hart (1968), employed a control group. The control which Hart suggested was not used, however, since it could not provide a test of the effectiveness of contingent feedback, but could only test the difference between groups which received no stimulation and those which received auditory feedback. A more appropriate control was obtained by matching pairs of subjects for basal level of alpha activity, and then yoking one to the other with respect to the type of stimulation which they received.

Method

Subjects: Forty Ss were solicited from introductory psychology classes at Simon Fraser University as participants in an experiment on language and brain waves. Ss were selected on the basis of LEM scores so that there were eual numbers of left- and right-movers of each sex. Ss ranged in age from 18 to 36 years.

Apparatus: A list of 20 proverbs was used to assess LEM scores (See Appendix H). The feedback system was essentially the same as in the previous study, except that a Uher 1400 tape-recorder was substituted for the Monarch Solid State Amplifier. The tape-recorder amplified and recorded feedback for experimental Ss, and provided appropriate stimulation for the yoked-controls.

Procedure: The method used to determine LEM scores was the same as in the first study. However, only Ss who were 70% consistent (i.e., who had at least 14 of 20 responses in the same direction) were scheduled for the EEG portion of the experiment.

When Ss arrived at the laboratory, the EEG recording procedures were explained briefly, and then they were escorted into the sound-proof booth. Electrode placements were identical to those used in the previous investigation. After attaching the electrodes, E asked each S to relax with closed eyes during all measuring periods. E then left the experimental chamber, turning off the lights. S was given three to five minutes to adapt to the darkened booth, after which a two minute recording was made to determine basal alpha activity. If S had an alpha index which was within 15 seconds of the index obtained by a previous experimental subject of similar sex and LEM, then S was yoked to that experimental subject.

The sequence of trials and instructions (See Appendix I) were identical for the yoked-control and experimental groups. However, the groups differed in respect to the type of stimulation which they received. The experimentals received alpha contingent feedback in all trials of the experiment where the tone was available. Yoked-controls received alpha contingent feedback only during an initial trial before training instructions; subsequently they heard a tape-recording of the tone produced by the experimental S with whom they were matched.

The training sequence in this study was similar to that used in the first investigation (Figure 7). However, all trials in the second study were only two minutes in duration. Immediately after the initial basal measure, the output of the tape-recorder was connected to the speaker inside the sound-proof booth. Each S was then asked to signal as soon as he was ready for E to take another two minute EEG recording. All Ss received auditory feedback (at 240 cycles per second) contingent upon alpha activity during this trial (T1). At the end of this first trial with the tone, E explained to S that the tone was produced by something which S was doing, and asked that in the next trial (T2), S attempt to keep the tone off as much as possible. From this time until the end of the experiment, the experimentals received alpha contingent feedback, while the yoked-controls heard a tape-recording of feedback which was not contingent upon alpha activity. Ss were next given 6 two minute trials (T3 to T8) where they were asked to practice producing the tone. After this practice period they were tested for their ability to produce alpha without feedback (T9). Following this test, Ss were given another five trials (T10 to T14) in which they were asked to practice producing the tone. After the second practice period, they were again tested for ability to produce alpha without feedback (T15).

Finally suppression (T16) and enhancement (T17) tests were given to assess Ss' ability to control the tone after feedback training.

After the last experimental trial, E entered the sound-proof booth, removed the electrodes, and asked each S what techniques he had developed to control the presence of the tone. Verbal reports were grouped in three categories: (A) Reports which indicated that S believed he had control over the presence of the tone; (B) Reports which showed that S was uncertain how, or if, he controlled the tone; and (C) Reports which indicated that S did not believe he had any control over the presence of the tone.

Results

LEM and Basal Alpha

The preliminary procedures of the second study provided additional information on the relation of LEM to resting level of alpha activity. Group means calculated for left- and right-movers within each sex (Table 4) showed that male left-movers again produced greater amounts of alpha during the basal period than male right-movers. Female left-movers tended to have slightly less resting alpha than female right-movers. Analysis of variance of these basal scores (See Appendix J) showed that the sex by LEM interaction was the only significant source of variance ($F=4.30$, $df=1,36$, $p<0.05$).

Feedback Training

Group mean alpha enhancement scores were computed for yoked-controls and experimentals in each of the eleven trials where Ss were asked to produce the tone (T3 to T8, and T10 to T14). These scores, plotted in Figure 8, show increased alpha activity as a function of practice trials for both groups. Analysis of variance (See Appendix K) indicated a significant main effect for trials ($F=3.73$, $df=10,160$, $p<0.001$); Figure 8 shows that both experimental and yoked-control Ss contributed to this main practice effect. The analysis failed to show any significant differences between the experimental and yoked-control Ss; moreover none of the interaction which included the yoke-experimental dimension approached significance in the enhancement analysis. In addition, the analysis failed to show a significant main effect for LEM, or a significant LEM by trials interaction. However, the three way interaction of LEM, by sex, by trials was significant ($F=2.06$, $df=10,160$, $p<0.05$). This interaction is represented graphically in Figure 9, which shows mean enhancement scores for left- and right-movers of each sex. Both female left- and female right-movers increased their enhancement scores as a function of practice trials. However, of the male Ss, only left-movers showed continually increasing amounts of alpha activity in successive practice trials. Male right-movers showed an initial increase, but dropped below their original level of alpha production during the later practice trials.

Analysis of tests for the ability to produce alpha without feedback after different amounts of training did not provide any significant results (See Appendix L). Analysis of early and late control indices also did not provide any significant differences in terms of the experimental variables. This indicates that experimental Ss did not differ significantly from the yoked-control Ss, and that neither differed in their early as opposed to late alpha control scores.

Verbal Reports

Although the preformance measures of alpha enhancement, alpha production without feedback, and alpha control failed to show significant differences between the experimental and yoked-control Ss, analysis of verbal reports (Table 5) indicated clear differences (Chi Square = 88.28, $p<0.001$). None of the experimental Ss expressed doubt that they had control over the presence of the tone; all but two offered explanations of methods which they had developed to control the tone. In contrast, only four yoked-control Ss offered explanations of how they controlled the tone, five reported that they were uncertain about what produced it, and eleven insisted that they had no control over the tone. Left-moving Ss accounted for eight of the eleven yoked-controls who reported that they had no control over the tone. Of the four yoked-controls who offered explanations, all were right-movers. Of the two experimentals who were uncertain about control, one was a female left-mover, and the other was a male right-mover.

Discussion

LEM and Basal Alpha

The results from both the first, and the second studies provided new information on the relationship between LEM and basal level of resting EEG alpha rhythm. The reported correlation of left eye-movements with high alpha indices (Bakan & Svorad, 1969) was found only for male subjects. For female subjects, the reverse relationship was found; female right-movers generally had higher alpha indices than female left-movers. This finding was replicated in the second experiment using a more stringent criterion of LEM classification. Although Bakan and Svorad reported using both female and male subjects, they did not report an analysis of their results which would have revealed a sex difference. Thus the present finding extends and clarifies their previous report. However, the sex difference in the relation of LEM to basal alpha tends to complicate the rationale which led to the Bakan and Svorad experiment, as well as the more general speculations by Bakan (1969) about the relation of LEM to functional brain asymmetries.

The hypothesis that left-movers should have more resting alpha activity than right-movers followed from previous reports that high susceptibility to hypnosis was correlated with high alpha indices (London, et. al., 1968; and Nowlis & Rhead, 1968) and with left eye-movements (Bakan, 1969). Since both studies relating alpha indices to hypnotic susceptibility analyzed data as a function of sex, and found no significant difference, it seems that the experiment relating LEM to hypnotic susceptibility should be replicated with greater attention to possible sex differences.

Bakan's specific interpretation of the LEM phenomenon entails the use of both physiological and psychological processes. Since lateral eye-movements are controlled contralaterally by activity in Brodmann's area 8 (Robinson, 1968), Bakan suggested that LEM may be "symptomatic of easier triggering of activities in the hemisphere contralateral to the direction of eye-movement" (Bakan, 1969, p. 930). In addition, Bakan's more general speculations about LEM draw heavily upon research which reports functional brain asymmetries. Citing evidence that the right hemisphere may be domnnant for some psychological processes characterized as pre-verbal, pre-logical, intuitive, subjective, synthetic, and diffuse, Bakan suggests that left eye-movements may indicate a more active right hemisphere resulting in a particular behavioral syndrome. The syndrome, according to Bakan, consists of greater use of pre-verbal imagery, greater hypnotic susceptibility, more humanistic orientation, poorer mathematical and logical abilities, and more resting alpha activity. The finding that LEM is related to basal alpha activity differentially for the sexes complicates Bakan's speculations, and may indicate possible sex-differences in other aspects of the hypothesized behavioral syndrome.

An alternate interpretation of this finding rests upon the suggestion by Lansdell (1964) that separate examination of functional brain asymmetries for each sex might provide clearer information on the relationship of morphology to function. Some clinical data on recovery rate from aphasic disorders show a sex-difference in favor of females (Geschwind, 1965). This difference could be viewed as evidence for structural or functional differences in the organization of the brain for each sex. Lansdell (1962) reported a study in which the surgical removal of cerebral tissues from the temporal lobe of the non-dominant (right) hemisphere led to impairment of design preference judgements in males, but not in females; while removal of tissues from the temporal lobe of the dominant (left) hemisphere led to a similar impairment in females, but not in males. If the localization of other attentional and internal processes is also different for the sexes, then the present finding would be compatible with Bakan's more general speculations, and could be viewed as indicative of the need for more detailed analysis of sex-differences in reports of functional brain asymmetries.

Reliability Measures

Reliability data was collected in the first study in order to determine the stability of LEM and basal measures in a test-retest situation where tests were separated by at least 24 hours. LEM scores were highly reliable, confirming the clinical observations of Day (1964, 1968). Basal measures were also highly reliable; however, males were significantly less reliable than females. This latter finding is consistent with other reports of sex-differences on test-retest measures (Garai & Sheinfeld, 1968).

Feedback Training

The design of the second feedback training study was intended to provide a means of estimating the effect of alpha training for both left- and right-movers. However, the results showed no significant differences between the experimental and yoked-control subjects. The similarity of alpha indices for these groups of subjects throughout the feedback training procedure casts doubt upon the effectiveness of contingent feedback alone to enhance alpha activity. This result implies that increased alpha activity during exposure to auditory feedback can be viewed as merely the result of shifts in basal level of alpha activity, rather than as the result of an operant conditioning technique.

Although the second study did not provide as much exposure to the contingent feedback as some of the other experiments with the feedback-loop (Hart, 1968; and Kamiya, 1969), the results of both of the present studies show comparable increases in amount of alpha activity. In addition, the reported relationship between degree of alpha enhancement and original basal level of alpha (Brown, 1968) was extended to the eyes-closed condition using auditory feedback. The only difference between the results of the present training studies and the results of previous work with the alpha feedback-loop consists of differences due to the inclusion of the necessary control for the contingency of the feedback tone.

The attempt to find an index of the feedback training which was independent of basal level was unsuccessful. Tests designed to measure acquisition of the ability to produce alpha activity without feedback after different amounts of training showed no substantial increase for either the high or low basal group. Although males obtained significantly higher control scores in the first study, this finding was not replicated in the second experiment. In both studies, control was unrelated to basal alpha; but the second experiment showed that training with the feedback-loop did not significantly alter the control scores for any group of subjects. Since the preformance of the yoked-controls, who did not receive contingent feedback during the suppression and enhancement tests, did not differ significantly from the preformance of the experimentals, the apparent control which all subjects demonstrated could be viewed as an artifact of instructions rather than as the effect of training with alpha contingent feedback.

The hypothesis that left-movers should benefit more from feedback training than right-movers seemed ill founded in terms of the similarity between yoked-controls and experimentals. However, the significant interaction between sex, LEM, and practice trials indicates that some between subject variation in changing alpha indices can be attributed to differences in LEM. If change in alpha activity is interpreted as a change in the basal alpha level, then this interaction indicates a difference between male left-movers and male right-movers with respect to the way in which basal level shifts. Male left-movers showed the most increase in amount of alpha activity over the trials; male right-movers showed an initial increase, but then dropped well below their original level of alpha activity. This difference, which was found for both yoked-controls and experimentals, was attributed to the possible differential reaction of the left- and right-mover to the experimental setting. If as Day (1964, 1968) suggested, the left-movers were more attentive to private, or internal experience and less attentive to the external environment, then the time which they spent in the darkened sound-proof booth may have been relatively enjoyable, and have led to greater relaxation. On the other hand, the right-mover, with his stronger attention to visual experience and greater reliance on external stimulation, may have found the time in the experimental booth more uncomfortable, and less conducive to relaxation. Thus as the left-mover continued to relax, his alpha index would continue to increase; while the right-mover might initially relax and increase his alpha index, but would eventually find the situation uncomfortable, become less relaxed, and decrease his alpha index.

Regardless of the interpretation which is found for the interaction between sex, LEM, and trials, this finding provides an interesting explanation of the individual differences which have been reported in the alpha feedback literature. Hart (1968) reported that only some of his control subjects showed increased alpha activity as a function of time in the experimental setting. Those controls who increased their alpha indices may have been females, or left-moving males; while those who showed no increment may have been right-moving males. Kamiya (1969) reported that basal (no tone) measures of alpha activity, taken at regular intervals during suppression and enhancement training with feedback, showed a gradual increase as a function of time. Kamiya interpreted this increase as the result of the alpha state becoming a preferred mode of waiting for the next set of suppression trials. However, in view of the present findings, this interpretation seems unwarranted. The shift in Kamiya's study seems similar to the shift in alpha activity found in yoked-controls -- subjects who had not been taught to maintain the alpha state. Kamiya's finding, like the the results in the present studies, is better interpreted as a shift in basal level due to adaptation to the experimental setting which leads to greater relaxation, and subsequent increases in amount of alpha.

Verbal Reports

The failure of previous researchers to adequately investigate the effects of the feedback-loop training is more understandable upon investigation of the different verbal reports of the yoked-control and experimental subjects. All of the experimentals felt that they had produced the auditory feedback, though two were uncertain about the technique of control. On the other hand, over half of the yoked-controls insisted that they had not produced the tone, while only four offered explanations of their control method. Such a difference in verbal reports indicates that subjects can learn about the contingencies of feedback training, and are likely to offer subjective accounts of experiences correlated with contingent feedback. This finding, perhaps, explains the enthusiasm of the original investigators, who, when confronted with increased alpha indices and similar subjective accounts of the alpha experience, assumed that the change in alpha was due to the feedback training -- a special form of operant conditioning.

It is likely that their assumption was misguided because they emphacized behavioral changes in alpha, rather than similarities in verbal reports. Even in the first of the present studies, verbal descriptions of private experience which was correlated with the presence of the feedback showed some general agreement among subjects. In addition, these reports were similar to verbal reports collected by Brown (1968, 1970) and by Mowlis and Kamiya (1970). Thus, although the present research casts doubt upon an operant interpretation of alpha feedback training by failing to show how contingent feedback alters alpha behavior, the feedback technique may still prove useful as a method for the study of internal, or private experience.

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Fig. 1. Diagram of Trial Sequence in Experiment 1.

Trial Number	Expreimental Condition	Feedback
0	Basal Measure	No Tone
1	Basal Measure	Tone
2	Practice	Tone
3	"	"
4	"	"
5	"	"
6	"	"
7	"	"
8	Test for Alpha	No Tone
9	Practice	Tone
10	"	"
11	"	"
12	"	"
13	"	"
14	"	"
15	Test for Alpha	No Tone
16	Practice	Tone
17	Alpha Suppression	Tone
18	Alpha Enhancement	"

Fig. 2. Mean Alpha Scores as a Function of Blocks and Sex. (Experiment 1.)

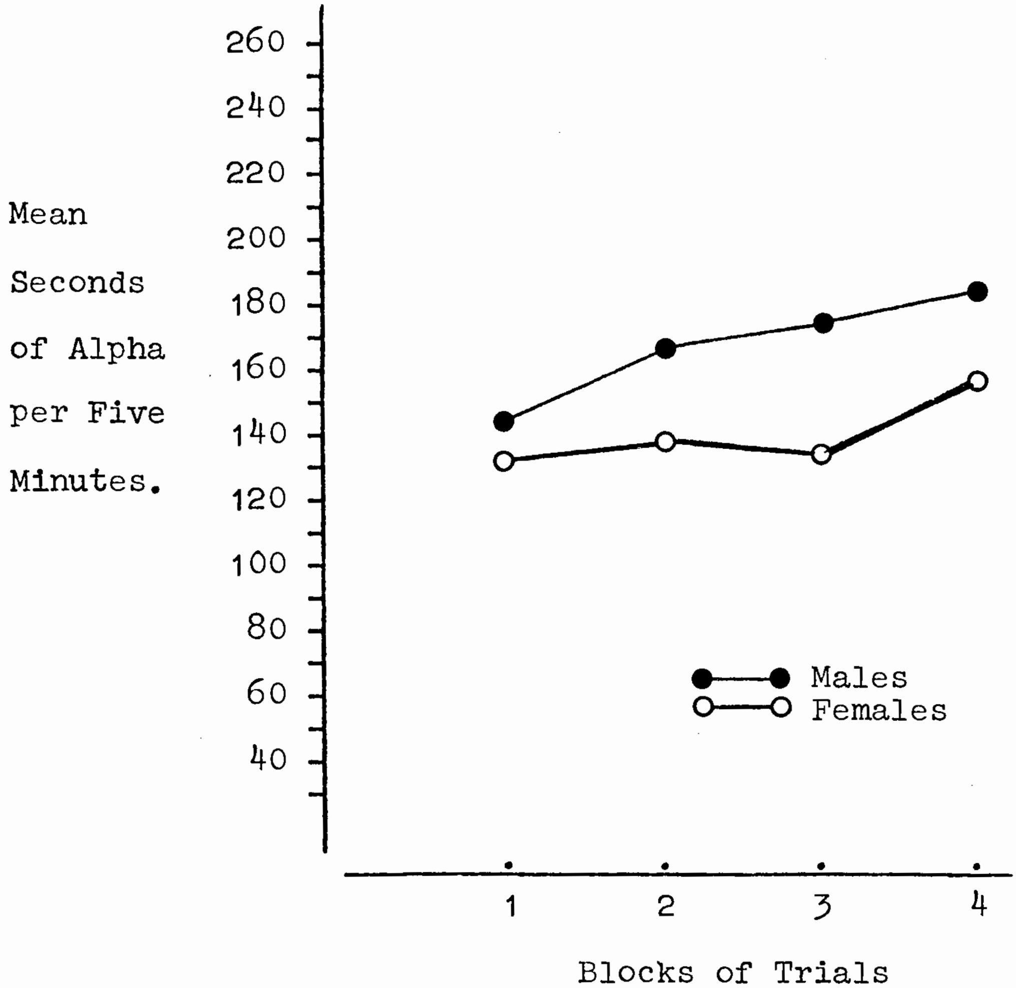


Fig. 3. Mean Alpha Scores as a Function of Blocks and Basal Group. (Experiment 1.)

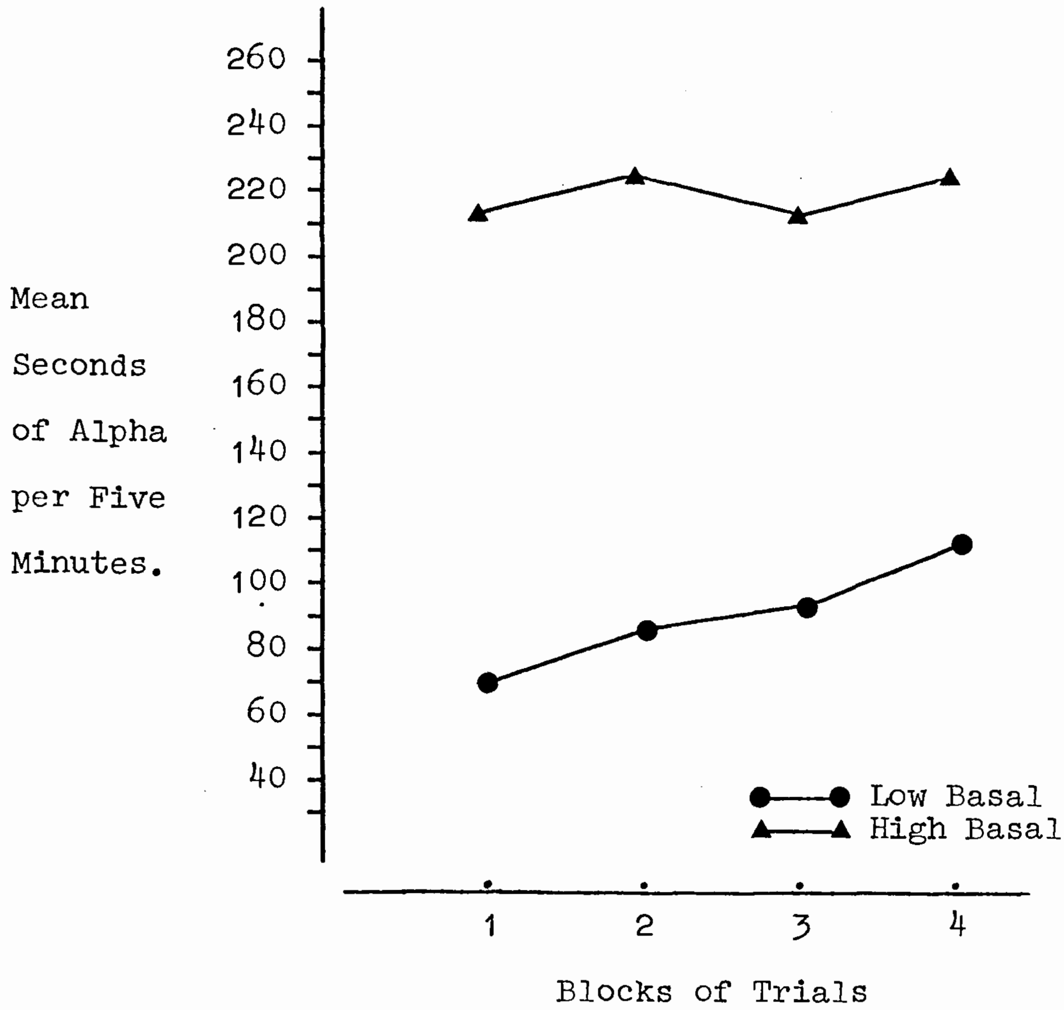


Fig. 4. Mean Alpha Scores as a Function of Blocks, Sex, and Basal Group. (Experiment 1.)

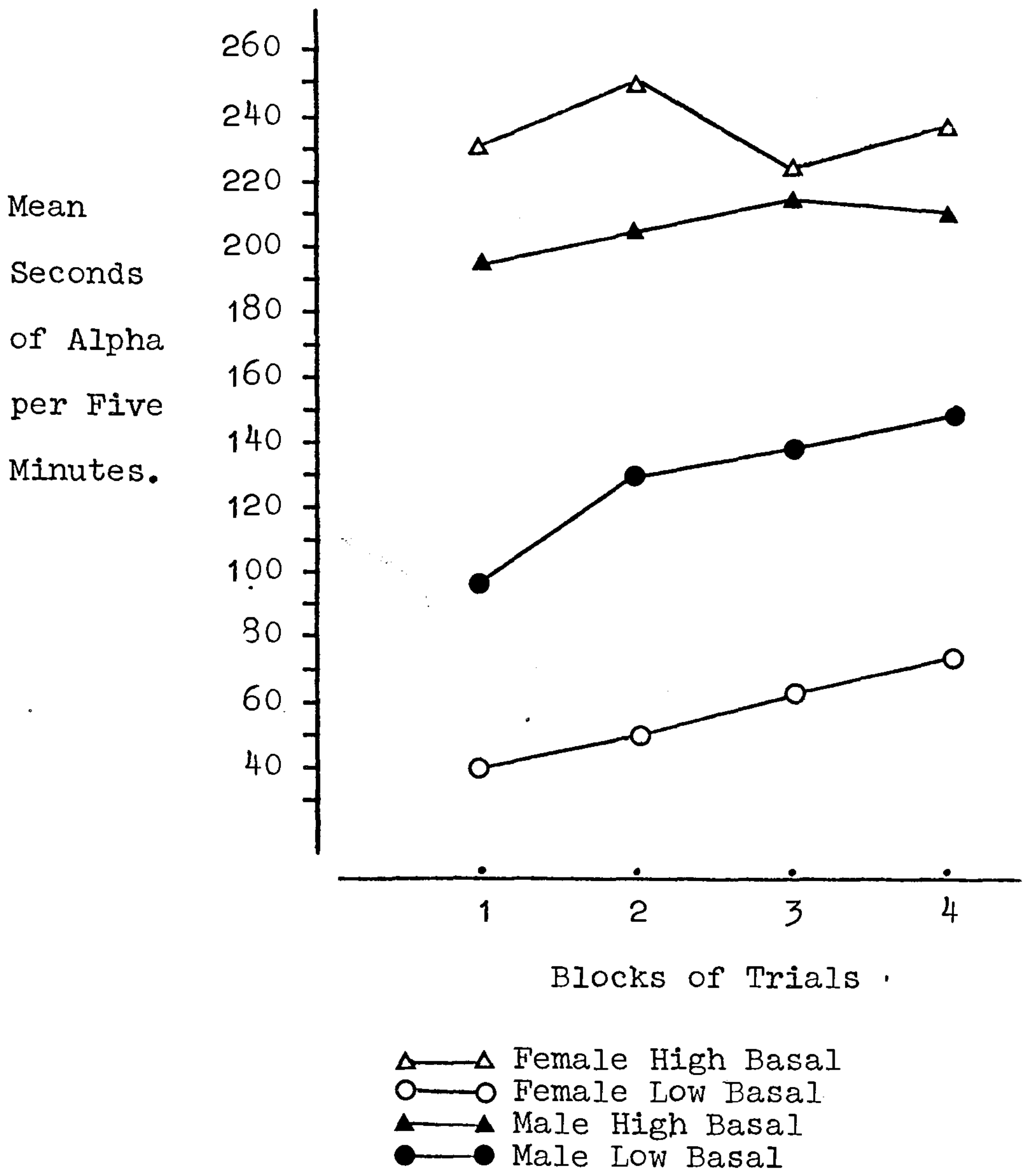


Fig. 5. Mean Alpha Scores during Tests Without Tone as a Function of Basal Group. (Experiment 1.)

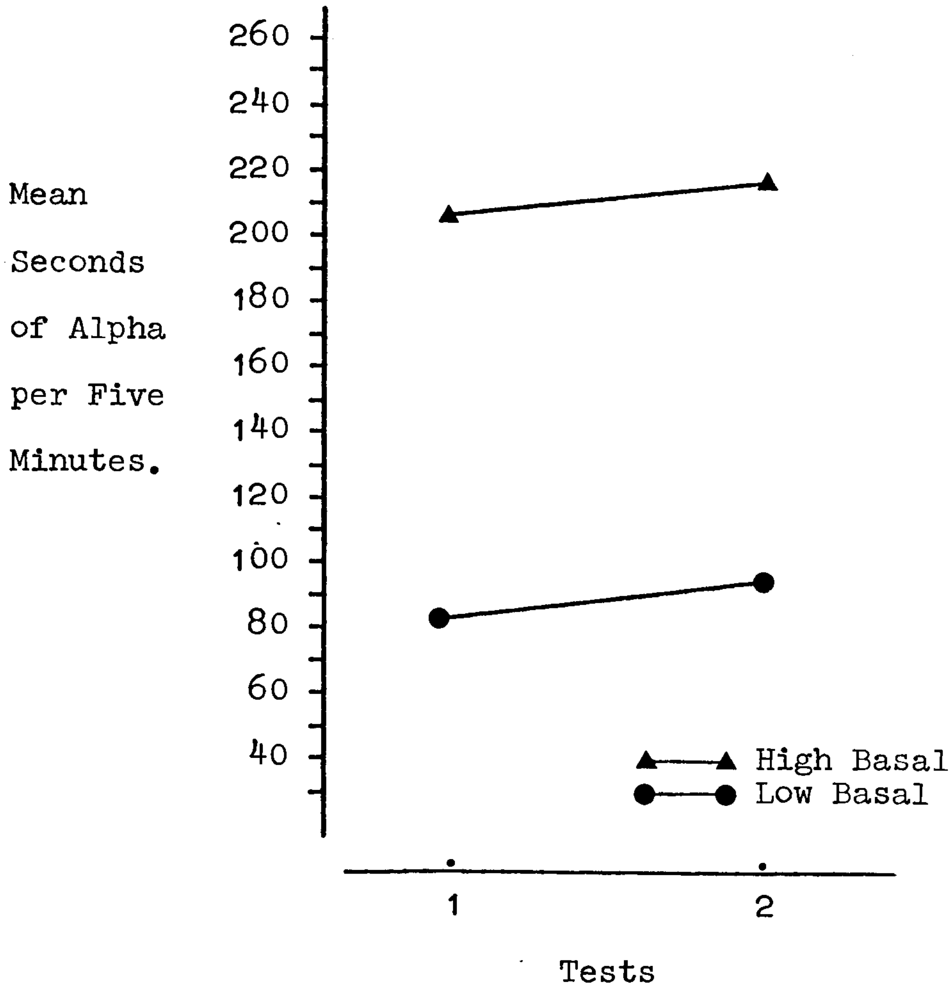


Fig. 6. Mean Alpha Scores during Tests Without Tone as a Function of Sex and Basal Group. (Experiment 1.)

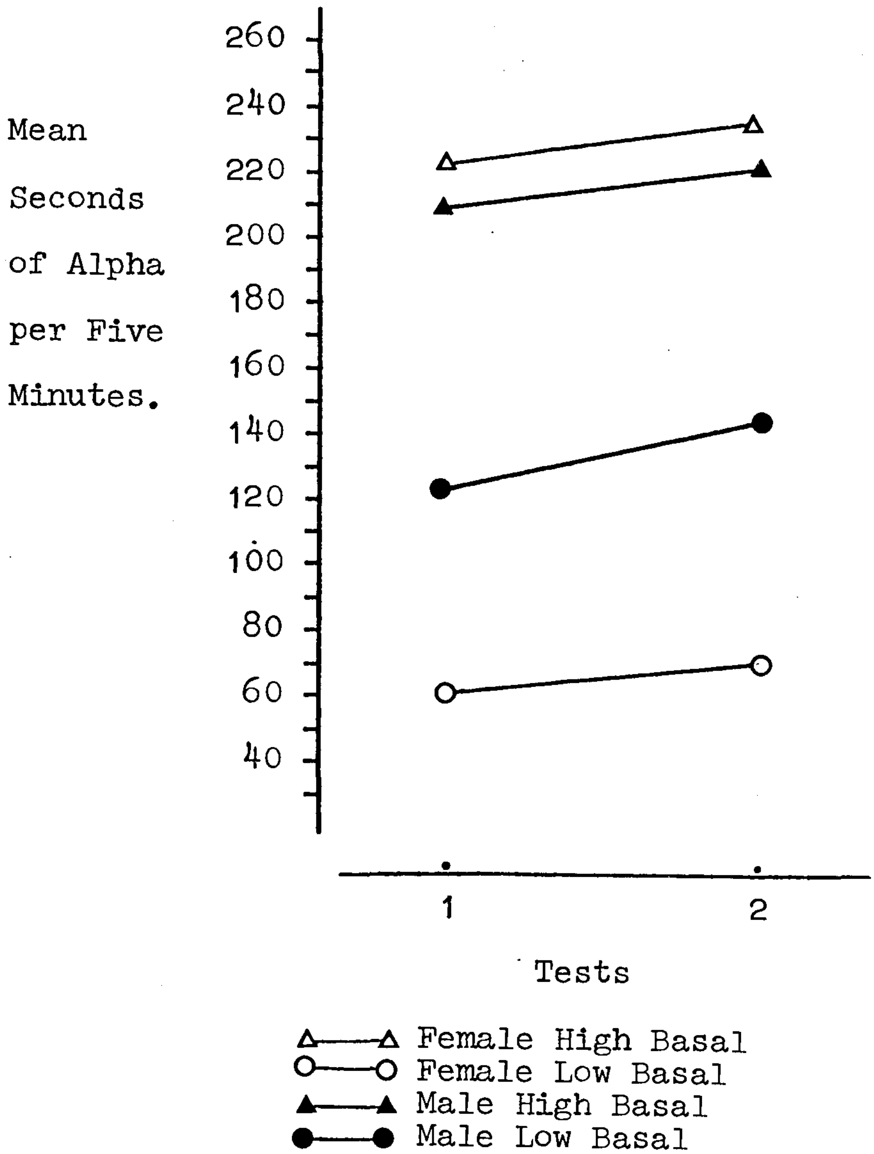


Fig. 7. Diagram of Trial Sequence in Experiment 2.

Trial Number	Experimental Condition	Feedback
0	Basal Measure	No Tone
1	Basal Measure	Tone
2 3	Alpha Suppression Alpha Enhancement	Tone "
4 5 6 7 8	Practice " " " "	Tone " " " "
9	Test for Alpha	No Tone
10 11 12 13 14	Practice " " " "	Tone " " " "
15	Test for Alpha	No Tone
16 17	Alpha Suppression Alpha Enhancement	Tone "

Fig. 8. Mean Alpha Scores for Yoked and Experimental Ss during Practice Trials. (Experiment 2.)

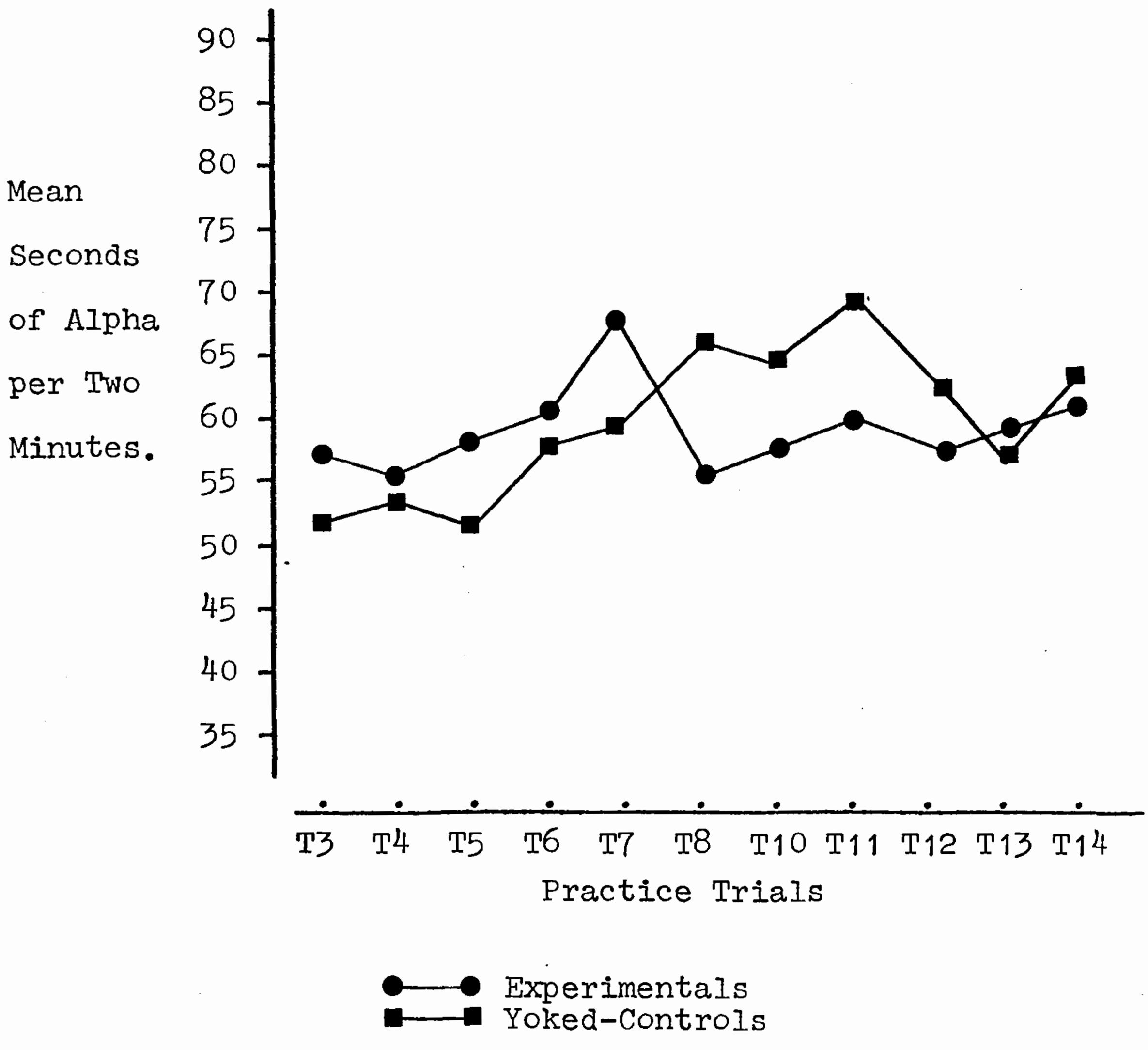


Fig. 9. Mean Alpha Scores as a Function of Sex, LEM, and Practice Trials. (Experiment 2.)

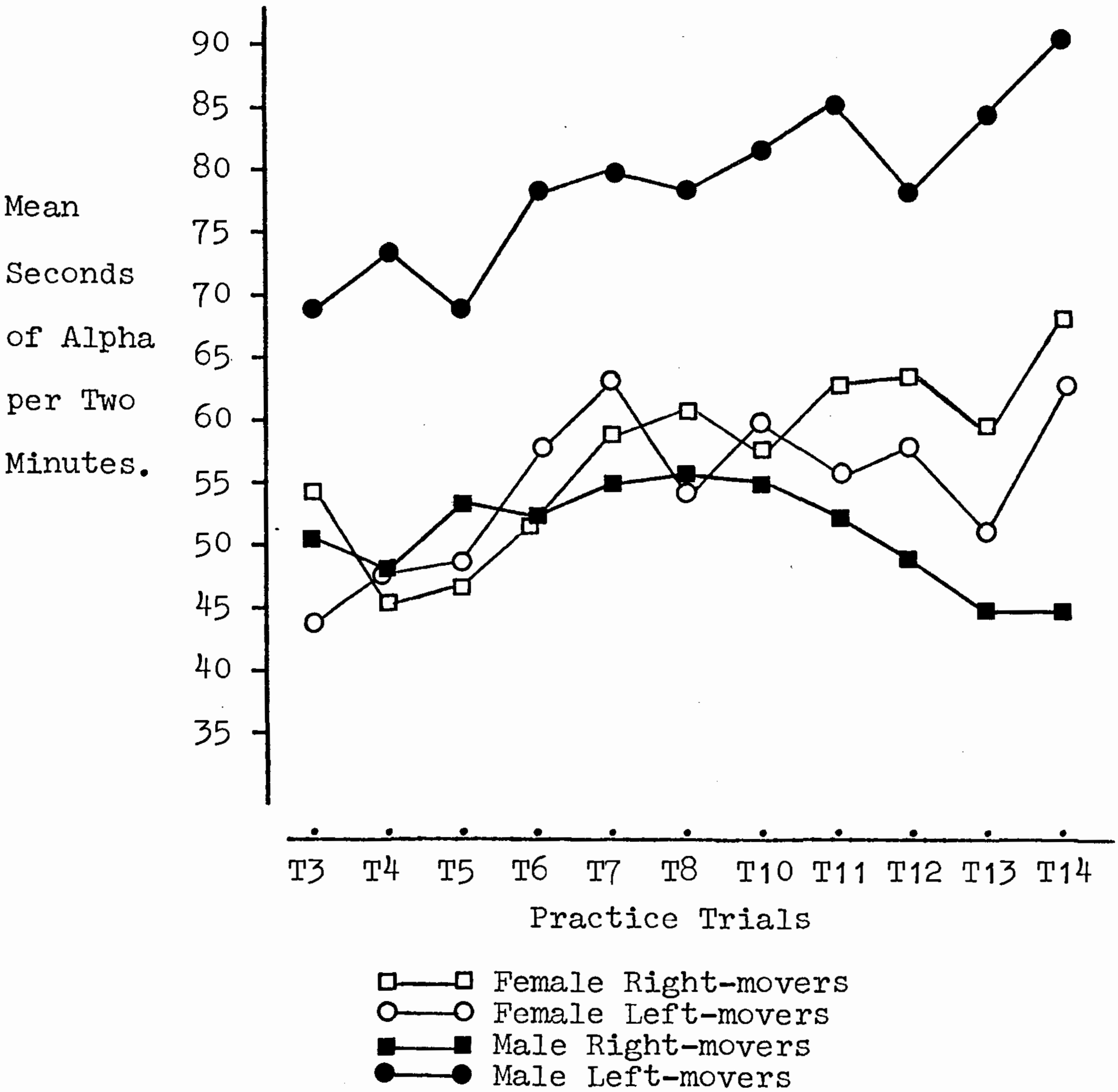


Table 1. Mean Basal Alpha Scores for 60 Ss according to Sex and LEM. (Experiment 1.)

	Females	Males
Right LEM	168.3 (n=15)	82.6 (n=15)
Left LEM	63.4 (n=15)	153.3 (n=15)

Table 2. Mean Control Scores* for 24 Ss according to Sex and Basal Group. (Experiment 1.)

	Females	Males
High Basal Group	24.4 (n=6)	60.1 (n=6)
Low Basal Group	4.7 (n=6)	59.3 (n=6)

* Control scores equal the difference between amount of alpha during the enhancement and suppression tests.

Table 3. Frequency of Reports on Methods used to Produce and Suppress Alpha Activity. (Experiment 1, N=24.)

		Frequency of Reports *				
		Females		Males		Total Reports per Item
		High Basal	Low Basal	High Basal	Low Basal	
Alpha Production	Auditory Sensations	1	2	1	1	5
	Visual Images	1	3	1	1	6
	Body Sensations	1	0	1	2	4
	Relaxation No Thought	4	2	3	3	12
	Active Thinking	0	1	0	0	1
	Emotional Arousal	0	0	0	0	0
	No Idea	1	1	2	1	5
Alpha Suppression	Auditory Sensations	0	0	0	1	1
	Visual Images	0	0	0	0	0
	Body Sensations	3	2	2	1	8
	Relaxation No Thought	0	2	0	0	2
	Active Thinking	1	3	4	3	11
	Emotional Arousal	1	0	3	3	7
	No Idea	2	2	1	1	6

* Some Ss offered more than a single report. All responses are included which occurred more than twice.

Table 4. Mean Basal Alpha Scores for 40 Ss according to Sex and LEM. (Experiment 2.)

	Females	Males
Right LEM	63.8 (n=10)	40.7 (n=10)
Left LEM	58.8 (n=10)	74.4 (n=10)

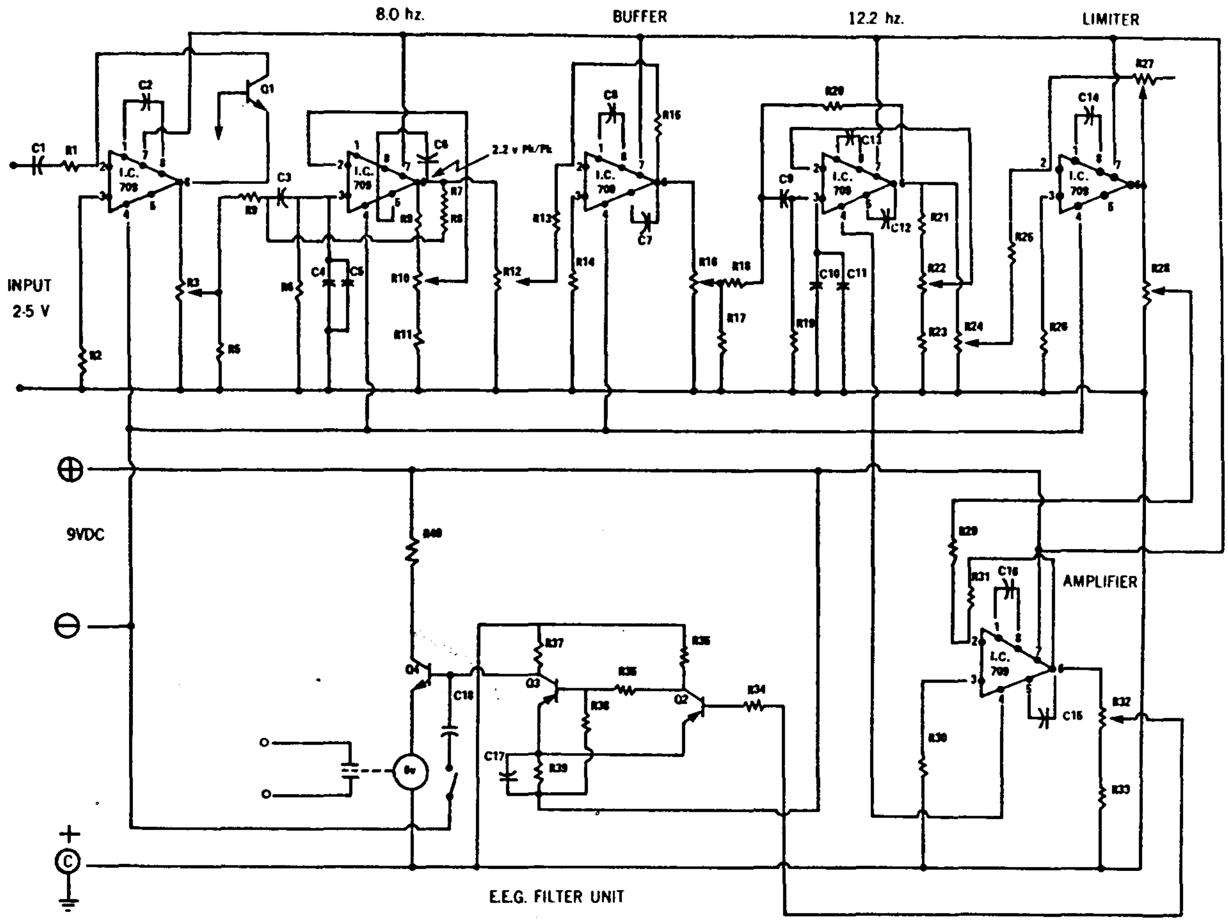
Table 5. Frequency of Reports regarding Control of Feedback Tone. (Experiment 2, N=40)

	Frequency of Reports									
	Female				Male				Totals	
	Right LEM		Left LEM		Right LEM		Left LEM			
	E	Y	E	Y	E	Y	E	Y	E	Y
Offered Explanation of a Control Method.	5	3	4	0	4	1	5	0	18	4
Uncertain about how to control the tone.	0	2	1	1	1	1	0	1	2	5
Felt that Control was not possible.	0	0	0	4	0	3	0	4	0	11

Appendix A: Proverb Scale used to Determine LEM in Experiment 1.

1. A rolling stone gathers no moss.
2. The hardest work is to go idle.
3. In the mirror, everyone sees his best friend.
4. A watched pot never boils.
5. Better a good enemy than a bad friend.
6. If you can't bite, then don't show your teeth.
7. A poor worker blames his tools.
8. He that lies on the ground cannot fall.
9. Better a bad peace than a good war.
10. What saddens a wise man, gladdens a fool.
11. They that are mute want to talk most.
12. Words should be weighed and not counted.

Appendix B: Schematic of Alpha Trigger



PARTS LIST

Resistors

R1 10K
R2 10K
R3 10K Pot
R4 33K
R5 1K
R6 75K
R7 2K
R8 10K
R9 33K
R10 25K Pot
R11 39K
R12 2M Pot
R13 10K
R14 10K
R15 100K
R16 10K Pot
R17 1K
R18 28.6K
R19 59K
R20 10K
R21 33K
R22 25K Pot
R23 39K
R24 50K Pot
R25 10K
R26 10K
R27 5M Pot
R28 50K Pot
R29 10K
R30 10K
R31 27K
R32 15K Pot
R33 6.8K
R34 4.7K
R35 1.8K
R36 18K
R37 1.8K
R38 15K
R39 .56K
R40 .10K

Capacitors

C1 .68mf Tantalom
C2 .05mf
C3 1mf
C4 .47mf
C5 .033mf
C6 .05mf
C7 .001mf
C8 .0047mf
C9 1mf
C10 .47mf
C11 .033mf
C12 .04mf
C13 .01mf
C14 .05mf
C15 .04mf
C16 .0047mf
C17 100mf
C18 30mf @15v

Transistors

Q1 2N697
Q2 RN3906
Q3 2N3900
Q4 2N2868

Integrated Curcuits

I.C. 709

Appendix C: Instructions used in Experiment 1.

Practice Instructions:

During the last period you occassionally heard a low tone come on. That tone was produced by something which you were doing. In the next few sessions, as you continue to relax with your eyes closed, you will probably hear the tone again. In all of these sessions, I'd like you to try to keep the tone on as much of the time as you possibly can. Before we begin, I'll sound the tone so that you will be certain to recognize it (example of the tone). Did you hear that? Okay, now lean back, close your eyes, and tell me when you are ready to start.

Test Without Tone Instructions:

Okay, you seem to have gotten the knack of it, Now I'd like to change things a bit. I want to see if you can do what usually produces the tone when it is no longer available as a signal. So in the next session, I want you to continue doing whatever you think produces the tone, even though you won't be able to hear it. Okay, lean back, close your eyes, and tell me when you are ready to start.

Control Test Instructions:

That's fine, now let's go on to the last stage of the experiment. Until now we have been experimenting with ways of increasing the duration of the tone. Now I'd like to see how this type of training influences your ability to control the presence of the tone. I want to see how well you can manipulate the tone, so in one session I'll ask you to keep it off, and then in the next I'll ask you to keep it on. The next session will be an off-session. As soon as you're ready, lean back, close your eyes, and tell me to start. (When S signaled that he was ready, he was reminded that this time the task was to turn-off the tone.)
Okay, just one last session. This time let's try it the other way. During the next session try to keep the tone on as much as you can. Signal when you are ready.

Appendix D: Analysis of Variance Table:
Basal Alpha as a Function of Sex and LEM.
(Experiment 1.)

Source	df=	MSS=	F=	p<
Sex (A)	1	64.90	0.01	ns
LEM (B)	1	4379.30	0.70	ns
Subjects (C)	56	6304.16	--	--
A X B	1	115579.90	18.33	0.001

Appendix E: Analysis of Variance Table: Alpha Scores as a Function of Sex, Basal Group, and Blocks. (Experiment 1.)

Source	df=	MSS=	F=	p<
Sex (A)	1	12989.85	2.29	ns
Basal Group (B)	1	400707.30	70.53	0.001
Blocks (C)	3	2347.63	6.39	0.01
Subjects (D)	20	5681.11	--	--
A X B	1	57025.44	10.04	0.01
A X C	3	563.31	1.53	ns
B X C	3	1094.19	2.98	0.05
D X C	60	367.55	--	--
A X B X C	3	677.38	1.84	ns

Appendix F: Analysis of Variance Table:
Alpha Without Tone as a Function of
Tests, Basal Group, and Sex.
(Experiment 1.)

Source	df=	MSS=	F=	p<
Sex (A)	1	9904.36	3.53	0.10
Basal Group (B)	1	181140.90	64.48	0.001
Tests (C)	1	1767.83	3.00	0.10
Subjects (D)	20	2809.07	--	--
A X B	1	19615.44	6.98	0.05
A X C	1	53.55	0.09	ns
B X C	1	7.98	0.01	ns
D X C	20	588.66	--	--
A X B X C	1	208.20	0.35	ns

Appendix G: Analysis of Variance Table:
Control Scores as a Function of
Basal Group and Sex.
(Experiment 1.)

Source	df=	MSS=	F=	p<
Sex (A)	1	12235.59	4.61	0.05
Basal Group (B)	1	629.35	0.24	ns
Subjects (C)	20	2656.48	--	--
A X B	1	544.39	0.21	ns

Appendix H: Proverb Scale used to determine LEM in Experiment 2.

1. The hardest work is to go idle.
2. A rolling stone gathers no moss.
3. The best fish swim deep.
4. Call no man happy til he is dead.
5. Every horse thinks its own pack heaviest.
6. He is rich who has few wants.
7. A watched pot never boils.
8. Better a good enemy, than a bad friend.
9. More than enough is too much.
10. Better to wear out than to rust out.
11. Lend your money and lose your friend.
12. Even no answer is an answer.
13. If you can't bite, then don't show your teeth.
14. A poor worker blames his tools.
15. He that lies on the ground cannot fall.
16. Better a bad peace than a good war.
17. Words should be weighed, not counted.
18. They who are mute want to talk most.
19. What saddens a wise man, gladdens a fool.
20. It is an ill wind that blows no one good fortune.

Appendix I: Instructions used in Experiment 2.

Control Instructions:

During the last period, you occassionally heard a low tone come on. That tone was produced by something which you were doing. In the next session, I want to see how easy it is for you to stop doing whatever produces the tone. So during the next period, try to keep the tone off as much as you possibly can. Okay, now lean back, close your eyes, and tell me when you are ready to start.

Fine, next I want to see how much of the time you can keep the tone on. So in the next session, try to produce the tone as much as you possibly can. Signal when you are ready.

Practice Instructions:

That was pretty good. Next I want to give you some practice with producing the tone, so that you will begin to learn exactly what causes it. During the next period, we'll have five two minute sessions where you should try to keep the tone on as much as you possibly can.

Test Without-tone Instructions:

That's enough practice for a while. In the next session, I want to see how well you can do whatever produces the tone, when you can't hear it. So in the next session, continue doing whatever you think causes the tone to come on, but this time it won't be there as a signal.

Appendix J: Analysis of Variance Table:
Basal Alpha as a Function of Sex and LEM.
(Experiment 2.)

Source	df=	MSS=	F=	p<
Sex (A)	1	129.96	0.15	ns
LEM (B)	1	2089.47	2.36	ns
Subjects (C)	36	885.77	--	--
A X B	1	3808.33	--	0.05

Appendix K: Analysis of Variance Table: Alpha Indices as a Function of Practice, LEM, Sex, and Experimental Group. (Experiment 2.)

Source	df=	MSS=	F=	p<
Sex (A)	1	10791.96	0.57	ns
LEM (B)	1	18576.03	0.98	ns
Experimental Group (C)	1	1.80	0.00	ns
Practice (D)	10	589.82	3.73	0.01
A X B	1	23791.16	1.25	ns
A X C	1	377.32	0.17	ns
B X C	1	15.41	0.01	ns
A X D	10	90.85	0.58	ns
B X D	10	165.86	1.05	ns
C X D	10	224.21	1.26	ns
Subjects (E)	16	19040.68	--	--
A X B X C	1	521.28	0.23	ns
A X B X D	10	325.76	2.06	0.05
A X C X D	10	168.99	0.95	ns
B X C X D	10	178.76	1.01	ns
E X C	16	2265.91	--	--
E X D	160	158.02	--	--
A X B X C X D	10	1510.12	0.85	ns
C X D X E	160	177.50	--	--

Appendix L: Analysis of Variance Table: Alpha Without Tone as a Function of Tests, Sex, LEM, and Experimental Group. (Experiment 2.)

Source	df=	MSS=	F=	p<
Sex (A)	1	1933.56	0.56	ns
LEM (B)	1	3462.38	1.00	ns
Experimental Group (C)	1	609.96	1.46	ns
Tests (D)	1	106.03	0.72	ns
A X B	1	12007.43	3.45	0.10
A X C	1	469.96	1.12	ns
B X C	1	41.90	0.10	ns
A X D	1	18.33	0.13	ns
B X D	1	140.19	0.95	ns
C X D	1	285.39	1.08	ns
Subjects (E)	16	3480.68	--	--
A X B X C	1	662.97	1.59	ns
A X B X D	1	436.63	2.97	ns
A X C X D	1	1,89	0.01	ns
B X C X D	1	142.85	0.54	ns
C X E	16	418.35	--	--
D X E	16	146.99	--	--
A X B X C X D	1	264.60	1.01	ns
C X D X E	16	263.36	--	--

Appendix M: Analysis of Variance Table: Control Scores as a Function of Tests, LEM, Sex, and Experimental Group. (Experiment 2.)

Source	df=	MSS=	F=	p<
Sex (A)	1	49.30	0.26	ns
LEM (B)	1	4.70	0.03	ns
Experimental Group (C)	1	342.79	1.24	ns
Tests (D)	1	215.17	1.34	ns
A X B	1	74.88	0.39	ns
A X C	1	858.05	3.09	0.10
B X C	1	113.76	0.41	ns
A X D	1	22.47	0.14	ns
B X D	1	233.24	1.45	ns
C X D	1	318.40	2.68	ns
Subjects (E)	16	190.38	--	--
A X B X C	1	107.18	0.39	ns
A X B X D	1	10.51	0.07	ns
A X C X D	1	208.66	1.76	ns
B X C X D	1	8.32	0.07	ns
C X E	16	277.54	--	--
D X E	16	161.17	--	--
A X B X C X D	1	139.92	1.18	ns
C X D X E	16	118.70	--	--