A PILOT STUDY COMPARING THE EFFECTIVENESS OF TAPE RECORDED RELAXATION INSTRUCTIONS AND NECK MUSCLE BIOFEEDBACK TRAINING ON MUSCLE CONTRACTION HEADACHES

by Stephen R. Grice

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Abstract

Five subjects with clear cases of muscle contraction headache were screened from volunteers with a special Diagnostic Headache Questionaire. These subjects were then tested for long-term, trait anxiety with Speilberger's STAI-Trait Inventory and for their feelings of internal vs. external control with Rotter's I-E Scale.

Subjects started keeping daily headache records for at least 11 days before laboratory training sessions began, and they continued record keeping for at least 7 days after laboratory training ended.

There were two treatment groups: (a) a verbal instruction group which received six laboratory sessions of tape-recorded relaxation instructions, and (b) a combined treatment group which received three laboratory sessions of tape-recorded relaxation instructions alternated with three laboratory sessions of audio signal biofeedback training on the muscles in the back of the neck. Both groups practiced daily relaxation at home.

EMG recordings were made for forehead and back-of-neck muscles for all subjects in all laboratory sessions. Also, headache intensity reports were taken and transient, subjective anxiety was measured (STAI-State Inventory) at the beginning and at the end of laboratory sessions.

There were some statistically significant results. Two

subjects showed a significant decrease in headaches from the pre- to the post-training period. And, for the whole group, headaches decreased from early in the training to late in the training period. (On the headache measures, no differences were found between the treatment groups.) End-of-session neck EMGs for the combined treatment subjects remained low during the last four laboratory sessions, whereas neck EMGs for verbal treatment subjects did not. Also, according to Rotter's I-E Scale, the group felt more externally controlled than normals.

There were patterns suggested by the data which were not statistically significant but which are of interest. Headaches appeared to increase from the pre-training period to the early training period. End-of-session forehead EMGs were higher after sessions two and four than after sessions one and three for both treatment groups. STAI-State scores decreased most during session one and least during session two. Scattergrams indicated some positive correlation between forehead and neck EMG change scores during verbal instruction sessions but negative correlation during biofeedback training sessions. Also, there was evidence for a positive correlation between STAI-State change scores and headache intensity change scores.

A self-regulating, negative-feedback system is suggested to explain the unexpected results.

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Systems with feedback cannot adequately be treated as if they were of one-way action...

William Ashby,

Design for a Brain,

1952.

Introduction

Muscle Contraction Headache and Its Treatments

Wolff, at the end of his chapter entitled, "Muscles of the Head and Neck as a Source of Headache and Other Pain (Muscle Contraction Headache)", summarizes his studies of muscle contraction headaches thus: "Headaches may result from the sustained contraction of skeletal muscle of the head and neck...Sustained contraction is a source of pain and paresthesia in tense, apprehensive and anxious people...The pain is characteristically sustained, persisting for days, weeks, months, or years (Wolff, 1972, pp. 559-560).

There are several treatment methods. The drugs commonly prescribed for simple cases of muscle contraction headache are aspirin, sometimes with phenacetin and caffeine, or phenobarbital (Holvey, 1972, p. 1274). But "headaches caused by sustained muscle contraction associated with life stress and emotional tension are only temporarily modified by sedatives or analgesics. Treatment should be directed at improving the patient's adjustment" (Plum, 1975, p. 618).

Muscle relaxation training methods have long been used for treating such stress and tension. Out of the many muscle relaxation methods available, the most commonly used (Tarler-Benlolo, 1978) are Progressive Relaxation (Jacobson, 1938), Autogenic Training (Shultz & Luthe, 1969) and, more recently, Transcendental Meditation (Campbell, 1974;

Schwartz, 1974; Wallace & Benson, 1969). In the first two methods, patients sit or lie comfortably and focus their attention on particular body areas, one area at a time, such as the forehead or the right arm. Patients attend to and/or manipulate the sensations from the area and then quietly tell the area to relax. In Transcendental Meditation, the patient assumes a comfortable position with eyes closed, and silently repeats or "experiences" a special sound or word which has been provided by the instructor.

Muscle relaxation methods and meditation seem to produce a common group of physiological correlates. Benson and his colleagues have reviewed the literature on Transcendental Meditation, Autogenic Training, Hypnosis, Zen and Yoga meditations, Cotention, Sentic Cycles, and Progressive Relaxation (Benson, 1975; Benson, Beary & Carol, 1974) looking for common physiological correlates; and they have made valuable contributions to research in this area (Beary, Benson, & Klemchuck, 1974; Benson, 1975).

To describe this common group of physiological correlates, they have coined the term "relaxation response". The response "appears to be an integrated hypothalamic response which results in generalized decreased sympathetic nervous system activity, and perhaps also increased parasympathetic activity...The relaxation response in man consists of changes opposite to those of the fight or flight response" (Benson, Beary, & Carol, 1974, pp. 37-38).

Some of these relaxtion methods have been tested as specific treatments for muscle tension headaches (Luthe & Schultz, 1969; Tasto & Hinkle, 1973), but some of the studies seem methodologically weak. The Tasto and Hinkle study, for instance, had only six patients and nc control group. These methods are promising, though, and warrant further research.

Biofeedback

In the course of investigating the physiological correlates of relaxation, it occurred to some investigators that providing the subject with immediate information directly from her or his own physiological system might aid the process of becoming relaxed. Thus, biofeedback training began partly merged with relaxation training (Tarler-Benlolo, 1978).

One of the physiological correlates of muscle relaxation is a decrease of the electrical activity within the relaxing muscles. This electrical activity, called "electromyographic" activity ("EMG"), can be detected, amplified, and used to modulate a visible or audible signal fed directly to the subject. Thus, "EMG biofeedback training" refers to a process in which subjects learn to relax their muscles by learning to reduce the electrical activity in their muscles by observing the varying output of a sensitive electronic device which detects and amplifies this electrical activity.

EMG Biofeedback for Tension Headaches: Recent History

An important study in the history of EMG biofeedback was done by Budzynski, Stoyva, Adler, and Mullaney in 1973. They suggested that subjects could learn to lower the resting level of electrical activity in their own frontales (forehead) muscles using EMG biofeedback training, and that the relaxation thus produced would generalize to muscles of the scalp and neck and thus reduce muscle contraction headaches. Budzynski et al. ran three treatment groups: (a) a frontalis biofeedback training group, (b) a pseudo-biofeedback training control group, and (c) a non-training control group. Subjects in the pseudo-biofeedback group received a signal which was not contingent on their own muscle activity. The pseudo-signals were tape recordings of real signals from the regular biofeedback training group. Subjects in both the real- and pseudo-feedback groups practiced simple relaxation at home twice each day in addition to their laboratory training sessions with biofeedback. Budzynski et al. found that only the group trained with real biofeedback had a statistically significant decrease in headache frequency and intensity; this decrease was large and clinically significant.

There are two important lines of development in the studies done since the study by Budzynski et al. in 1973: (a) studies which separate and compare components of the treatment methods in the Budzynski et al. study, and (b) studies which challenge the underlying principles which generated the hypotheses of that study.

Studies Which Compare Components of the Budzynski Treatment

Budzynski et al. noted "...the critical importance of daily practice outside the laboratory..." Twice each day patients were to "...relax in the same way they had in the laboratory -- but of course, without the aid of any instruments" (p. 487). Patients in both the real- and the pseudo-feedback group practiced relaxation at home, but notice that because their home relaxation was modelled on their laboratory experiences -- they were to "relax in the same way they had in the laboratory" -- the home relaxation practices of the two groups were not really matched, and so the differences between the pseudo- and the real-biofeedback signals might have been confounded with the differences in quality of their home practice. For this reason, it was not clear from this study whether either biofeedback training or home relaxation alone would have reduced headaches.

Haynes, Griffin, Mooney, and Parise (1975) addressed themselves to this confusion. They compared verbal relaxation instruction training with frontalis muscle biofeedback training on subjects with muscle contraction headaches. They found that both treatment methods were equally effective. In another study by Haynes, Moseley, and McGowan (1975), normal subjects without headaches were trained for a single session. Frontalis biofeedback training was compared with pseudo-biofeedback training and with two types of verbal relaxation instructions: (a) passive relaxation instructions in which subjects simply listened to suggestions to relax, and (b) more active relaxation instructions in which subjects followed suggestions first to tense their muscles and then to relax them. Real biofeedback training and the passive relaxation instructions were most effective in reducing frontalis EMG levels, and, again, the difference in effectiveness between verbal relaxation instruction and biofeedback was not significant.

A year later, in 1976, Chesney and Shelton compared verbal relaxation instructions, frontalis biofeedback, and a combined verbal relaxation - frontalis biofeedback treatment. Both of the single treatment methods were equally effective for reducing headache duration and frequency, but only the combined treatment method significantly reduced average headache intensity.

Because of these findings, the superiority of frontalis EMG biofeedback is not clearly established. (See also studies by Farnes, 1974; and Siverson, 1973.)

Studies Which Challenge the Budzynski Hypotheses

Alexander (1975) questioned the hypothesis that relaxation of the frontalis muscles generalizes to other muscles. He also doubted the hypothesis that subjects' reports of subjective feelings of relaxation correlate with frontalis EMG levels. Alexander's subjects were normals who did not have headaches. Alexander measured EMG activity from the frontalis, the forearm, and the leg while his treatment group received biofeedback training on the frontalis and while his control subjects relaxed without any aids. During the training sessions subjects reported their overall feelings of tension-relaxation. Alexander found that although the biofeedback-trained group decreased frontalis EMG levels and the controls did not, relaxation of the frontalis in his biofeedback treatment subjects did not generalize to the forearm or to the leg; in fact, forearm tension increased. In addition, he found no correlation between frontalis EMG levels and subjects' reports of their feelings of tension-relaxation.

Another study critical of the early work was done by Shedivy and Kleinman in 1977. They trained normal subjects to both decrease and increase their frontalis EMG levels using biofeedback. Subjects were aware that they were increasing and decreasing frontalis tension by increasing or decreasing their feedback signal. The results were similar to Alexander's. Changes in frontalis EMG levels did not generalize to neck muscles, and subjective reports of tension did not correlate with frontalis EMG levels.

Toward a New Study

These studies raise a number of questions. First, was the effectiveness of the Budzynski treatment due to biofeedback training or due to his subjects' home relaxation practice or was it a result of both? While the Budzynski et al. pseudo-biofeedback subjects (who did home relaxation practice) did not reduce their headaches, subjects in the study by Haynes et al. and subjects in the study by Chesney and Shelton had more explicit and full relaxation instructions and reduced their headaches as well as those with biofeedback training. To disentangle these possibly confounded effects, an improved method would require the use of explicit and full verbal relaxation instructions alone for one treatment condition.

A second question arises from the two lines of investigation described above: Why are results from the two lines apparently contradictory? Notice that one important difference between the two types of investigations is that most subjects in the studies which compare components of the Budzynski et al. treatment had headaches, whereas all subjects in the studies which challenge the Budzynski et al. hypotheses did not have headaches. It seems plausible that both generalization of relaxation from the frontalis and correlation between subjective tension levels and frontalis EMG levels may be clear effects in subjects with contraction headaches but may be much reduced in normals. If this were so, studies using subjects with headaches would be more likely to show significant effects. For this reason, and because the intent of this study was to compare clinical effectiveness, it seemed more fruitful to study subjects with clear cases of muscle contraction headache.

Several studies in the treatment-methods-comparison line reported low correlations between subjective anxiety measures and EMG levels (Haynes, Mosely, and McGowan, 1975, p. 550; and Siverson, 1973, p. 3037-B), but none compared subjective tension reports directly with headache reports. It seemed useful to compare subjective tension reports with reports of headaches.

The total amount of biofeedback training received by each of Alexander's subjects was 27 minutes divided throughout five training sessions. This may not have been enough training to produce a detectable effect. To test for this possibility, subjects should recieve more biofeedback training.

Alexander (1975, p. 661) makes an important point about the generalization of frontalis relaxation: "...to expect a trained reduction in tension in one muscle group to lead to the reduction in tension in a second ... group may be rather naive ... Biofeedback may be considerd by its very nature ... as highly discriminative rather than as training designed to promote generalization." For these reasons it appeared useful to monitor other muscle groups involved in tension headache (such as the muscles in the back of the neck) in addition to the frontalis.

In none of the studies referred to above were the criteria for diagnosing muscle contraction headache made explicit. Muscle contraction headaches can arise from causes other than psychological stress, and they can easily be confused with other kinds of headaches. It would seem worth knowing to what extent the muscle headache subjects in the studies referred to above came from similar populations, and a study which made the subjects' characteristics more explicit would be an improvement.

The patients of Budzynski et al. plotted their daily headache activity on graphs. Haynes, Griffin, Mooney, and Parise (p. 678) criticized this method of self reporting and suggested that using data sheets without graphs might reduce subjects' evaluation of their "progress" and thereby reduce response bias. Also, Haynes et al. stressed the need for an initial, uncounted baseline period of self-observation to reduce the reactive effects of self-observation. Both these practices were adopted for the present study.

Place of the Present Study

The present study is in line with those which separate and compare confounded components of the original study by Budzynski et al. It compares a combined verbal relaxation - biofeedback training method with verbal relaxation instruction treatment alone. At the same time, this study also questions some of Budzynski et al.'s explanatory hypotheses. It assesses the generalization of relaxation from neck muscles to frontalis, and it looks for correlations between the following variables: reported headaches, subjective general tension, frontalis EMG levels, and neck muscle EMG levels. Thus, the present study fits into both lines of development.

Hypotheses

This study was designed to test three hypotheses:

1. Verbal instruction relaxation training combined with EMG biofeedback training will be more effective than relaxation instruction alone for reducing simple muscle contraction headaches.

2. With such training, relaxation will generalize from the muscles in the back of the neck to the frontales.

3. For such headaches, high headache activity will be associated with subjective feelings of high general tension.[1]

In addition to testing these hypotheses, I sought answers to these questions:

1. Do subjects with simple muscle contraction headaches differ from the normal population in their general anxiety as measured on Spielberger's STAI-Trait Inventory? (Spielberger, Gorsuch, and Lushene, 1970.)

2. Do such subjects differ from the normal

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[1]This hypothesis is not meant to imply that low headache activity will be associated with low subjective tension. High subjective tension can also occur without headaches.

population in the extent to which they believe that their own actions cause their own fortunes as measured on Rotter's Internal vs. External Control of Reinforcement scale? (Rotter, 1966.)

Method

Subjects

Subjects were selected from volunteers recruited by posters put up on the Simon Fraser University campus during October of 1977. (A copy of the poster is in Appendix I.) Subjects were screened with a diagnostic Headache Questionaire to select those with simple muscle tension headaches. Out of the 15 initial volunteers, 4 females and 1 male became subjects in the study. Three of them were students, one was an elementary school teacher, and one was a secretary; their ages ranged from 21 to 38.

Measurements

Reports and Questionaires

A diagnostic Headache Questionaire was developed for this study on the basis of diagnosis information in the medical literature (Chusid, 1968; Falconer, Patterson, & Gustafson, 1976; Friedman & Merritt, 1959; Holvey & Talbott, 1972; Kunkle, 1959; Ostfeld, 1962; Wolff, 1970). The 29 questions in the questionaire focused on those symptoms which most reliably discriminate among the different kinds of headaches. (A copy of the Headache Questionaire is in Appendix II.)

Also, a system of daily Headache Record Cards was designed to minimize subject response bias. The rating scale for headache pain intensity was adapted from the general pain word descriptors list in the McGill Pain Questionaire (Melzak, 1975). These descriptors have been shown to carry very uniform meanings for both patients and doctors. Subjects filled cut their cards at specific, pre-arranged times twice each day. These times were arranged with each subject in her/his initial interview, and then these times remained set for the subject throughout the study. The reason for using two recording times each day was to reduce distortions of memory. The unvarying reporting times were meant to reduce distortions from any headaches which might vary systematically with time of day. Subjects were asked to hand in their cards frequently in crder to reduce the possibility that they would ccmpare one day's reports with another's.

The series of daily headache reports from each subject through the course of the study was divided into five periods. Subjects started keeping headache records at least 11 days before their first laboratory training session, and they continued record keeping after their last laboratory session. The first 8 days of record keeping were set aside for the reactive and sensitization effects of self-observation. This period was named the Adjustment Period. The period immediately after the first 8 days and before the first laboratory session was named the Pre-training Period. It ranged from 3 tc 11 days. Then followed the Early Training Period. It spanned the first 8 days of the laboratory training period. The Late Training Period spanned the remaining days of the laboratory training period. This period ranged from 8 to 11 days. The Post-training Period immediately followed, ranging from 7 to 9 days.

After the cards were filled out and handed in, numerical values were assigned to the pain intensity descriptors as follows:

0 = no headache

1 = mild

2 = discomforting-annoying

3 = distressing-miserable

4 = horrible-intense

5 = excruciating

The double-adjective pain descriptors at 2, 3, and 4 were linked together on the headache report cards. Choosing one of a pair meant choosing the other. These numerical values were used to calculate average headache pain intensities for each subject for the five record periods described above. (Instructions for the Headache Record Cards and sample cards are in Appendix III.)

At the beginning and end of each laboratory session subjects were handed a Headache Record Card and asked to report the intensity of their headache at that moment. These reports were used to evaluate the correlation between headache reports, EMG levels, and anxiety level scores on the STAI-State Inventory (Spielberger, Gorsuch, & Lushene, 1970).

Spielberger's STAI-Trait Inventory was used to measure subjects' long-term levels of subjectively-felt anxiety. The STAI-State Inventory was used to measure changes in more transient subjective anxiety levels at the beginning and end of laboratory sessions. Both scales ask subjects to rate themselves on items like this: "I am inclined to take things hard" or, "I feel calm". The STAI-Trait Inventory was titled "Self-Evaluation Questionaire TR", and the STAI-State Inventory was labelled "Self-Evaluation Questionaire ST". The inventories were administered to subjects using these new titles. (Copies of both inventories are in Appendix IV.)

Spielberger, Gorsuch, and Lushene (1970) have shown that the STAI-Trait scale is highly corellated with other measures of trait anxiety and that the STAI-State scale is a very useful indicator of transient anxiety. Test-retest reliability for the STAI-Trait scale is high, ranging from $r = 0.73$ for college undergraduates over a 104 day period to $r = 0.84$ for a one hour test-retest period. An example of evidence for the validity of the Trait scale is that for a large group of college students the correlation between the STAI-Trait scale and the IPAT Anxiety Scale (Cattel & Scheirer, 1963) and between the Trait scale and the Taylor (1963) Manifest Anxiety Scale are $r = 0.75$ to 0.76 and $r = 0.79$ to 0.80, respectively.

An example of evidence for the validity of the STAI-State Inventory comes from a study of 977 undergraduates at Florida State University (Spielberger et al.). Students filled out the inventory under two conditions. In one condition, they were to respond as they would feel just before an important final examination. In the other condition they responded as they felt at that moment. The mean scores for the State scale under the examination condition were considerably higher than the scores under the at-that-moment, less anxious, condition. Also, all but one of the scale items significantly discriminated between the two conditions for the males, and all items discriminated for the females.

Rotter's (1966) Internal vs. External Control of Reinforcement scale ("Locus of Contol" scale) attempts to measure the extent to which a person believes that reinforcement from the environment is contingent on her/his own behavior. The scale is made up of 29 forced-choice pairs such as this: "(a) No matter how hard you try some people just don't like you, (b) People who can't get others to like them don't understand how to get along with others." (The scale labelled "Personal Beliefs Inventory" in Appendix V is Rotter's I-E scale.)

Rotter (1966) has found that when subjects perceive a situation as one in which external forces control reward, success, or reinforcement, they are less likely to raise their expectations of reward following success in that situation, and they are less likely to lower their expectations after failure. Also, subjects under such conditions less frequently generalize their experiences of success or failure from one task to similar ones. In addition, individuals differ in their generalized, characteristic expectations. Individuals can differ in how they regard the same situation. These individual differences can be measured by a number of different methods with high intercorrelations between methods. Rotter's scale is one such method. Item analysis and factor analysis are reasonably high, and test-retest reliability is satisfactory. For example, test-retest reliability ranged from $\underline{r} = 0.60$ to $\underline{r} = 0.83$ over a one month period for Ohio State University students (Rotter, 1966).

At the end of the last laboratory session, subjects were interviewed to obtain their reactions to their treatment method. (Final interview questions are in Appendix VI.)

Electrophysiological Measures

The EMG measurements were made from bipolar recordings taken from the frontales muscles and from the left and right upper trapezius muscles in the back of the neck. The measurements were taken during a two minute period at the beginning and at the end of each laboratory session. In order to record <u>resting</u> muscle activity levels which would be free of body movement contamination and equipment noise, each actual EMG measurement was of the movement-free and noise-free 15 second interval which was closest to the centre of the two minute measurement period. Also, the 15 second intervals from the three muscle sites within each two minute period were simultaneous. Figure 1 shows a typical section of the polygraph strip chart record. The area enclosed under the d.c. curve in each 15 second interval was carefully measured with a Keuffel and Esser Compensating Polar Planimeter model number 62005, and this area was then converted to average mircovolts/second. This constituted the EMG measurement.

Apparatus

EMG activity was recorded on a Grass Model 7 Polygraph with three Grass 7P3 Wide Band AC Pre-Amplifier-Integrators and Grass Polygraph DC Driver Amplifiers.

Two types of records were made from each of the three muscle recording sites: (a) a raw ac recording used to reveal machine noise and body movement noise, and (b) an integrated (smoothed) dc recording for EMG measurements and for the biofeedback signal. The time constant setting for integration was 0.2 seconds.

The biofeedback circuit used the smoothed dc output signal to modulate the frequency of an audio click signal. The click rate was rapid for high dc levels and lower for lower dc levels. (A circuit diagram is in Appendix VII.)

All electrodes were Beckman 16 mm silver-silver chloride disc type. Each electrode site was cleaned with rubbing alcohol, lightly abraded with abrasive electrode

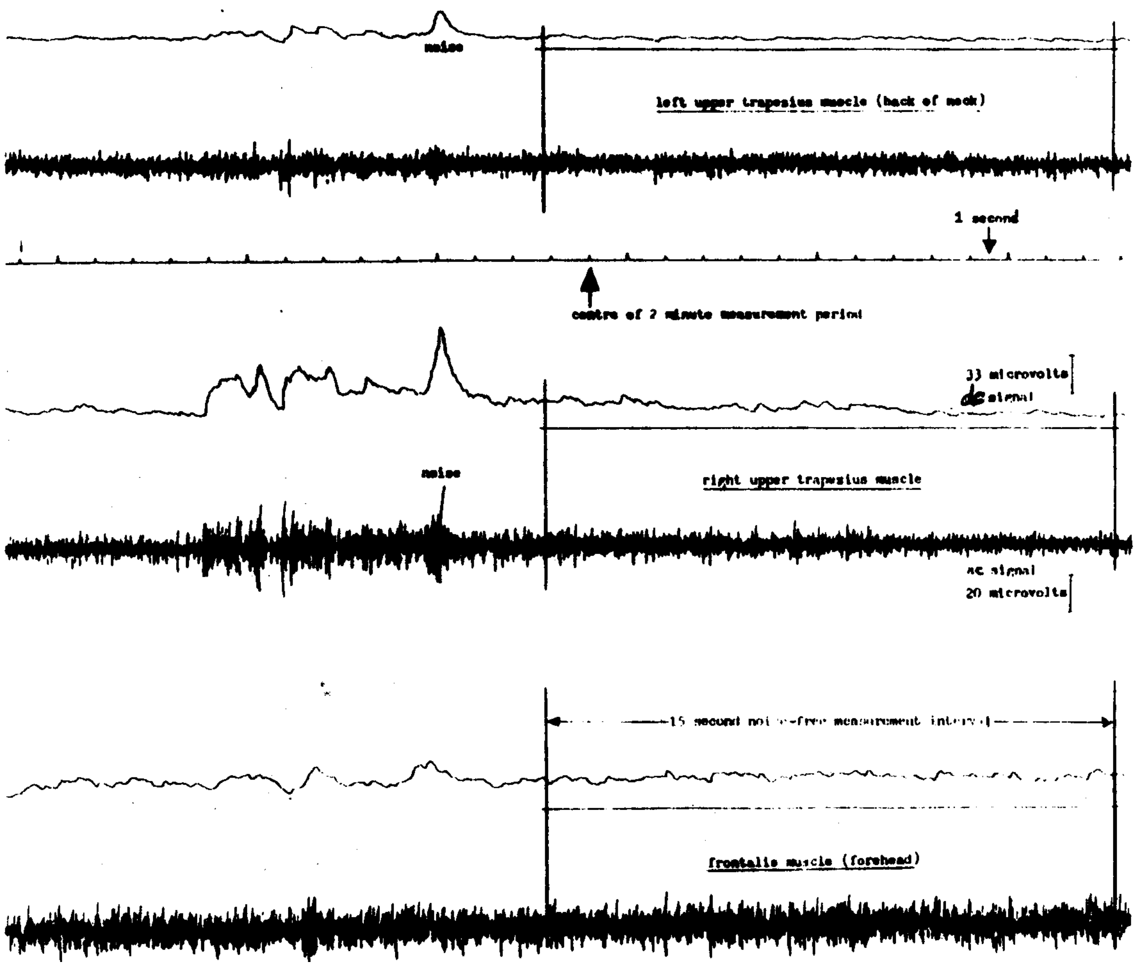


Figure 1. Typical Polygraph Record.

paste, and then wiped dry. The electrode for the site was filled with Beckman Offner Paste and attached with a circular adhesive collar. To ensure good skin contact, all electrodes were checked for electrical resistance after they were attached. The resistance between any two electrodes was kept below 10k ohms.

Each EMG bipolar recording site had its own set of electrodes and its own set of pre-amplifiers and driver amplifiers throughout the experiment. Thus, comparisons of any one site across subjects or across training sessions would not be distorted by differences in electrode and amplifier response characteristics.

Electroencephalograph (EEG) signals at the frontalis site and electrocardiograph (EKG) signals at the neck muscle sites were large and had to be eliminted. Since higher frequency electrical waves are attenuated more rapidly than lower frequency waves as these waves travel through body tissue, it is possible to eliminate the interference of even large electrical waves from distant sources in the body by filtering out low frequencies (Freeman, Note 1). I found that accurately-matched 0.0033 microfarad ceramic disc capaciters placed directly in each pair of electrode leads from each muscle site virtually eliminated these interfering signals. With the Grass 7P3 Pre-amplifier, these capaciters produced a filter which blocked out frequencies below a half-amplitude point of 30 Hz.

Procedure

Figure 2 is a flow chart of the time order of the experiment procedures.

All those who volunteered for this study went through an initial individual screening interview. In this interview the following information was exchanged: (a) I collected identification information and a brief history of the volunteer's headache. (b) The volunteer then got a brief description of the experiment and was assured that both verbal relaxation instruction and biofeedback training had been found effective for tension headaches in other studies. (c) The volunteer then completed the diagnostic Headache Questionaire. (d) The questionaire was then evaluated. If the headache did not appear to be a clear-cut, simple, muscle contraction headache, the volunteer was referred to a physician, thanked, and dismissed. (e) If the symptoms were clearly those of a simple case of muscle contraction headache, I asked the volunteer to sign a consent form and to obtain a physician's clearance to participate in the study. (f) I then taught the volunteer how to fill out the Daily Headache Record Cards and asked her/him to start keeping the records.

About one week later volunteers returned for a second individual pre-training interview. During this interview, I (a) collected headache record cards, corrected any misunderstanding about the card system, and encouraged the subject to keep accurate and faithful records; (b)

1st interview
- Diagnostic headache questionaire
- Daily headache record keeping begins

2nd interview
- Internal vs external reinforcement test (Rotter's I-E Scale)
- Trait anxiety test (Spielberger's STAI-Trait Inventory)

1st laboratory session
- Pre-session headache report
- Pre-session state anxiety test (Spielberger's STAI-State Inventory)
- Attach electrodes
- VERBAL RELAXATION INSTRUCTIONS
- Remove electrodes
- Post-session headache report
- Post-session state anxiety test
- Home relaxation practice begins

	COMBINED TREATMENT	VERBAL INSTRUCTION TREATMENT
2nd lab session	Pre-session headache report Pre-session state anxiety test Attach electrodes Biofeedback instructions BIOFEEDBACK TRAINING Post-session headache report Post-session state anxiety test	Pre-session headache report Pre-session state anxiety test Attach electrodes ---------- ------- RELAXATION INSTRUCTIONS Post-session headache report Post-session state anxiety test
3rd lab session	Pre-session headache report Attach electrodes RELAXATION INSTRUCTIONS Remove electrodes Post-session headache report	Pre-session headache report Attach electrodes RELAXATION INSTRUCTIONS Remove electrodes Post-session headache report
4th lab session	Pre-session headache report Attach electrodes BIOFEEDBACK TRAINING Remove electrodes Post-session headache report	Pre-session headache report Attach electrodes RELAXATION INSTRUCTIONS Remove electrodes Post-session headache report
5th lab session	Pre-session headache report Attach electrodes RELAXATION INSTRUCTIONS Remove electrodes Post-session headache report	Pre-session headache report Attach electrodes RELAXATION INSTRUCTIONS Remove electrodes Post-session headache report
6th lab session	Pre-session headache report Pre-session state anxiety test Attach electrodes BIOFEEDBACK TRAINING Remove electrodes Post-session headache report Post-session state anxiety test Final interview	Pre-session headache report Pre-session state anxiety test Attach electrodes RELAXATION INSTRUCTIONS Remove electrodes Post-session headache report Post-session state anxiety test Final interview
	Daily headache record keeping ends	Daily headache record keeping ends

Figure 2. Flow Chart of Experiment Procedures.

administered Rotter's I-E Scale and Spielberger's STAI-Trait Inventory; and (c) scheduled laboratory training session appointments.

Each subject came to two laboratory sessicns per week for three weeks. Each laboratory session took about 1 1/2 hours.

Laboratory session procedures for all subjects were similar except that biofeedback traininq occurred for subjects in the combined verbal instruction - biofeedback training treatment group in their second, fourth, and sixth sessions, while all other laboratory sessions contained tape recorded verbal relaxation instructions. Thus, subjects in the combined treatment condition received three 20 minute training periods of biofeedback and three 20 minute periods of taped recorded verbal instructions, while subjects in the verbal instruction condition received six 20 minute periods of taped relaxation instructions.

For both types of laboratory treatment sessions, subjects sat in a slightly reclined position in a recliner chair. Both the tape recorded relaxation instructions and the biofeedback siqnals were played to subjects through a loudspeaker near the chair.

Subjects were randomly assigned to the two treatment methods. Subject assiqnments were as follows:

CR, female - combined treatment

RR, male --- combined treatment

TV, female - combined treatment

MC, female - verbal instruction treatment

MF, female - verbal instruction treatment.

Treatments

The study by Haynes, Mosely, and McGowan referred to earlier, in which they compared a passive with a more active verbal relaxation method, showed that 20 minutes of passive instruction was most effective. Thus, for this study I prepared a tape recording from a transcript of Haynes et al.'s passive instructions. (A transcript of the Relaxation Instructions used in the present study is in Appendix VIII.)

In all the previously-referred-to studies which applied biofeedback training, the training was applied to the frontales. But muscle contraction headaches usually start in and around the back of the neck and spread from there (Holvey, 1972, p. 1269; Wolff, 1970, p. 90). Instead of applying biofeedback to the frontalis with the expectation that it would generalize from there, I applied biofeedback training to the upper left and right trapezius muscles in the upper back of the neck and monitored frontalis EMG levels to see if relaxation would generalize from the back of the neck to the frontalis.

The electrodes which picked up muscle electrical activity were positioned with templates. The forehead positions were slightly adapted from the standard lead placements shown in Lippold (1967, p. 285). The neck sites were developed especially for this experiment. (Dimensions for the templates are in Appendix IX.)

Note that all subjects in all laboratory sessions had electrodes attached at the same three muscle sites.

Subjects who got biofeedback training were instructed about biofeedback just before their first feedback training session. They were told that the train of quiet audio clicks they would hear was from the muscles in the back of their neck, that a low click rate meant that their neck muscles were relaxed, and that they should try to keep the click rate as low as possible. (A transcript of the biofeedback instructions appears in Appendix X.)

While subjects during the verbal relaxation instruction sessions simply listened to the tape recording for 20 minutes, the time schedule during biofeedback sessions was somewhat more complex. The 20 minutes of biofeedback training in each biofeedback laboratory session was divided into four parts. The first five minutes of biofeedback came form the upper left trapezius, then followed a two minute rest period. Then followed five minutes of biofeedback from the upper right trapezius, then another two minute rest, then feedback from the upper left trapezius again, then another two minute rest, and then five minutes from the upper right trapezius again.

Order of Events

The order of events in each laboratory session was as follows:

1. I collected filled-out headache record cards and encouraged the subject in the record keeping.

2. The subject was then handed a separate headache record card and asked to rate the intensity of her or his headache at that moment.

3. In the first, second, and sixth laboratory sessions, subjects then filled out the STAI-State Inventory of anxiety.

4. Next, the EMG electrodes were attached. The seven electrodes for each subject (two for each muscle site and one ground) took approximately 35 minutes to attach.

5. Subjects then rested for five minutes in the recliner chair. The last two minutes of this five minute rest period was the pre-session EMG measurement period.

6. Subjects next received either 20 minutes of tape recorded relaxation instructions or 20 minutes of EMG biofeedback training.

7. The last two minutes of biofeedback training or of verbal relaxation instructions was the post-session EMG measurement period.

8. The EMG electrodes were then removed.

9. The subject was then given a new headache record card and again asked to rate the present intensity of his or her headache.

10. On the first, second, and sixth laboratory sessions, the subject again filled out the STAI-State inventory.

11. Subjects were then instructed or encouraged to practice relaxation at home for 15 minutes each day. Using the laboratory relaxation instructions as their model, they were to focus their attention on each area of their body and quietly tell that area to relax. (See Instructions for Practicing Relaxation at Home in Appendix XI.)

At the end of their last laboratory session, subjects were interviewed for their reactions to the headache treatment. (See Final Interview Questions in Appendix VI.)

Subjects were asked to continue with the daily headache record keeping and with their home relaxation practice for seven days after their last laboratory session, and they were told that they would receive a cassette copy of the relaxation tape at the end of the seven days when they turned in their final headache records.

Results

Tables of all scores and measurements obtained in this study are in Appendix XIII.

Headache Reports

Daily Headache Records

Daily headache reports were of two types: (a) headache pain intensity reports of the subject's pain at the moment when the card was being filled out, and (b) reports of the maximum pain intensity during the half-day period immediately preceding the time when the card was being filled out. The at-this-moment reports were positively correlated with their corresponding half-day reports, but at-this-moment reports were usually lower in intensity than corresponding half-day reports and were often zero. Thus, at-this-moment reports appeared to be the less sensitive measures. Since half-day reports appeared to be more sensitive, they were used for these analyses.

The daily headache report records for each of the five subjects are shown in Figures 3 through 7, and mean headache intensities for each subject during each of the five headache record Periods are shown in Figure 8.

A repeated measures analysis of variance was done to evaluate subject treatment (combined vs. verbal) by Period (Pre-training vs. Early Training vs. Late Training vs. Post-

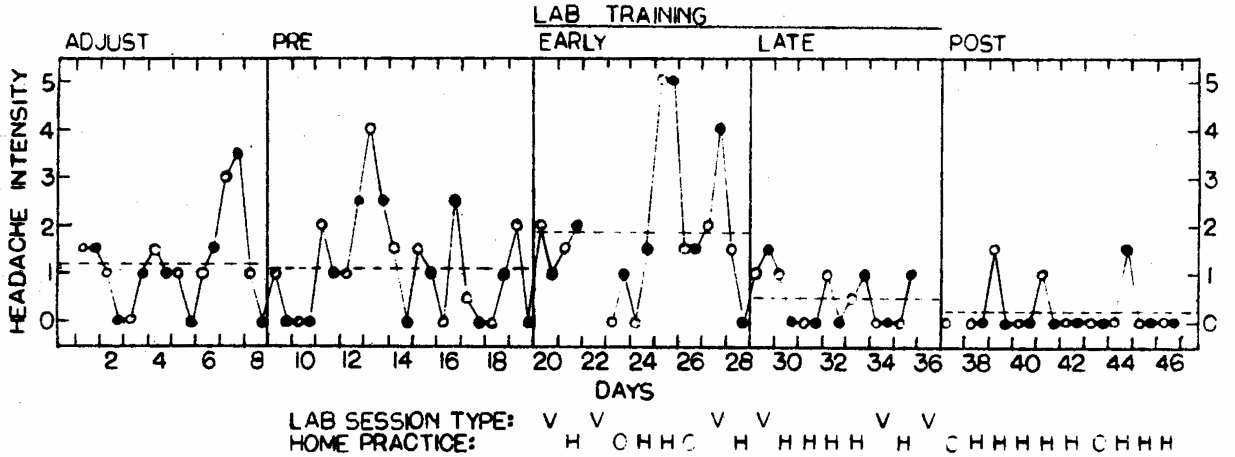


Figure 3. Daily Headache Reports From Subject MC. (Verbal treatment subject, female. Periods: Adjustment, Pre-training, Early Training, Late Training, Post-training. Dashed line = Period mean. Headache intensity: 0 = no headache, 5 = excruciating. Session type: V = verbal instruction, B = biofeedback training. Home relaxation: H = practiced, O = omitted.)

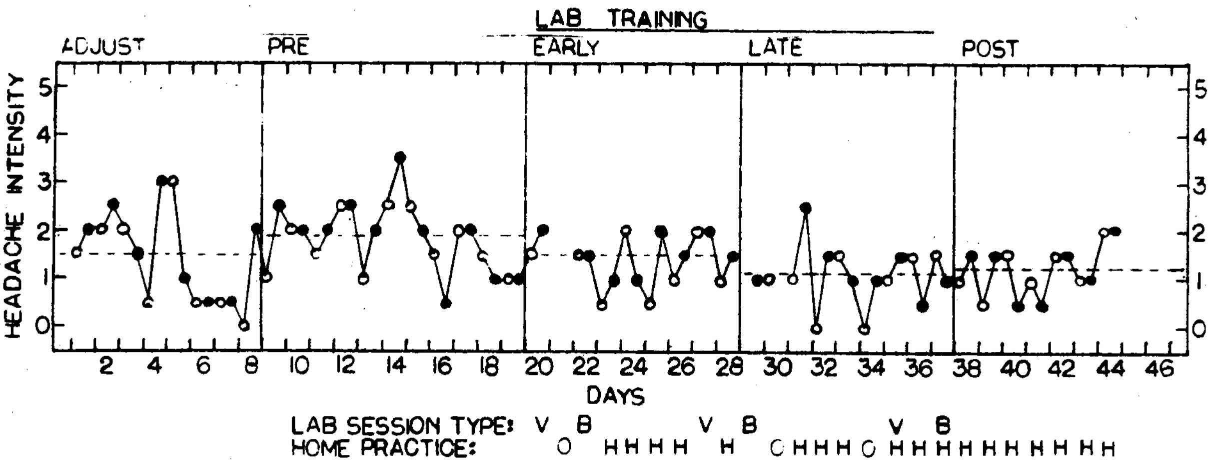


Figure 4. Daily Headache Reports From Subject RR. (Combined treatment subject, male. Periods: Adjustment, Pre-training, Early Training, Late Training, Post-training. Dashed line = Period mean. Headache intensity: 0 = no headache, 5 = excruciating. Session type: V = verbal instruction, B = biofeedback training. Home relaxation: H = practiced, O = omitted.)

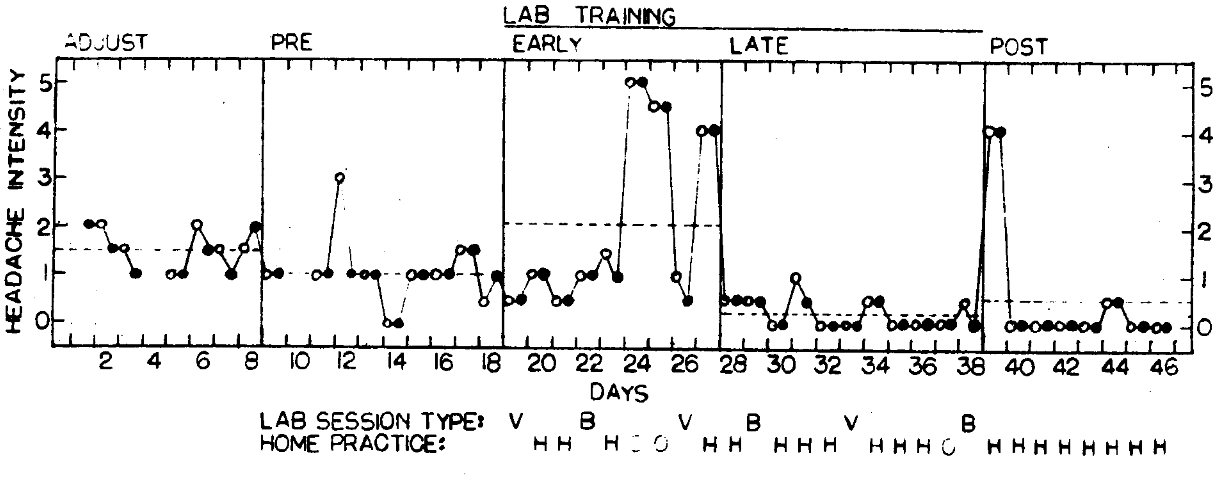


Figure 5. Daily Headache Reports From Subject TV. (Combined treatment subject, female. Periods: Adjustment, Pre-training, Early Training, Late Training, Post-training. Dashed line = Period mean. Headache intensity: 0 = no headache, 5 = excruciating. Session type: V = verbal instruction, B = biofeedback training. Home relaxation: H = practiced, O = omitted.)

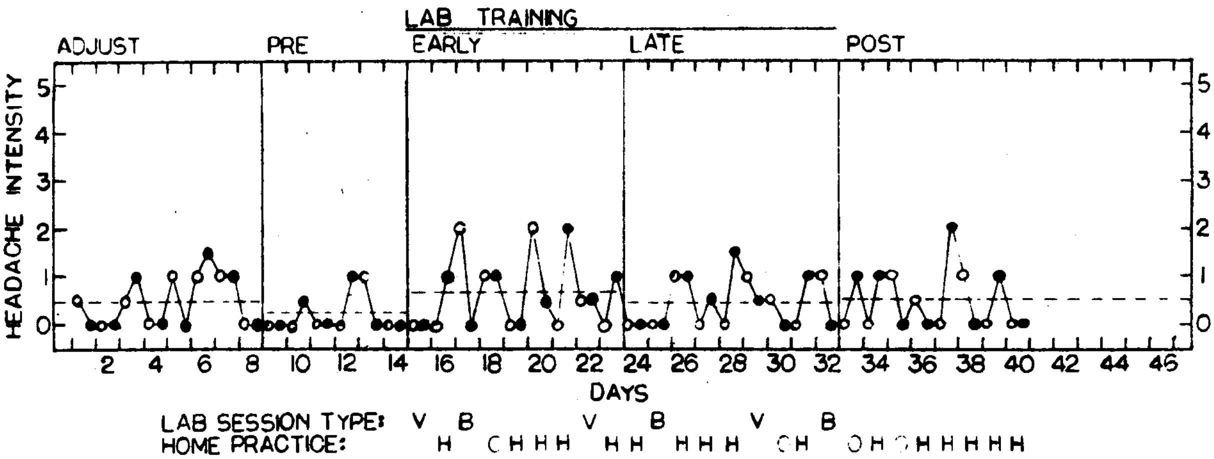


Figure 6. Daily Headache Reports From Subject CR. (Combined treatment subject, female. Periods: Adjustment, Pre-training, Early Training, Late Training, Post-training. Dashed line = Period mean. Headache intensity: 0 = no headache, 5 = excruciating. Session type: V = verbal instruction, B = biofeedback training. Home relaxation practice: H = practiced, O = omitted.)

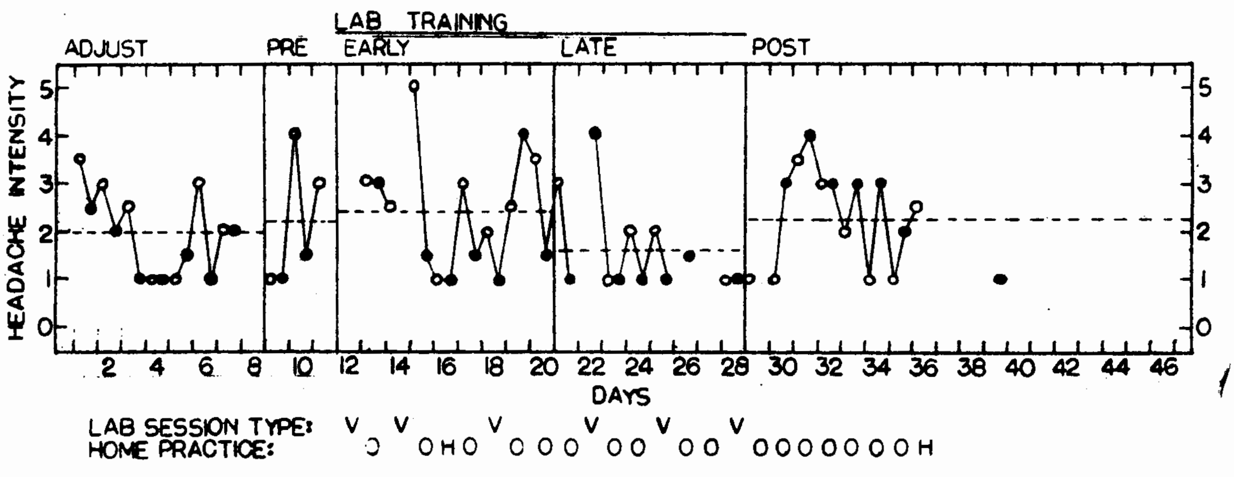


Figure 7. Daily Headache Reports From Subject MF. (Verbal treatment subject, female. Periods: Adjustment, Pre-training, Early Training, Late Training, Post-training. Dashed line = Period mean. Headache intensity: 0 = no headache, 5 = excruciating. Session type: V = verbal instruction, B = biofeedback training. Home relaxation: H = practiced, O = omitted.)

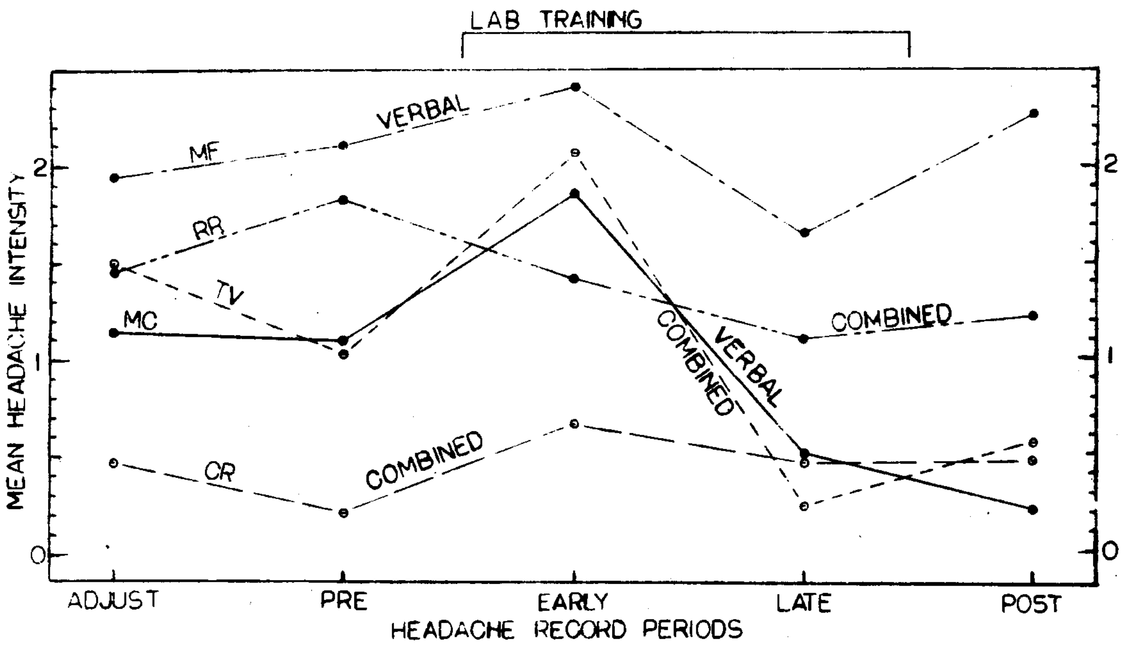


Figure 8. Mean Headache Intensities for Each Subject for Each Headache Record Period. (Headache intensity computed from daily headache reports in which 0 = no headache, 5 = excruciating. COMBINED = combined verbal relaxation - biofeedback training treatment, VERBAL = verbal relaxation instruction only treatment. For time spans of Periods, see Figures 3 - 7.)

training) main effects and interactions. There was no significant overall difference between treatment groups, and there was no interaction between treatment groups and Periods. However, the main effect of Periods was very close to an acceptable alpha level ($p = 0.06$). The following *t* tests, then, should be taken as indicative but not as completely justified.

Main Effects. Independent groups *t* tests were done on the records from each individual subject in order to compare headache reports from different Periods. Two subjects showed a significant decrease from Pre- to Post-training Periods: MC, a verbal treatment female (see Figure 3), and subject RR, a combined treatment male (Figure 4). For both subjects, $p < 0.005$ in a one-tailed test.

Paired observation *t* tests were done on the mean headache intensities within each Period from the five subjects. The tests showed no significant decrease from the Pre-training Period to the Post-training Period, but the decrease from the Early Training Period to the to the Late Training Period was significant ($p < 0.005$ in a one-tailed test.

Treatment Method Differences. Inspection of Figure 8 and the fact that one verbal treatment subject and one combined treatment subject showed significant decreases from Pre- to Post-training Periods suggests no difference between the two treatment methods for these two Periods. Independent groups *t* tests on the Period means showed no significant difference between the two treatment groups in any of the record keeping Periods.

Pre-training to Early Training Increases. There is some evidence that headaches *increased* from the Pre-training to the Early Training Period. In Figure 8, four of the five subjects show such an increase. However, a paired observations *t* test applied to the subject means for the two periods showed no significant difference. Independent groups *t* tests were applied to each subject's daily headache reports for the two periods. Since these tests were *post hoc*, the alpha level was set to 0.01 on a two-tailed test. With these restrictions, subject MC (Figure 3) showed a significant increase.

Beginning- and End-of-Session Headache Reports

The headache reports which subjects filled out at the beginning and at the end of each laboratory session were also analyzed. Most of the end-of-session reports from sessions one and two were lost, so the analyses were done on reports from the last four sessions only.

Main Effects. Figure 9 shows mean beginning- and end-of-session headache intensities for each subject. There is slight statistical evidence for a main effect. Paired observation *t* tests were done for each subject using her/his

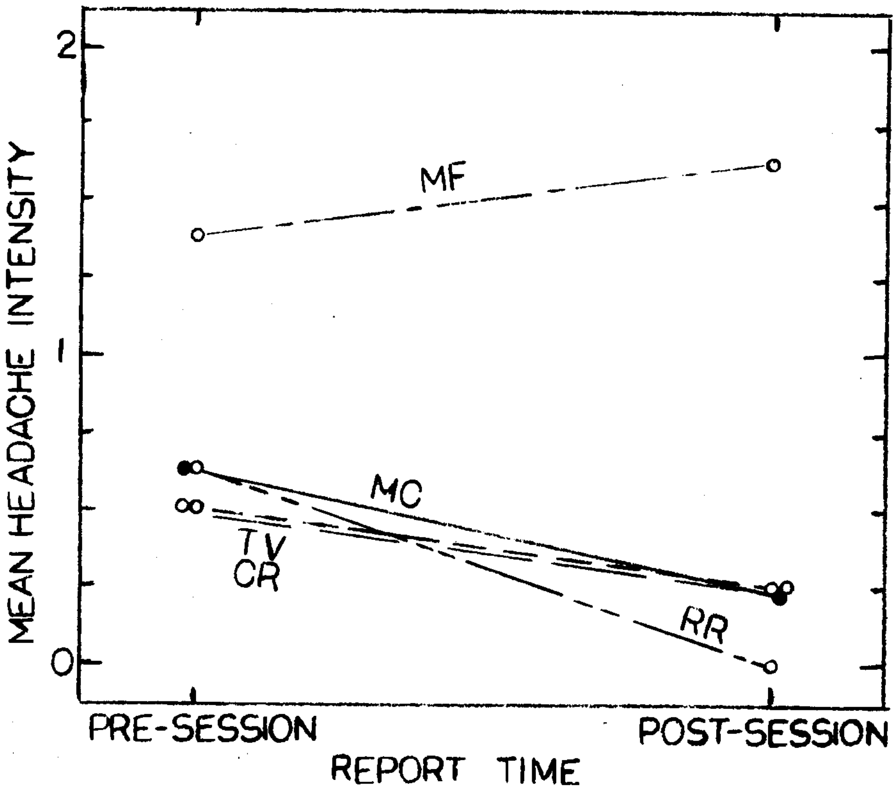


Figure 9. Mean Headache Intensities at the Beginning and at the End of Laboratory Training Sessions. (Computed from reports from the last four sessions only.)

four beginning- and end-of-session headache pain reports. For one subject there was a significant decrease (subject RR, $p < 0.05$, one-tailed test, Figure 4). For the remaining subjects, there was no significant change. Another paired observations *t* test comparing the beginning-of-session means from the five subjects with their end-of-session means also showed no significance.

Combined Treatment vs. Verbal Treatment. An independent groups *t* test compared the beginning- to end-of-session headache change scores averaged for each subject in the combined treatment condition with the average change scores for each subject in the verbal treatment condition. The test showed no significant difference.

Biofeedback Sessions vs. Verbal Instruction Sessions. For subjects within the combined treatment condition, mean headache change scores from biofeedback sessions were compared with mean change scores from verbal instruction sessions. Again, a paired observations *t* test was used. Results were not significant.

EMG Levels.

The EMG measurements from the left and the right sides of the neck were averaged together for each measurement occasion. These means for the neck EMGs were used in all the analyses which follow. Figure 10 shows end-of-session EMG levels for each treatment group for each laboratory session. (Graphs of beginning- and end-of-session EMG measurements for the left and the right back-of-neck sites and for the forehead site are in Appendix XIII).

Repeated measures analyses of variance were done on end-of-session EMG levels and also on beginning- to end-of-session change scores for both the forehead site and the averaged neck sites. For these ANOVAs, the six laboratory sessions were grouped into three pairs. Sessions one and two were Pair 1. Sessions three and four were Pair 2, and sessions five and six were Pair 3. For the combined treatment subjects, then, one biofeedback laboratory training session and one verbal instruction laboratory session occurred in each pair. For the verbal treatment subjects, both sessions within a Pair were verbal instructions sessions. For both treatment groups, this pairing allowed analysis of the effects of repeated lab sessions. The first session in each pair was designated a V type session; the second session, a B type session. The analyses of variance evaluated subject treatment condition (combined vs. verbal) by Pair (Pair 1 vs. Pair 2 vs. Pair 3) by session type (V vs. B) for main effects and interactions. The ANOVAs done on the beginning- to end-of-session change scores for both forehead and neck produced no significant results. These scores were not analyzed further. The ANOVAs done on the neck and forehead end-of-session EMG levels did yield some significant results, and these results are discussed under their appropriate headings in the following

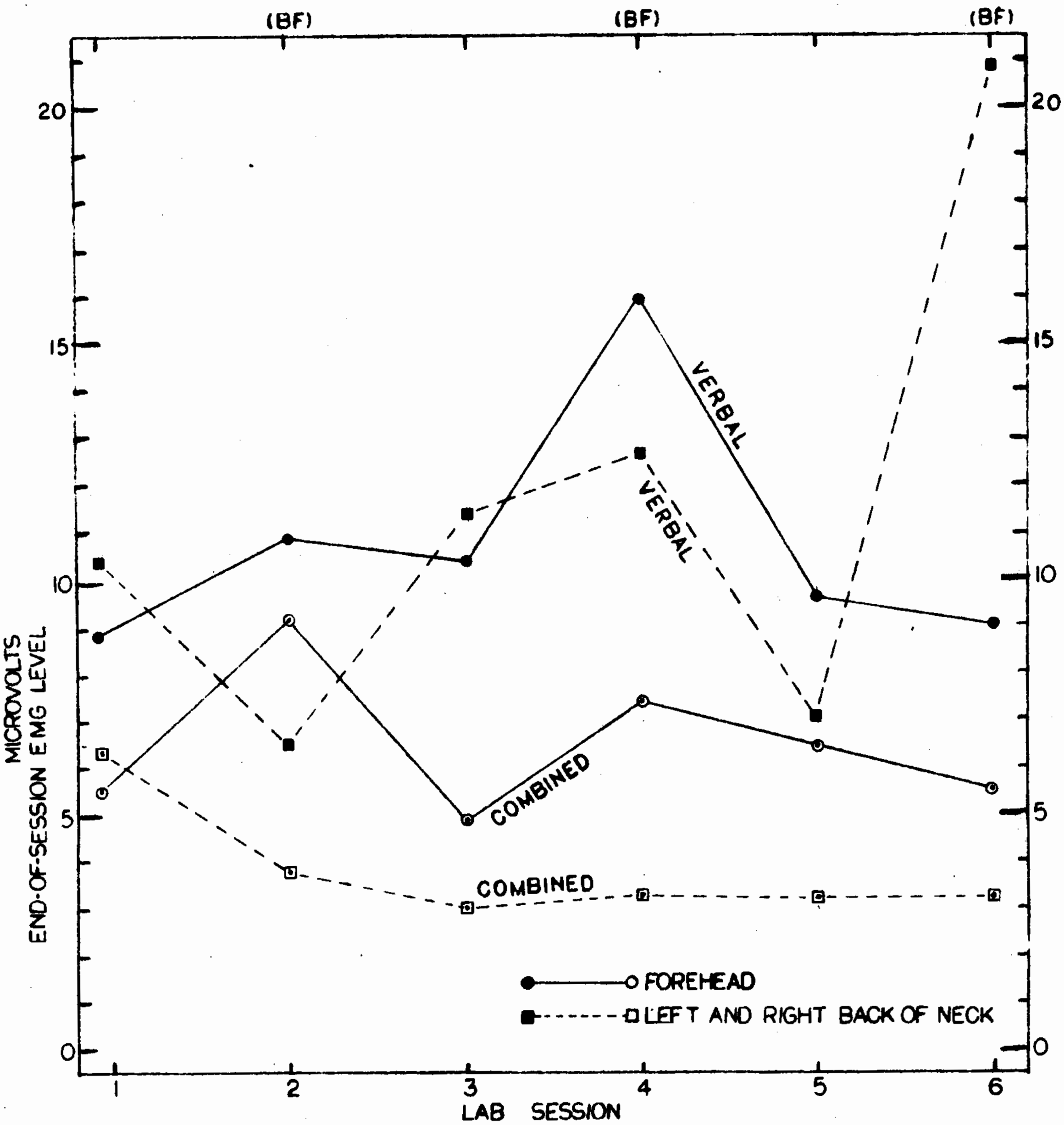


Figure 10. End-of-session Mean EMG Levels for Combined Treatment Subjects and Verbal Treatment Subjects. (Neck measurements are means for the left and the right sides of the back of the neck. Sessions 2, 4, and 6 were biofeedback training sessions for combined treatment subjects. All other laboratory sessions were verbal relaxation instruction sessions.)

sections.

Main Effects

Forehead. There was no statistical evidence for an overall treatment effect. The ANOVA showed no significant change in forehead EMG levels over all subjects from one Pair of laboratory sessions to another. Also, there was no significant interaction between the two subject treatment conditions from one Pair to another. There was, however, a significant overall difference between the two treatment groups ($p = 0.002$). Figure 10 suggests that, overall, verbal treatment subjects had higher end-of-laboratory-session forehead EMG levels. An independent groups *t* test comparing the means of each combined treatment subject with the means of each verbal treatment subject showed a highly significant difference ($p < 0.01$, two tailed test). Verbal treatment subjects' forehead EMGs averaged 4.2 microvolts higher than those of combined treatment subjects.

Neck. As with the analysis of the forehead EMGs, there was no change in overall neck EMGs across Pairs, and there was no significant Pairs by treatment interaction. There was, as with the forehead, an overall difference between the treatment groups ($p = 0.011$). Figure 10 suggests that neck EMG levels overall were higher in the verbal treatment group, and an independent groups *t* test found the the verbal group to be higher by 7.5 microvolts ($p < 0.05$, two tailed-test).

Interactions

Forehead. There was evidence that forehead EMGs did not simply decrease from the first session in a Pair to the second. The ANOVA produced a Pairs by type-of-session (V vs. B) interaction ($p = 0.030$). Thus, for all subjects considered together, the relationship between the means of the two session types changed significantly from Pair 1 to Pair 2 to Pair 3. What Figure 10 suggests is that forehead EMG levels increased from session one to two and from session three to four but not from session five to six. A post hoc *t* test was done for this evaluation. For each subject, the score from session one was combined with the score from session three, and the score from session two was combined with the score from session four. A matched observations *t* test done on these combined scores produced a significance level which would be $p < 0.02$, two-tailed, for a planned comparison. With this same test, there was no significant difference between sessions five and six.

Neck. As with forehead EMG levels, there was evidence that neck EMGs over all subjects did not simply decrease through the course of the laboratory sessions. The ANOVA showed a significant pairs by type-of-session interaction over all subjects ($p = 0.017$). Figure 10 might suggest an overall decrease from sessions one to two and from sessions four to five. But a _post hoc_ paired observations _t_ test comparing each subject's EMG levels from sessions one and four combined to the levels from two and five combined was not significant. In addition, paired cbservation _t_ tests on individual subject scores comparing sessions one with two, sessions three with four, and sessions five with six showed no significant differences. The pattern of this over-all-subjects interaction, then, is unclear.

There is evidence that during the last four laboratory sessions, neck EMGs were lower for combined treatment subjects than for verbal treatment subjects. The ANOVA revealed a significant session type by Pairs by treatment group interaction ($p = 0.044$). Put simply, this means that the pattern of the relationship between the session types (V vs. B) from one Pair to another was significantly different for the two treatment groups.

Figure 10 again suggests a pattern. It appears that end-of-session neck EMG levels decreased for both treatment groups from session one to two, but then differed from each other from sessicns three through six. While neck EMGs remained low for combined treatment subjects, verbal treatment subject neck EMGs increased from session two to three, decreased from four to five, and then increased again from session five to six. However, paired observation _t_ tests done on individual scores comparing sessions two with three, sessions four with five, and sessions five with six showed no significant differences. Also, a similar t test done on the combined scores from sessions two and five compared with the scores combined from three and six showed no significant difference. A reasonable conclusion here might be, then, that while the neck EMGs of combined treatment subjects in the last four sessions stayed low, neck EMGs for verbal treatment subjects in these last four sessions did not.

STAI-State Inventory

Main Effects

STAI-State Inventories were administered to subjects at the beginning and the end of the first, second, and sixth sessions. There was evidence that, generally, scores for each subject decreased from the beginning of sessions to the end of sessions. For each of the five subjects, the means of the beginning- to end-of-session change scores were calculated, and a paired observations t test was done to determine if these means differed from zero. The mean decrease was 6.3 and the decrease was significant ($p < 0.025$, one-tailed test).

In another paired observations t test, the means for the end-of-session scores were computed from sessions one and two for each subject, and then these means were compared with the end-of-session scores from session six. No significant difference was found.

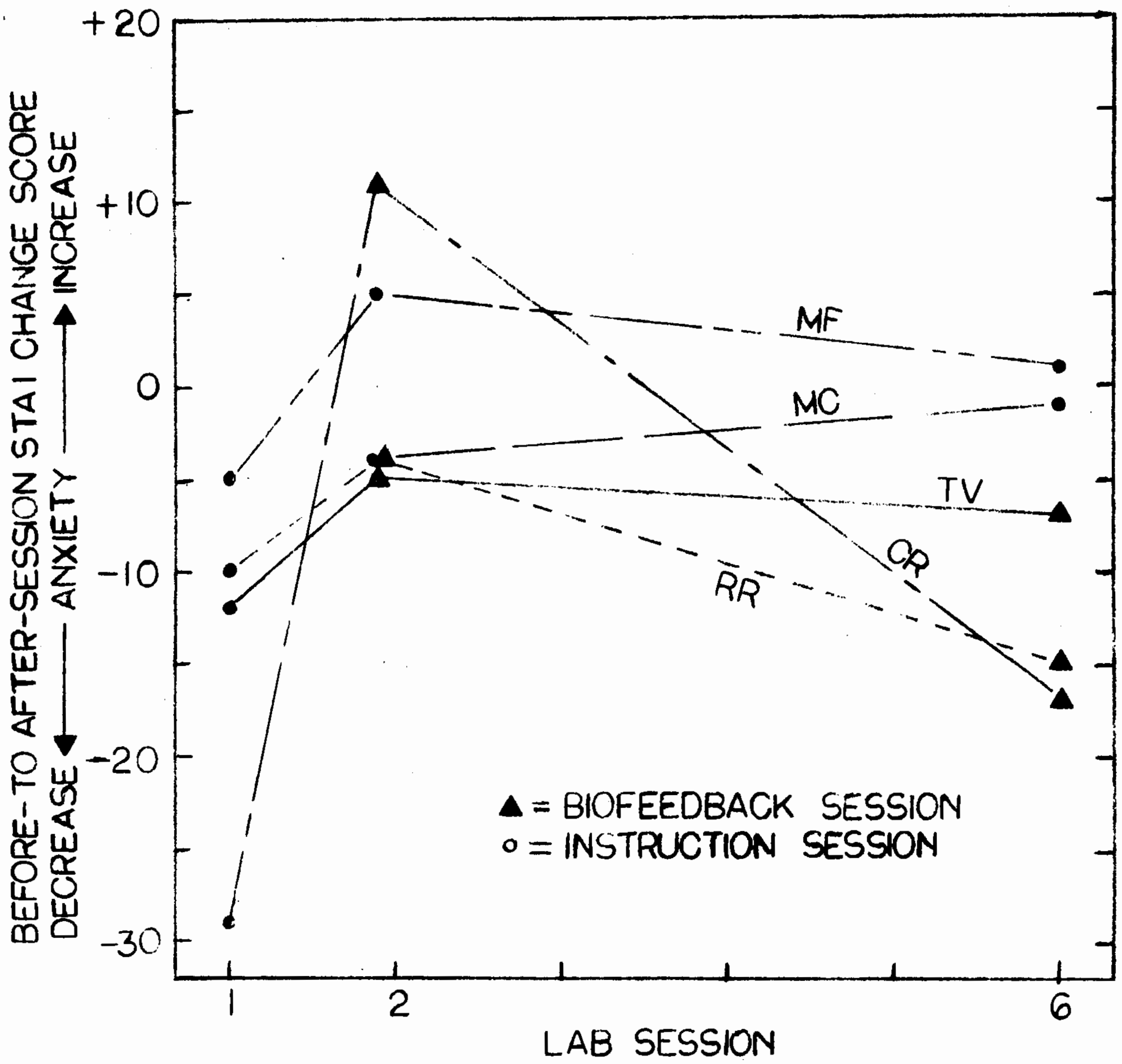
Also, for each subject, before- to after-session change scores were computed and then averaged together for sessions one and two. These means were then compared with a paired *t* test with the change scores from the last session. Again, no significant difference was found.

The mean STAI-State change scores from subjects in the combined treatment condition were compared with the means from the verbal treatment subjects. An independent groups *t* test showed no significant difference. The same test was used to evaluate mean end-of-session scores for the two groups. Again, there was no significant difference.

Interactions

In Figure 11 all the STAI-State change scores are plotted. Note that scores decrease most during the first laboratory training session and least during the second lab session. In fact, some scores *increased.* However, paired observation *t* tests showed no significant differences between sessions one and two and between sessions two and six. The pattern, then, can only be taken as suggestive.

STAI-State raw scores are plotted in Figure 12. The Figure suggests that the large decreases in scores during session one may have been partly due to high beginning-of-session scores and that the lack of decrease during session two may have been due to low beginning-of-session scores.



<u>Figure 11.</u> Beginning- to End-of-Session STAI-State Change Scores. (Change scores = after-session score minus before-session score. No change score was obtained for subject MC in session 1. Minimum-maximum possible scores: 20-80)

However, this explanation appears insufficient, because end-of-session scores are higher for session two than for the other sessions.

Notice, also, that beginning-of-session scores are lowest for session two.

Correlations

In all of the following correlation analyses, only change scores are discussed and illustrated. In all cases, scattergrams were plotted for the corresponding raw scores and showed no association.

EMGs and Beginning- to End-of-Session Headache Reports

There is some indication that neck EMG change scores may be better predictors of headache changes than forehead change scores. For the association between EMGs and headache change scores, two scattergrams were constructed. One plotted the association between neck EMG change scores and headache change scores, and the other showed the association between forehead EMG change scores and these same headache change scores. Both scattergrams are in Figure 13. In each of the scattergrams, each of the subjects contributed four data points: one point each from sessions three through six. While these scattergrams suggest that neck EMG change scores may be more closely associated with headache changes than forehead change scores, both associations are low. Two

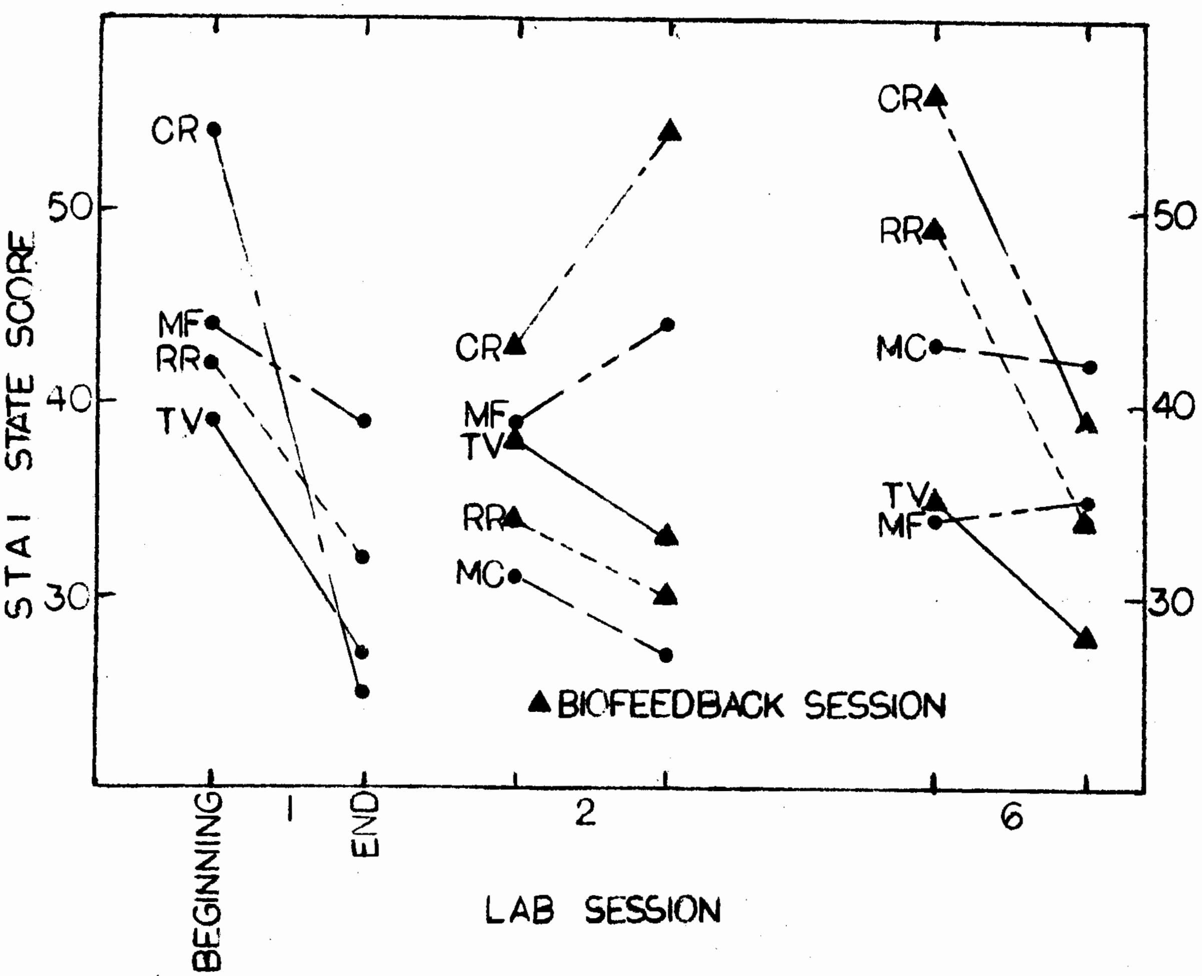


Figure 12. Beginning- and End-of-Session STAI-State Raw Scores. (Minimum-maximum possible scores: 20-80).

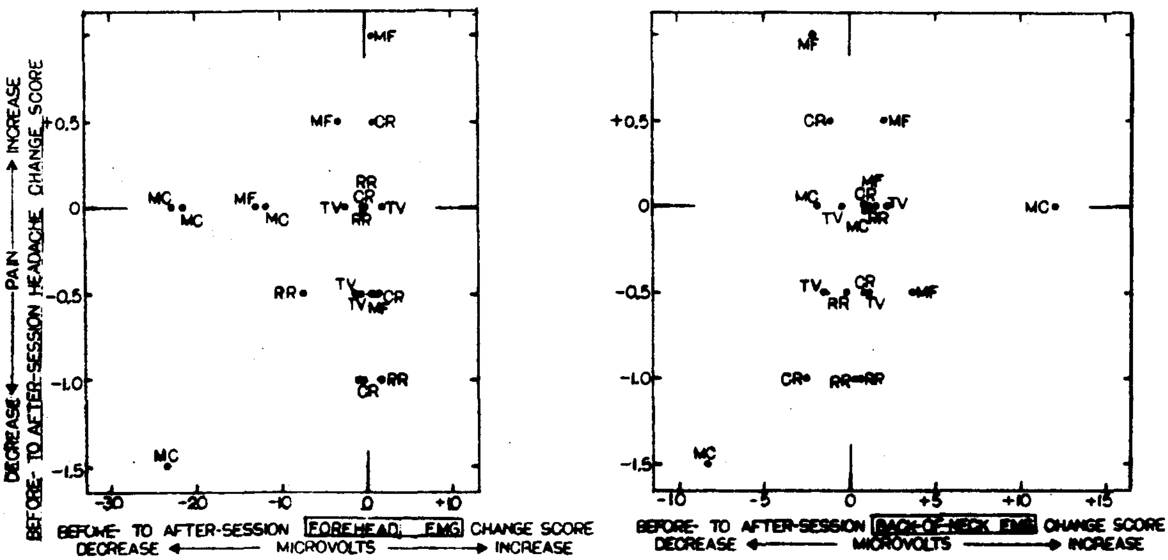


Figure 13. Scattergrams of EMG Change Scores and Beginning-to End-of-Session Headache Change Scores. (Headache pain scale: 0 = no headache, 5 = excruciating. Each of the five subjects contibuted data points on both scattergrams from sessions 3, 4, 5, 6. Points are labelled by subject.)

Pearson correlation coefficients were calculated for each subject on the two sets of score pairs. None of these individual *r*'s was significantly different from zero. Also, paired observation *t* tests were used to evaluate the difference between the five *r* values for the neck-to-headache correlation and the forehead-to-headache correlation. These sets of *r* values were not significantly different from each other nor were they different from zero.

EMGs and STAI-State Scores

There was some indication that neck EMG change scores might be more closely associated with STAI-State change scores than forehead EMGs. EMG measurements and STAI-State scores occurred together in sessions one, two, and six. As with EMGs and headache change scores, two scattergrams were constructed. One evaluated the relationship of neck EMG change scores to STAI-State change; the other, the relation between forehead EMG change scores and STAI-State change scores. The scattergram patterns were very similar to those for the headache change scores. Again, neck changes seemed to be slightly better predictors than forehead change scores, but both associations were close to *r* = 0.00. Statistical analyses like those done for EMG-to-headache correlations of individual and mean *r*'s again yielded no significant results.

STAI-State Scores and Beginning- to End-of-Session Headache Scores

There was also some indication of positive correlation between STAI-State change scores and headache change scores. In laboratory session six, STAI-State change scores and headache intensity change scores cccurred together and could thus be inspected for association. A scattergram for these data points is shown in Figure 14. In the figure there appears to be some positive correlation. A Pearson r was calculated using the points from all subjects frcm session six only. Again, the r value was not significant.

EMG to EMG Associations

Scattergrams of neck-to-forehead EMGs showed no appreciable association over all sessions. Individual subject r's were calculated using score pairs from all six sessions. Only the r for subject IV was significantly different from $r = 0.00$ ($r = -0.82$, $p < 0.005$, two-tailed test). The group of r's was then tested for significant difference from zero with a paired observations t test. There was no significant difference. Also, there was no significant difference between verbal and combination treatment r's.

However, there was indication that neck-forehead EMG correlation might change radically from verbal to biofeedback sessions. Within the combined treatment group,

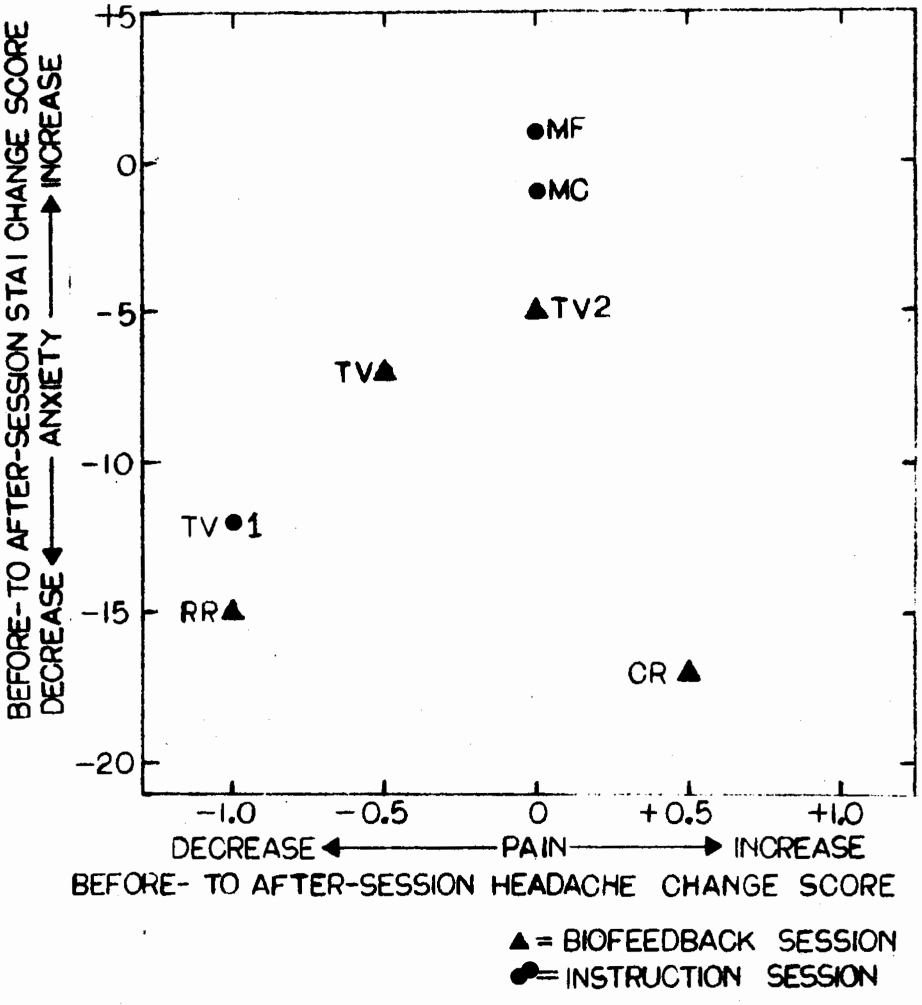


Figure 14. Scattergram of Beginning- to End-of-Session Headache Change Scores and STAI-State Change Scores. (Headache changes from a scale in which 0 = no headache, 5 = excruciating. All points are from session 6, except those labelled "1" and "2". All points labelled by subject.)

correlation coefficients were calculated separately for verbal relaxation sessions and biofeedback sessions. None of these individual coefficients were significant. However, scattergrams of the biofeedback session points and of the verbal relaxation points suggested some association, but the directions of the suggested associations were opposite. For verbal relaxation sessions, the association was low but positive, whereas during biofeedback sessions the association between forehead and neck EMG change scores appeared to be negative. The two scattergrams are shown together in Figure 15.

STAI-Trait Inventory

Three of the five subjects ranked above the 70th percentile on the STAI-Trait Inventory. But using Spielberger, Gorsuch, and Lushenes' (1970) Florida State University undergraduates as a normal comparison population, an independent groups *t* test did not show this group to be, on average, significantly different from either males or females in that population. (Individual STAI-Trait scores are in Appendix XII.)

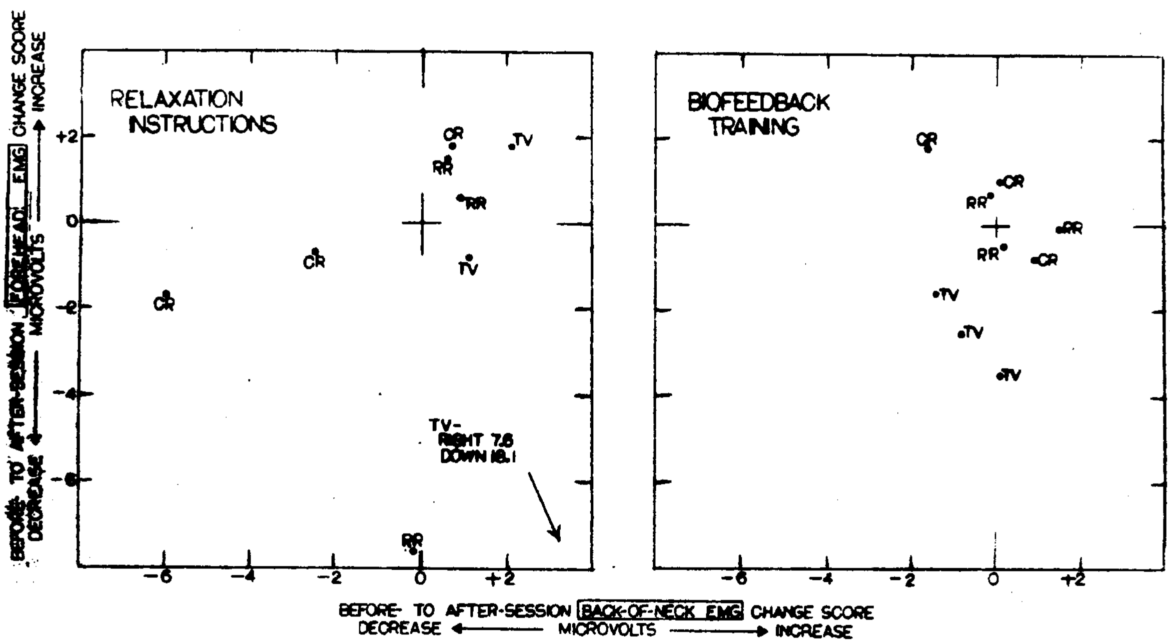


Figure 15. Scattergrams of Forehead and Neck EMG Change Scores for Verbal and Biofeedback Sessions. (All points from combined treatment subjects only. Verbal relaxation instruction session data points from sessions 1, 3, 5 for each subject. Biofeedback training session data points from sessions 2, 4, 6 for each subject. Points labelled by subject.)

Rotter's I-E Scale

The subjects in this study, as a group, recieved scores 4.7 points higher than the scores of Rotter's (1966) Ohio State undergraduate students ($p < 0.01$, two-tailed test). Subjects in this study, then, were more externally controlled than normals. (Individual I-E scores are in Appendix XII.)

Final Interview

In the final interview, all the subjects said that their treatment had reduced their headaches. Many felt that their daily relaxation practice was the most beneficial part of the treatment for their headache, and some felt more confident from having acquired a tangible relaxation technique.

Several subjects found the biofeedback irritating. Also, several subjects wanted the relaxation tape to be shorter than 20 minutes. A few were bothered by polygraph equipment noises. (A summary of each subject's answers to the interview questions is in Appendix VI.)

Summary of Results

Daily Headache Reports. One combined treatment subject and one verbal treatment subject showed a significant decrease in headaches from the Pre-training to the Post-training Periods, and there was strong evidence that, for the whole group, headaches decreased from the Early Training Period to the Late Training Period. There was some evidence that headaches increased from the Pre-training Period to the Early Training Period. There was no evidence of a differential effect on the two treatment groups.

Beginning- and End-of-Session Headache Reports. There was some evidence that headache intensity decreased from the beginning to the end of laboratory sessions. There was no evidence of differential effects between the two treatment groups or between biofeedback and verbal instruction sessions.

End-of-Session EMG Levels. Throughout the sessions, verbal treatment subjects had significantly higher neck and forehead EMG levels than combined treatment subjects. There was no significant overall change in EMG levels from early laboratory sessions to late sessions.

There was evidence that for all subjects EMGs did not simply decrease from session to session. Forehead EMGs increased from sessions one to two and from sessions three to four. And there was good evidence that overall neck EMGs also did not simply decrease from session to session, but with neck EMGs a pattern could not be established.

In addition, there was good evidence that during the last four sessions neck EMGs remained low for subjects in the combined treatment group whereas neck EMGs for verbal treatment subjects did not.

STAI-State Inventory Scores. Over all sessions, STAI-State scores decreased significantly from the beginning to the end of laboratory sessions. However, there was no evidence of change from early laboratory sessions to late laboratory sessions either in end-of-session scores or in beginning-to-end of session change scores. Nor was there a difference between treatment groups.

There was some indication that for all subjects for sessions one, two, and six, STAI-State scores decreased most during session one and least during session two.

Change Score Correlations. Scattergrams suggested that neck EMG scores might be better predictors of headache scores than forehead EMG scores, but both associations were close to zero.

There was also indication that there might be a positive correlation between STAI-State scores and headache scores.

There was no indication of an association between neck and forehead EMG scores for either treatment group considered separately or for all subjects considered together. However, scattergrams suggested that the correlation between neck and forehead EMG scores is slightly positive during verbal instruction sessions and negative during biofeedback training sessions.

STAI-Trait Inventory Scores. There was some slight evidence that subjects are higher in Trait Anxiety than normals.

Rotter's I-E Scale Scores. Subjects in this study scored significantly higher than normals on Rotter's I-E Scale. They are more externally controlled.

Discussion

Conclusions

The first two of the three hypotheses which this experiment was designed to test remain unconfirmed. Even though combined treatment subjects maintained end-of-session neck EMGs which were lower than those of verbal treatment subjects, there was no evidence that the combined treatment was more effective than the verbal treatment for reducing headaches. Also, the only condition under which there was any indication of a generalization of muscle relaxation was for combined treatment subjects in their verbal instruction sessions, and for these subjects in their biofeedback sessions the association between neck and forehead EMGs appeared to be negative.

There was some weak evidence favoring the third hypothesis. The change scores for anxiety as measured on the STAI-State Scale seemed to be positively associated with beginning- to end-of-session headache change scores.

The two further questions which I sought answers for in this study are answered as follows: (1.) There is only slight evidence that subjects with muscle contraction headaches are higher in trait anxiety as measured on the STAI-Trait Scale than normals. (2.) Subjects with muscle contraction headaches feel significantly more externally controlled than normals as measured on Rotter's I-E Scale.

With respect to the two lines of research described in the introduction to this paper, the results from this study tend to confirm both Alexander's (1975), and Shidevy and Kleinman's (1977) conclusion that biofeedback trained muscle relaxation does not generalize, and that subjective reports of relaxation are not significantly correlated with forehead EMG levels. With respect to the other line of research, I, like Haynes, Mooney, and Parise (1975); and Haynes, Moseley, and McGowan (1975), found no sign of any difference in effectiveness between the two treatment methods.

There were several patterns which emerged during the analyses of the data which were not expected when this study was designed. Most of them are tentative. They are: (a) an increase in headaches from the Pre-training Period to the Early Training Period, (b) an increase in end-of-session forehead EMG levels from sessions one to two and from sessions three to four, (c) the lack of a steady decrease for all subjects from session to session in end-of-session neck EMGs, (d) the lack of decrease in STAI-State scores during the second laboratory session compared to the decrease in these scores during the first and last sessions, and (e) the apparent negative correlation between forehead and neck EMG change scores during biofeedback training sessions. These unexpected patterns suggest new directions for research. Some of these new directions are discussed in a section which follows.

Improvements on the Present Study

Measurements

The measurements and the design of the present study could be improved. For example, in this study I was able to treat only five subjects. It is likely that more certain results would have come from this study if I had used more subjects in each treatment group. Probably ten subjects in each condition would have revealed any clinically useful differences in the effectiveness of the treatment methods.

The diagnostic Headache Questionaire could be refined. For this study, I looked for an overall pattern of symptoms which indicated simple muscle contraction headache, but I had no formalized scoring rules. The questionaire could be improved by deriving differential weighting values for the answers to each question by administering the questionaire to known headache populations.

The daily headache reports could be simplified by omitting at-this-moment reports. These reports appeared to be less sensitive indicators than the reports of headaches during the previous half day.

Spielberger's STAI-State Inventory could have been administered more often. Because I wanted to keep the time required for each laboratory session to a minimum, I administered the test only on the first, second, and sixth sessions. But subjects did not seem to be bothered by the overall length of the sessicns. And STAI-State scores from all sessions might have yielded useful informaton about the lack of decrease in these scores during the second session and information about the association between these scores and the beginning- to end-of-session headache reports.

It appears that there is electronic equipment available which is more sensitive to muscle potentials than the Grass equipment used in this study. After the subjects in this study were run, I made an informal comparison between the electronic noise levels in the Grass Polygraph - 7P3 Preamplifier system and noise levels in the Autogen 1700 Biofeedback Amplifier. The Autogen system was quieter and thus capable of detecting weaker signals. During biofeedback training sessions, subjects in the present study usually reduced the biofeedback signal within the first few minutes of the training session, and they usually had no difficulty keeping the tone at its lowest level throughout the rest of the session. A more sensitive system might have produced deeper muscle relaxation and therefore stronger biofeedback training effects.

A caution: Most commercially available EMG biofeedback equipment provides no visual record of ongoing EMG activity. Such a record is necessary for studies like those reported here, because _resting_ levels cf muscle activity can be seriously confounded with the more transient bursts of electrical activity which occurs when the subject moves. In addition, signals produced by static electricity in the equipment and in the subject are frequent. Both of these kinds of noises are very large compared to resting muscle levels. The output of biofeedback systems such as the Autogen 1700, or tape recordings of the output of such systems, should be monitered with an oscilloscope or a strip chart recorder before EMG measurements are taken so that these noises can be detected and excluded from EMG resting level measurements.

In a very recent paper, Davis, Brickett, Stern, and Kimball (in press) have argued against the standard two-point frontalis electrode positions as specified, for example, in Lippold (1967, p. 285). This standard position was the one used in the present study. There are two frontalis muscles in the forehead; one muscle extends vertically above each eyebrow. Davis et al. argue that with the standard lead placement, frontalis muscle potentials are attenuated, because one lead is on each muscle. Since recording in this case is bipolar, the amplifier picks up only the <u>differences</u> in electrical potential between the two muscles. If both muscles are contracting at the same time, the electrical signals in each muscle may be large, but the <u>difference</u> between the signals may not be. Davis et al., therefore, recommend a seperate set of bipolar leads for each of the two frontalis muscles.

However, an important modifying consideration is left out of their arguement. In most EMG biofeedback training, lower frequency muscle action potentials are filtered out.

The Autogen 1700, for example, is normally set to reject all signals below 200 Hz (Note 2). It is unlikely that ac signals from the two frontales at these higher frequencies are in phase. In practice, electrical potential differences between the two frontales seem to become more frequent as either or both muscles become more electrically active. Out-of-phase signals from the standard lead placement seem to vary positively with general frontales tension levels.

Also, in EMG biofeedback training for general muscle relaxation, a signal representing the average activity of several muscles is often more useful than a more specific signal, and two electrodes are more convenient to apply than four. Thus, in order for the new four lead position to be adopted for biofeedback relaxation training, we need to establish that the averaged signal from the four-lead position is a better indicator of general forehead tension than the signal from the standard two leads.

Design

For the purpose of clarifying the course of development of the relaxation response from one session to the next, another combined treatment condition could be added to the present design. For such a condition, the first, third, and fifth laboratory sessions would be biofeedback training sessions. In the present study, for combined treatment subjects, the second, fourth, and sixth sessions were always biofeedback sessions, so any effects of the <u>order</u> of the type of the treatment session may have been confounded with the effects of the simple repetition of any type of laboratory session. At the time when this study was designed, this type of confounding was estimated to be unimportant for the purposes of comparing the overall clinical effectiveness of the treatment methods. However the data suggest that important adjustments may be occurring in the first few sessions. Future studies which pursue the nature of these adjustments would need such control.

Also, a control group of about ten subjects would probably establish the effects of expectation, daily home practice, and the effects of being attended to in the laboratory. Ideally, subjects in such a control group would practice relaxation at home, attend laboratory sessions, and be measured in the same way as subjects in the treatment groups. The only difference between such controls and the treatment subjects would be that controls would relax during laboratory sessions without either verbal instruction or biofeedback training.

Toward Future Studies

I have chosen to interpret some of the unexpected patterns which emerged from this study as the outcomes of the operations of central nervous system self-regulating, negative-feedback systems. The characteristics of such systems in human behavior, and the ways in which the existence of such systems can be experimentally verified, are explained especially well in a book by W. T. Powers, Behavior: The Control of Perception (1973).

There are, of course, other ways to interpret these results.

The possibility, suggested by Figure 8, that mean levels of tension headaches increase from the pre-treatment period to the period of the first nine days of treatment, is unexpected. Nowhere in the studies reviewed in or for this report, including the critical and comprehensive review of the literature by Tarler-Benlclo (1978), is such an increase mentioned. This effect, then, needs to be confirmed in future studies.

The meaning of such an increase, if it is confirmed, is open to speculation. One such line of speculation is this. Consider, first, the indications that more intense headaches appearently did not occur during or directly after any particular laboratory training session. For all subjects in this study, the first nine days of treatment contained their first three laboratory sessions. The before- to after-session reports available indicate no especial increase in headaches during any of these sessions (Table B, Appendix XII), and the daily headache reports do not suggest that intense headaches occurred especially frequently on or directly after any particular laboratory session day (Figure 3 - 7). To check this latter possibility, I divided the daily headache reports from each subject into groups such that each group contained all the reports from the evening of the day of one laboratory session through the evening just before the day of the next laboratory session. I did this for the first three sessions. I then plotted the means for these three groups for each subject. No pattern emerged. Means were not especially higher after any particular session. So it seems that something about the whole early part of the treatment caused overall headaches to increase, even though the last part of the treatment apparently caused headaches to decrease.

In some important respects, this pattern suggests the functioning of a very slow-acting self-regulating system. It is possible that the central nervous system is "set" to maintain an overall level of head-neck muscle tension, and, since sustained muscle contraction causes headaches, an overall level of headache pain. Perhaps, then, the relatively sudden introduction of muscle relaxation causes a delayed central nervous system reaction which increases muscle action potentials in order to restore them to their former tension levels. And, perhaps, this slow-acting compensating system "overshoots".

One implication of this line of speculation is that the way to achieve a permenant lowering of muscle tension levels is to somehow re-adjust the central nervous system "setting". Perhaps that is what is being achieved by the time of the later training period. This line of reasoning also suggests that simple muscle relaxation may not, in itself, directly produce a permenant decrease in overall muscle tension levels. In fact, we would predict compensatory increases. Rather, those aspects of the treatment process which cause a lowering of the set point are the effective causes of cure. Future studies, then, might tease these aspects out.

The ANOVA and Figure 10 suggest that for all subjects end-of-session frontalis EMGs increased from session one to two, decreased from two to three, increased again from three to four, and then decreased from four to five to six. During the first four sessions it seems that there is something about "achieving" a low end-of-session forehead EMG that prevents its occurrence during the next session. And not "achieving" a low end-of-session level allows it at the next session. Again, it is easy to see this pattern as the reactions of a self-compensating system. The system seems to oscillate about a set point before settling down. This system, in contrast to the headache level system just described, seems more directly tied to training sessions. Perhaps it is situation specific.

Recall that during sessions two and four there was evidence of a negative correlation between neck muscle tension change scores and forehead change scores. While neck muscle tension was decreasing under biofeedback training, forehead muscle tension was increasing.

Shedivy and Kleinman (1977), in the process of searching for the generalization of muscle tension changes from the frontalis to the sternomastiod and semispinalis/splenius muscles of the neck, found that when the frontalis was under biofeedback training not only did the sternomastoid and semispinalis/splenius muscles fail to increase or decrease in EMG levels along with the frontalis, but, in fact, semispinalis/splenius EMG levels increased while frontalis levels decreased. Alexander (1975), too, found an increase in muscle tension while the frontalis decreased under biofeedback training. In this case, forearm tension increased.

There is, then, some evidence, all of it admittedly *post hoc*, that biofeedback training on one muscle group can cause increased tension in other muscles. Again, this pattern suggests the actions of a self-regulating, negative-feedback system. This time, though, the system seems to be fast-acting, and an overall muscle tension level is maintained by increasing tension in muscles other than those being relaxed.

Perhaps it is time to conduct a study directed toward testing an hypothesis similar to this:

> There is some simple, direct mathematical function of EMG level measurements such that under relaxation conditions in which a muscle group is being trained to decrease or increase its EMG levels by biofeedback training, and under conditions in which central nervous system processes are otherwise held constant, there will

be a corresponding increase or decrease in EMG levels in other muscles such that the overall value of this function for all muscles will remain constant.

Evidence supporting such an hypothesis might weigh more heavily against the generalization hypothesis than the evidence that exists now. So far, much of the evidence comes from experimenters' inability to find significant changes in the EMG levels of other muscles when frontalis levels are being changed. A study demonstrating clear increases in muscle tension while a biofeedback training muscle was decreasing and clear decreases while a biofeedback training muscle was increasing would be stronger.

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Appendix I

Headache Poster

DO YOU OFTEN GET HEADACHES?

Research is being done in the Psychology Department comparing 2 different kinds of Relaxation Training methods for the relief of frequent headaches. Each person accepted into this study will go to 2 Relaxation Training sessions each week for 4 weeks. These sessions will be individually fitted into each participant's schedule.

If you are interested in joining this study, or if you want more information, please print your name, address, and 'phone number below, or print this information on a slip of paper and put it into the "RELAXATION TRAINING STUDY" mailbox. This mailbox is located on the West side (the Library side) of the Academic Quadrangle, on the 2nd floor, in the hallway between the coffee shop and the student cafeteria. We will contact you. Or you may 'phone 732-6651 and ask for, or leave a message for, Steve Grice.

M. L. Bowman, Ph. D.
S. R. Grice

PLEASE PRINT CLEARLY

NAME	ADDRESS	PHONE

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Appendix II

Headache Questionaire

HEADACHE QUESTIONAIRE

IDENTIFICATION

The information you give us in this questionnaire will be kept strictly confidential.

NAME: Ms/Miss/Mr/Mrs Last Name: ____________________

First Name: __________ Middle Name: __________________

DATE: ____________ AGE: _______ SEX: _____

PRESENT OCCUPATION: ____

HISTORY

HEADACHE COUNT: Estimate how many headaches you have had in the past

week: ________; in the past month: ________.

PREVIOUS DIAGNOSES: If you have previously been examined by a doctor for headaches, please tell us:

Approximate date(s) of examination: ________________________

Name of the doctor(s): __________________________________

Kind(s) of headache the doctor said you had -- if he told you:

____

What do you think are the causes of your headaches?:

____

____

____

What cures, if any, have you tried to use for your headaches? And how well have they worked for you?

____

____

____

____

HEADACHE QUESTIONNAIRE

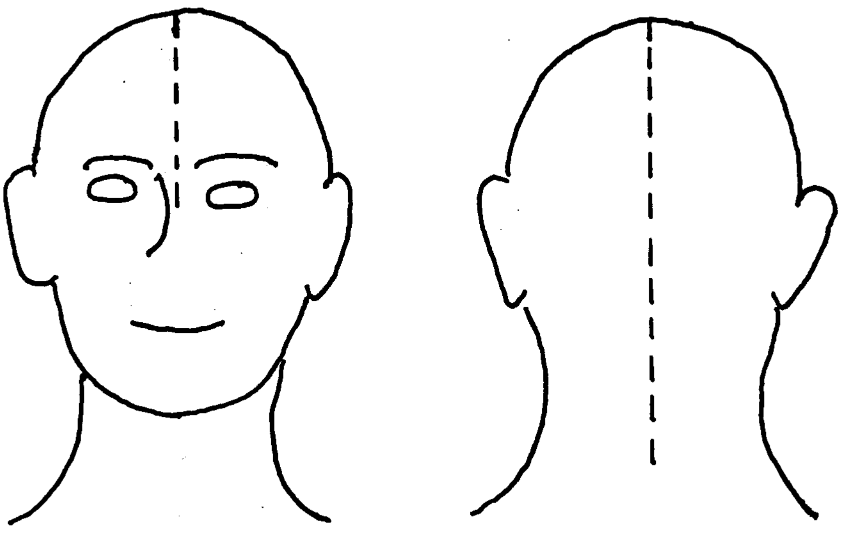
INSTRUCTIONS

There are many different kinds of headaches. This questionnaire is designed to give us some clues about which particular kind(s) you have.

Please read each statement very carefully. Take your time. Then remember what your headaches are like. If a statement is a true and accurate description of what your headaches are like, then mark "YES". If the statement is almost true for your headaches but not quite right, then mark the "YES BUT" answer, and tell us how you would change the statement to make it true for you. Write your correction in the space provided next to the "YES BUT" answer.

If the statement is not true for you, then mark "NO". If you are unsure, if you can't remember, if you just don't know, then mark "DON'T KNOW".

In this questionnaire, when we refer to the "right side" of your head, we mean all the areas of your head which are to your right of a line drawn up through the very centre of your forehead, across the top of your head, and down through the centre of the back of your head. "Left side" refers to areas to your left of this line.



HEADACHE QUESTIONNAIRE

STATEMENTS

1. My headaches occur mostly in the winter months.

   YES BUT ______________________________

   YES NO DON'T KNOW

2. My headaches began before I was 10 years old.

   YES BUT ______________________________

   YES NO DON'T KNOW

3. My headaches often have a prickling or a crawling sensation.

   YES BUT ______________________________

   YES NO DON'T KNOW

4. I have at least one close relative (mother, father, brother, sister, daughter, son) who has had headaches quite often.

   YES BUT ______________________________

   YES NO DON'T KNOW

5. My headaches are usually worst in the morning after I've gotten out of bed, and then they become less intense in the afternoon or in the evening.

   YES BUT ______________________________

   YES NO DON'T KNOW

6. (Remember how we defined "side" in the "INSTRUCTIONS".) My headache attacks always happen on the same side of my head.

   YES BUT ______________________________

   YES NO DON'T KNOW

7. Sometimes just before a headache I get a blind spot in one or in both of my eyes.

   YES BUT ______________________________

   YES NO DON'T KNOW

8. There have been periods of months in between times when I've gotten a series of headache attacks.

   YES BUT ______________________________

   YES NO DON'T KNOW

HEADACHE QUESTIONNAIRE

9. I almost always feel sick to my stomach sometime during a headache attack.

YES BUT ______________________________

YES NO DON'T KNOW

10. My headaches usually are at their worst or else they usually begin at the end of a working day.

YES BUT ______________________________

YES NO DON'T KNOW

11. My headaches feel like a tightness or a pressure on my head or like a tight band or a very tight cap.

YES BUT ______________________________

YES NO DON'T KNOW

12. My headaches have prevented me form sleeping for periods of more than three hours at a time during the night.

YES BUT ______________________________

YES NO DON'T KNOW

13. My headache attachs are often so bad that they leave me completely exhausted, and yet in between my headache attacks I am completely free of any trace of them.

YES BUT ______________________________

YES NO DON'T KNOW

14. My headaches occur mostly on the very top of my head.

YES BUT ______________________________

YES NO DON'T KNOW

15. My headaches usually start on both sides of my head at once.

YES BUT ______________________________

YES NO DON'T KNOW

16. I get a headache every day.

YES BUT ______________________________

YES NO DON'T KNOW

HEADACHE QUESTIONNAIRE

17. For many years now I've had headaches often.

YES BUT ______________________________

YES NO DON'T KNOW

18. Some of my headaches have lasted continuously for more than three full days.

YES BUT ______________________________

YES NO DON'T KNOW

19. Do not answer this statement if you have not taken these drugs. I have been given or I've taken ergotamine tartrate ("Gynergen", "Femergin", "Ergomar", or "Cafergot") or dihydroergotamine ("D.H.E. 45") during some of my headaches, and when I've had one of these drugs, my headache has gone away much sooner than it would have without the drug.

YES BUT ______________________________

YES NO DON'T KNOW

20. My headaches start sometimes on the right side of my head and then at other times my headaches start on the left side of my head, but they almost never start on both sides of my head at once.

YES BUT ______________________________

YES NO DON'T KNOW

21. Many of my headaches occur during the rest days after days when I've been working long and hard, or after days when I've been under a lot of stress.

YES BUT ______________________________

YES NO DON'T KNOW

22. I've had headaches that have been with me continuously for more than two weeks.

YES BUT ______________________________

YES NO DON'T KNOW

23. Just before a headache attack I sometimes get spots within my area of vision in which I see strange visual patterns.

YES BUT ______________________________

YES NO DON'T KNOW

HEADACHE QUESTIONNAIRE

24. My headaches occur once or more each day for a week or longer, and then they go away for months at a time, and then they return again.

    YES BUT ______________________________

    YES NO DON'T KNOW

25. (Answer only if you get menstrual periods.) I usually get headaches just before my menstrual periods.

    YES BUT ______________________________

    YES NO DON'T KNOW

26. When my headaches begin they throb or pound in time with my heartbeat.

    YES BUT ______________________________

    YES NO DON'T KNOW

27. My headaches sometimes wake me up early in the morning.

    YES BUT ______________________________

    YES NO DON'T KNOW

28. My headaches often start in the back of my head or in the back of my neck.

    YES BUT ______________________________

    YES NO DON'T KNOW

29. I often get more than average gas in my bowels when I'm having a headache attack.

    YES BUT ______________________________

    YES NO DON'T KNOW

Is there anything else about your headaches that you think we should know?

____

____

____

____

____

HEADACHE QUESTIONNAIRE DIAGNOSIS NOTES

I.D.: ______________________________ Date: __________

Headaches of different origin can occur together in the same person. E.g., "Contraction of the muscles of the head and neck occur with all headaches. If the contractions are of sufficient duration, they themselves become a cause of headache." (Wolff p. 92)

Bizarre symptoms may indicate a psychogenic headache associated with conversion hysteria or anxiety states. (Holvey p. 1272)

"YES BUT" answers are meant to bring out symptoms which do not closely fit questionaire descriptions but which may be of diagnostic value. "YES BUT" answers may also suggest ways in which questionaire statements could be improved.

The following numbers correspond to questionaire statement numbers. The diagnosis comments following the number apply if the patient answered "YES".

NO.	DIAGNOSIS COMMENTS	NOTES	REFERENCES
1.	Typical of nasal & paranasal headaches.		Holvey p. 1272 Wolff p. 92
2.	Likely to be migraine. Rare for muscle contraction headache.		Kunkle p. 24 Wolff p. 92
3.	Possibly psychogenic (conversion hysteria, anxiety states).		Friedman pp. 31-2 Holvey p. 1272
4.	Typical of migraine and, less frequently, arterial hypertension headaches.		Friedman p. 233 Holvey p. 1270 Wolff p. 94
5.	Typical of nasal and paranasal headaches.		Holvey p. 1272 Wolff p. 91
6.	May be "cluster" migraine or headache from structural lesion.		Kunkle p. 25
7.	May occur with migraine or certain brain tumors. Rare with muscle contraction h.		Friedman p. 233 Holvey p. 1270 Ostfeld p. 12 Wolff p. 93

HEADACHE QUESTIONNAIRE DIAGNOSIS NOTES

NO.	DIAGNOSIS COMMENTS	NOTES	REFERENCES
8.	Usually indicates migraine or muscle contraction h.		Kunkle p. 24
9.	Usual during migraine. Not usual during muscle contraction h. or with hs..from sinus or eye disease.		Friedman p. 233 Ostfeld pp. 8, 12 Wolff p. 92
10.	Common with muscle contraction h. or eye disease h.		Holvey p. 1272 Wolff p. 91
11.	Typical of muscle contraction h.		Holvey p. 1269 Wolff p. 90
12.	Anxiety or depression may be dominant aspects (migraine; muscle contraction, sinus, & brain tumor seldom disrupt sleep for long periods).		Wolff p. 93
13.	A "striking feature" of migraine.		Wolff p. 91
14.	Possibly psychogenic or hypertension.		Holvey 1272 Kunkle pp. 31-2
15.	Very typical of muscle contraction h. Unusal in migraine.		Friedman p. 233 Kunkle p. 25
16.	Very unlikely for migraine. Possible brain tumor or intracranial lesion.		Friedman p. 233 Holvey p. 1269
17.	"Points to" vascular or muscle contraction mechanisms. Unlikely to be expanding masses or inflammatory lesions.		Kunkle p. 23
18.	Not usual for migraine.		Ostfeld p. 12 Wolff p. 91

HEADACHE QUESTIONNAIRE DIAGNOSIS NOTES

NO.	DIAGNOSIS COMMENTS	NOTES	REFERENCES
19.	Vascular headache (usually migraine).		Chusid p. 409 Falconer p. 65 Ostfeld p. 6 Wolff p. 95
20.	Very typical of migraine. Very rare in muscle contraction. Unlikely to be from structural lesion.		Friedman p. 233 Kunkle p. 25 Wolff p. 90
21.	Common in some patients for migraine. Less common in muscle contraction h.		Kunkle p. 25 Wolff p. 92
22.	Probably muscle contraction.		Wolff p. 91
23.	May occur with migraine or certain brain tumors. Rare with muscle contraction h.		Friedman p. 233 Holvey p. 1270 Ostfeld p. 12 Wolff p. 93
24.	Almost always migraine ("cluster") h.		Kunkle p. 25
25.	Very common with migraine h.		Wolff p. 92
26.	Very common in migraine. Also occurs with some tumors and in some arterial hypertension.		Friedman p. 233 Holvey p. 1270 Kunkle p. 26 Wolff p. 90
27.	Commom with migraine and hypertension hs.		Wolff p. 91
28.	Almost always muscle contraction h.		Holvey p. 1269 Kunkle p. 25 Wolff p. 90
29.	Common in migraine and muscle tension, but seldom associated with other hs.		Wolff p. 92

HEADACHE QUESTIONNAIRE DIAGNOSIS NOTES

Tentative questionaire diagnoses:

Diagnoses from other sources:

HEADACHE QUESTIONNAIRE DIAGNOSIS NOTES

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Appendix III

Daily Headache Record Card Instructions

DAILY HEADACHE RECORD CARD INSTRUCTIONS

NAME: ______________________________ DATE: ____________

Your first ½-day period is from ________ to ________.
Your headache record-marking time for this first ½-day period is ________.
Your second ½-day period is from ________ to ________.
Your record marking time for this second ½-day period is ________.

It is important that you fill in the appropriate section of your record card as close to your appointed record-marking time as possible.

What to do with completed cards: ______________________________

This is how you should fill out your card:

1) When your first record-marking time arrives, get out a card, print on it your name and the date, and circle the correct day of the week.
2) Then, under the heading "REPORT AT END OF FIRST ½ OF DAY", print the actual time, to the nearest 5 mintes, including a.m. or p.m..
   Even if you don't mark your record at your appointed time, print in the actual time when you do mark the record.
3) Then, mark an "X" in the brackets under the phrase or word which best describes how your headache feels at that moment.
   Mark in the brackets between phrases or words if your headache is best described this way.

Here is a partly-filled-out example:

NAME: A NEWTON
DATE: 2 FEB 75
DAY: M Tu W Th F Sa (Su)

Columns: no headache | mild | discomforting-annoying | distressing-miserable | horrible-intense | excruciating

REPORT AT END OF FIRST ½ OF DAY
The correct time right now is 12:15PM
My headache at this moment is........( )( )( )(X)( )( )( )( )( )( )( )
My worst headache during the first ½ of today was.......( )( )( )( )( )( )( )( )( )( )( )

REPORT AT END OF SECOND ½ OF DAY
The correct time right now is _____
My headache at this moment is........( )( )( )( )( )( )( )( )( )( )( )
My worst headache during the second ½ of today was........( )( )( )( )( )( )( )( )( )( )( )

PAIN-RELIEVING MEDICINES TAKEN: Time, type & amount: ____________

RELAXATION PRACTICE: Starting time(s) & how long: ____________

4) Next, go to the sentence "My worst headache during the first ½ of today was..". Now think back over the time during the first ½-day period, and then indicate how bad your worst headache got during this period, by marking an "X" in the appropriate brackets.

5) Now go to the bottom of the card. After the phrase "PAIN-RELIEVING MEDICINES TAKEN"; print the time when you took medicine along with "a.m." or "p.m."; the name of the medicine; the number of tablets, teaspoons, etc. taken; and the amount of pain reliever contained in each tablet, teaspoon, etc. Look at the card below for an example.

6) One more step. After the phrase "RELAXATION PRACTICE", print the starting time for each time you did a relaxation home practice session, along with the length of time each session lasted.

Use the back of the card if you need more space.

Using the same card, follow steps 2 to 6 when your second record-marking time arrives.

Here is what a completed card might look like after the second record-marking:

NAME: M. SMITH

DATE: NOV. 21, 1978

DAY: M Tu (W) Th F Sa Su

Columns: no headache — mild — discomforting-annoying — distressing-miserable — horrible-intense — excruciating

REPORT AT END OF FIRST ½ OF DAY

The correct time right now is 12:20 p.m.

My headache at this moment is........( )( )( )( )(X)( )( )( )( )( )

My worst headache during the first ½ of today was.......( )( )( )( )( )(X)( )( )( )( )( )

REPORT AT END OF SECOND ½ OF DAY

The correct time right now is 10:55 pm

My headache at this moment is........(X)( )( )( )( )( )( )( )( )( )( )

My worst headache during the second ½ of today was........( )( )( )( )( )( )( )(X)( )( )( )

PAIN-RELIEVING MEDICINES TAKEN: Time, type & amount: 11:30 a.m. - ASPIRIN - 2 TABS - 5 GRAINS EACH. 4:55 pm "ATASOL" - 2 TABS - 325 mg. ACETOMINOPHEN EACH.

RELAXATION PRACTICE: Starting time(s) & how long: 10:35 am - 5 MINS. 7:35 pm - 35 mins.

In order for this study to be most useful to yourself and other people, do your best to be unbiased while you are filling out the record card. When you are filling out the card, set aside any beliefs you may have about how your treatments are working. Your headaches may get worse, they may get better, they may not change much at all - you really don't know. Just try to take the position of a careful, neutral observer.

The cards can be folded into thirds and carried in your wallet, so you can always have a card with you when your record-marking time arrives.

During your first few days of record keeping, you may need to set up reminders for yourself so that you won't forget. You can do things like this:

- put up a note on your front door to remind yourself to put some cards in your wallet before you leave your house.
- put up a reminder at school or work so you won't forget to fill out your card on time.
- set an alarm clock for your record-marking times.

Until this record-marking becomes a habit for you, make a special effort to remember.

Appendix IV

Self-Evaluation Questionaires

(STAI Inventories)

SELF-EVALUATION QUESTIONAIRE ST

Name: Ms/Mr/Miss/Mrs Last:____________________ First:__________________

Date:______________ Age:______ Sex: F/M

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	Not at all	Somewhat	Moderately so	Very much so
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I am regretful	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel rested	1	2	3	4
9. I feel anxious	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I feel jittery	1	2	3	4
14. I feel "high strung"	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel over-excited and rattled	1	2	3	4
19. I feel joyful	1	2	3	4
20. I feel pleasant	1	2	3	4

SELF-EVALUATION QUESTIONAIRE TR

Name: Miss/Mr/Mrs/Ms Last:______________ First:__________ Middle:________

Date:__________________ Age:______ Sex: F/M

Other Information:____

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you generally feel.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

		Almost never	Sometimes	Often	Almost always
1.	I feel pleasant	1	2	3	4
2.	I tire quickly	1	2	3	4
3.	I feel like crying	1	2	3	4
4.	I wish I could be as happy as others seem to be	1	2	3	4
5.	I am losing out on things because I can't make up my mind soon enough	1	2	3	4
6.	I feel rested	1	2	3	4
7.	I am "calm, cool, and collected"	1	2	3	4
8.	I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
9.	I worry too much over something that really doesn't matter	1	2	3	4
10.	I am happy	1	2	3	4
11.	I am inclined to take things hard	1	2	3	4
12.	I lack self-confidence	1	2	3	4
13.	I feel secure	1	2	3	4
14.	I try to avoid facing a crisis or difficulty	1	2	3	4
15.	I feel blue	1	2	3	4
16.	I am content	1	2	3	4
17.	Some unimportant thought runs through my mind and bothers me	1	2	3	4
18.	I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
19.	I am a steady person	1	2	3	4
20.	I become tense and upset when I think about my present concerns	1	2	3	4

SCORING THE SELF-EVALUATION QUESTIONAIRES TR AND ST

(SPIELBERGER'S STAI-TRAIT AND STAI-STATE ANXIETY INVENTORIES)

High scores indicate high anxiety.

To score the TR Questionaire, reverse the order of the answer numbers for statements 1, 6, 7, 10, 13, 16, and 19. Then add together the circled scores.

To score the ST Questionaire, reverse the order of the answer numbers for statements 1, 2, 5, 8, 10, 11, 15, 16, 19, and 20. Then add together the circled scores.

Appendix V

Personal Beliefs Inventory

(Rotter's I-E Scale)

PERSONAL BELIEFS INVENTORY

PLEASE PRINT CLEARLY--

Name: Ms/Miss/Mrs/Mr Last:______________ First:______________

Date: __________________ Age: ______ Sex: M/F

Other Information: ______________________________________

This is a questionaire to find out the way in which certain important events in our society affect different people. Each item consists of a pair of alternatives lettered a or b. Please select the one statement of each pair (and only one) which you most strongly believe to be the case as far as you're concerned. Be sure to select the one you actually beleive to be more true rather than the one you think you should choose or the one you would like to be true. This is a measure of personal belief: obviously there are no right or wrong answers.

Please answer these items carefully but do not spend too much time on any one item. Be sure to find an answer for every choice. Black-in the space provided beside a or b -- the one you choose as the statement more true.

In some instances you may discover that you believe both statements or neither one. In such cases, be sure to select the one you more strongly believe to be the case as far as you're concerned. Also try to respond to each item independently when making your choice; do not be influenced by our previous choices.

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

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

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

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

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

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

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

PERSONAL BELIEFS INVENTORY

Name: Last:____________________ First:____________________

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

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

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

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

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

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

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

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

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

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

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

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

PERSONAL BELIEFS INVENTORY

Name: Last:____________________ First:____________________

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

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

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

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

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

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

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

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

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

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

SCORING THE PERSONAL BELIEFS INVENTORY (ROTTER'S I-E SCALE)

A high score indicates high expectations of external control of reinforcement.

Score one point for each of the following answers:

2a	16a
3b	17a
4b	18a
5b	20a
6a	21a
7a	22b
9a	23a
10b	25a
11b	26b
12b	28b
13b	29a
15b	

Appendix VI

Final Interview Questions and Answers

FINAL INTERVIEW QUESTIONS

1. How could we improve this treatment for headaches? Consider daily record cards, placing and removing the electrodes, relaxation tape, biofeedback training, our interaction.

2. Do you think that participating in this study has reduced or increased your headaches from what they would otherwise be?

3. What aspects or parts of this treatment have been most helpful in reducing your headaches?

4. What aspects or parts of this treatment have been most detrimental for reducing your headaches?

5. Have you benefited in any other ways from being in this treatment? If so, how? If so, what aspects or parts have been beneficial?

6. Have you been hindered or bothered in any other ways from being in this treatment? If so, how? If so, what aspects or parts have bothered you?

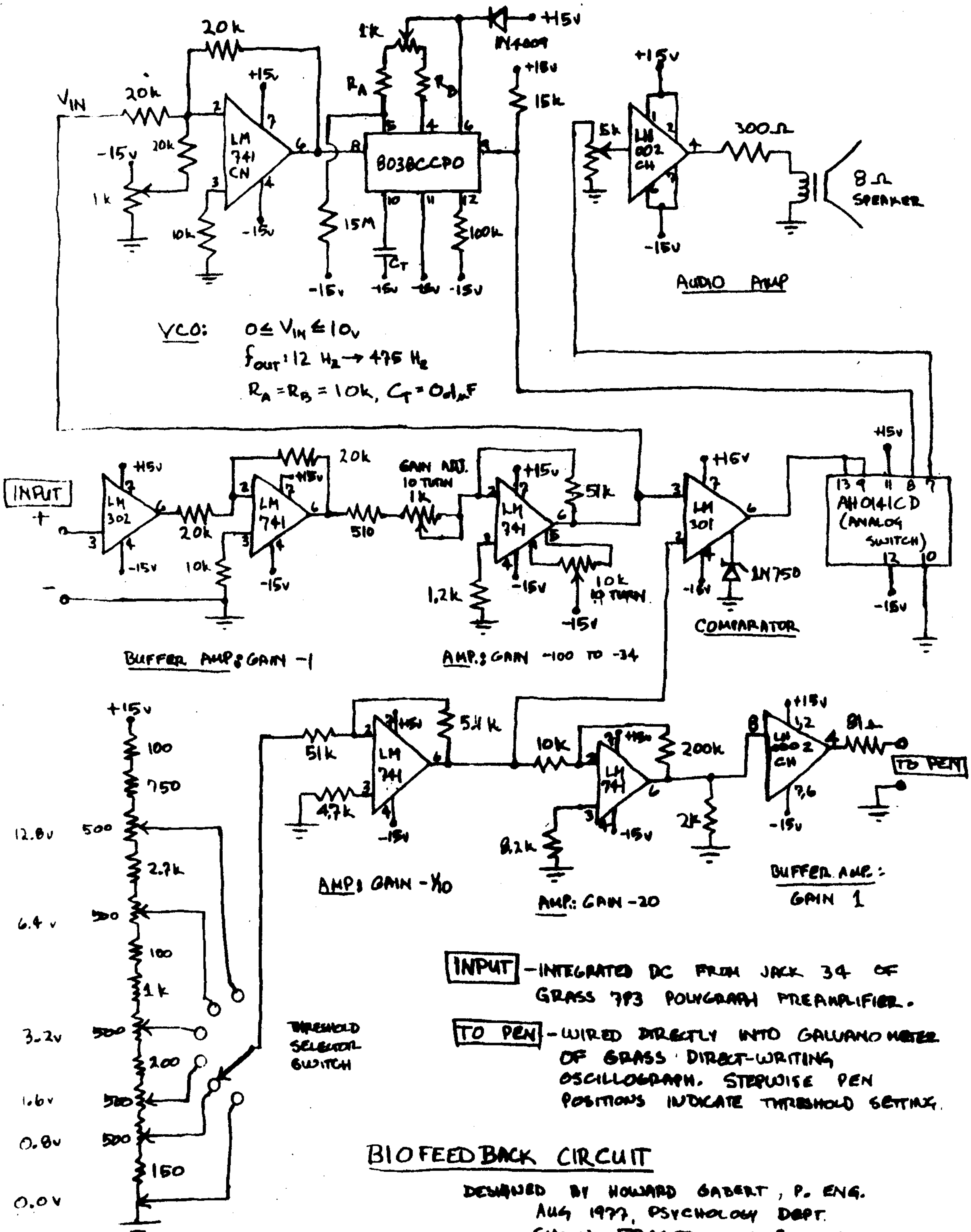
7. Do you have any other comments or criticisms?

ANSWERS TO FINAL INTERVIEW

	Combined Treatment Subjects			Verbal Treatment Subjects	
	CR	RR	TV	MC	MP
1. Improvements?	Replace "relaxation" with "calm" in tape. Biofeedback tone is grating.	Want to be able specify types of headaches on card. Fell asleep in lab at times.	Often tense in neck & jaw after biofeedback session.	Tape is a bit too long.	Pauses too long in tape.
2. Headache reduced?	Definitely.	A lot. I take less medication.	Reduced.	Reduced.	Less severe.
3. Most helpful for h'daches?	Being required to relax. Tape prevents mind wander.	Tape tells specifically how to relax; biofeedback confirms that relaxation is actually occurring.	Being required to relax 15 min/day.	Being required to relax.	
4. Most unhelpful for h'daches?	Biofeedback — preferred tape.	Polygraph machine noises.			
5. Other benefits?	Learned tangible relaxation technique.	Helps me get to sleep. Can use relaxation to prevent outbursts of anger.	More self confidence & control of my own feelings.	Being required to relax is good.	My chiropracter says my muscles are less tense.
6. Other detriments?	Takes up time.				
7. Comments?	Could hear polygraph pens.		Enjoyed it.		

Appendix VII

Biofeedback Circuit



INPUT – INTEGRATED DC FROM JACK 34 OF GRASS 7P3 POLYGRAPH PREAMPLIFIER.

TO PEN – WIRED DIRECTLY INTO GALVANOMETER OF GRASS DIRECT-WRITING OSCILLOGRAPH. STEPWISE PEN POSITIONS INDICATE THRESHOLD SETTING.

BIOFEEDBACK CIRCUIT

DESIGNED BY HOWARD GABERT, P. ENG.
AUG 1977, PSYCHOLOGY DEPT.
SIMON FRASER UNIVERSITY

Appendix VIII

Passive Relaxation Instructions

PASSIVE RELAXATION INSTRUCTIONS

These instruction were read at a slow, even pace. They took about 20 minutes. Triple hyphens indicate a long pause.

These instructions are meant to help you become relaxed. Please listen carefully and cooperate with these instructions as fully as you can.

- - -

As you practice relaxation you will find that you get better at it. You will be able to relax your muscles more and more completely.

- - -

Now settle back in the chair, keep your eyes closed, and let yourself become very, very comfortable. Keep your arms on the arms of the chair and your feet on the foot of the chair and slightly spread apart. Just let yourself become very, very comfortable.

- - -

If you feel any tension or tightness in your body, just let the tension or tightness fade and let yourself become very, very relaxed.

- - -

Now begin by concentrating on the feelings in your <u>fingers</u> and in your <u>hands</u>. Concentrate on these feelings, and as you concentrate, let any tension, tightness, or constricted feelings — let them gradually fade and let yourself feel the relaxation very gradually, very slowly taking over.

- - -

Let those muscles lose any tense or anxious feelings and let them become very, very relaxed, very calm, very quiet. Just let yourself go.

- - -

Keep your attention focused on those feelings and let those muscles become longer and smoother, free of tension and tightness. Just let yourself go.

- - -

Concentrate now on the muscles in your <u>forearms</u>. Put your attention on the muscles in your forearms, and when you concentrate let these muscles become very, very relaxed, very quiet, very calm, and let the tension and tightness fade. Just let it go.

- - -

Let those muscles go deeper and deeper into relaxation.

- - -

Focus all your attention on the feelings there. If you find your mind wandering, just bring it back and continue to concentrate on the muscles in your forearms and in your hands. Let those muscles become longer, calmer, smoother, and quieter.

Let them remain very, very still, very, tranquil. Just let yourself go. Let that feeling of relaxation just sweep over those muscles and replace any feelings of tension or tightness which remain.

- - -

Concentrate now on the feelings in your <u>upper arms</u> — your biceps and your triceps. Let those muscles lose their tense, tight feelings. Any tension or tightness that might be there, just let it fade. Let it very slowly and very gradually be replaced by a calm, loose, quiet, and tranquil feeling.

- - -

Let those muscles go. Just let them hang there very loosely, very limply. Let those muscles go; just let them hang there free of any tension or tightness. Just let your muscles hang there very loosely; very limply. Just let them go.

- - -

No tightness, no constriction, no pulling. Just completely, completely relaxed.

Completely relaxed.

- - -

Continue to concentrate on those muscles and keep your attention focused on these feelings. Again, if your mind wanders just bring it back and continue to think only about the feelings in your muscles. As you concentrate on these feelings let them become even more and more relaxed, quiet and calm.

- - -

And now concentrate on the muscles in your <u>shoulders</u> and let your shoulders also become very relaxed, very quiet, and very calm. Let yourself go. Let your whole body remain very still, very quiet, and very calm. Just let your shoulders sag — free of any pulling or constriction or contracting.

- - -

Let those muscles become longer and smoother; free of tension and tightness. Just let yourself go. Let your shoulders just hang there very, very heavily. Very heavy. Let them continue to get heavier and heavier and heavier.

- - -

Sometimes relaxation occurs in stages, and at other times it is a very gradual, smooth process. Just continue to focus on those feelings,and let the relaxation take over more and more of those muscles. When you're tense or tight those muscles are contracting and constricting; when you're relaxed they are very long, they're very smooth, they're very quiet and calm. Let that calm, quiet feeling take over your entire body. As your shoulders become more and more relaxed, also let your upper arms, your forearms, your hands, and your fingers become even more relaxed. Deeper and deeper into a state of relaxation.

- - -

Now concentrate on the muscles in your <u>back</u>, in the upper part of your back. Let those muscles also become very calm, very smooth, quiet and tranquil. Just let them become very, very relaxed — free of any tension or any tightness.

- - -

If you feel any tension or tightness at all, just let a feeling of relaxation replace it. Just let the tenseness and tightness fade very gradually from your body and be replaced by one of relaxation and calmness. Just let yourself go. Let it happen to you. Let the relaxation sweep over your body.

- - -

And now the muscles in the <u>back of your neck</u>. This is often a place where we express tension and anxiety — the muscles in the back of the neck. So pay particular attention to these muscles as they become very, very relaxed; very free of tension. Let those muscles become longer and smoother, quieter and calmer.

- - -

Focus your attention on the feelings in the muscles in the back of your neck. Concentrate. Continue to let them relax and lose that tense, tight feeling. Just let yourself go.

- - -

Let the muscles in the back of your neck become relaxed. And as they become relaxed let your entire body go deeper and deeper into relaxation. Let yourself go.

- - -

Now the muscles around your jaw. Just let your jaw open to a place that's very comfortable, very quiet and calm, so that you don't feel any pulling or contraction of muscles. There shouldn't be any tension there at all. Let that feeling of relaxation take over those muscles, and let them become very, very relaxed — free of tension and free of tightness. Just let yourself go.

- - -

Concentrate on the feelings in the muscles in your jaw. Just let your jaw find that place where it's very calm, very quiet -- so it feels like there's no tension and no tightness.

- - -

As your jaw becomes more and more relaxed, I want you to begin to concentrate on the muscles around your mouth. Let them become very tranquil, very smooth, very calm. Just let yourself go. Let yourself go.

- - -

And now the muscles around your cheeks and your eyes. Concentrate. Feel those muscles and let them continue to become more and more relaxed. Let those muscles become very, very calm, very smooth, very tranquil. Just let your cheeks and your whole face sag. Let them sag on your face — very, very heavy.

- - -

Oftentimes when you're very, very relaxed you get a feeling of heaviness or a feeling of warmth. Just continue to let your muscles sag very limply. That's a sign that you are losing your tension and tightness; that those muscles are becoming longer and smoother.

- - -

Let yourself go.

- - -

Now the muscles on your <u>forehead</u>. Let them also relax. Just let that feeling of relaxation sweep over those muscles and replace any tense or tight feeling which may be there. Concentrate on those muscles. Focus your attention. Remember, if your mind wanders or if you begin to think about anything else, just bring it back and just concentrate on the feelings in those muscles — the feeling in the muscles of your forehead.

- - -

As your forehead becomes more and more relaxed — as you become deeper and deeper in relaxation — let your entire face and neck go deeper and deeper and deeper into relaxation. Just let yourself go.

- - -

Let all those muscles become relaxed. If you feel any tension or any tightness, concentrate on that and let the feeling of relaxation take over. Focus on relaxing by letting your muscles lose their tense, tight constriction.

- - -

Now focus on the muscles in your stomach. Let those muscles also become very limp and very, very heavy, very calm, very peaceful. Let the feelings of relaxation replace any constricted or tight feelings you may have. If you feel any tension or tightness at all, concentrate on those feelings and let those muscles become more and more relaxed. Let them become more and more relaxed. Just let yourself go.

- - -

As your stomach becomes more relaxed, let your entire body just sink deeper and deeper and deeper into relaxation — your entire body.

- - -

Now concentrate on the muscles around your thighs — the top and bottom of your thighs. Just let the upper parts of your legs go very, very deeply into relaxation. Let those muscles become totally calm, totally quiet, and very, very relaxed — very calm, very quiet, and very relaxed. Just let yourself go. Let yourself go.

- - -

Concentrate on the muscles in the upper parts of your legs. If there's any residual tension or tightness or feelings of anxiety, let those feelings just fade away and be replaced by feelings of tranquility and peace and calmness.

- - -

When you're very, very relaxed, your muscles lose all their tension and tightness, and they become very much longer and smoother.

- - -

And now concentrate on the feelings in your shins and your calves and let those muscles also lose their tense, tight feelings. Let the feeling of relaxation replace any feelings of tension which may be there. Let your muscles become longer; very, very still, and very, very peaceful.

- - -

As your legs become more and more relaxed, let your entire body become more and more relaxed. Let yourself just sink into the chair and become very, very heavy; very, very limp; free of any tension or tightness. Let yourself go. Just let yourself go.

- - -

Continue to concentrate on the muscles around your calves and your shins and, as those muscles become more and more relaxed, let your feet become very, very limp; very loose; free from any tension or tightness which may be there.

- - -

Concentrate on those feelings. Keep your attention focused there. Again, if your mind wanders, just bring it back and continue focusing on those feelings. Let yourself become very, very relaxed; very quiet; very calm.

- - -

Let your feet, your legs, your stomach, the muscles in your face, your neck — just let all those muscles become very, very tranquil; very, very loose.

- - -

Let your breathing become very free and very even.

- - -

Let your whole body just sink into the chair very passively. Let your arms and your legs and your back and your head become very, very limp. Just let yourself go.

- - -

Let all those muscles become very, very limp — very tranquil. If you feel any tension or any tightness in any parts of your body, just let that tension and tightness fade and let it be replaced by one of very deep relaxation.

- - -

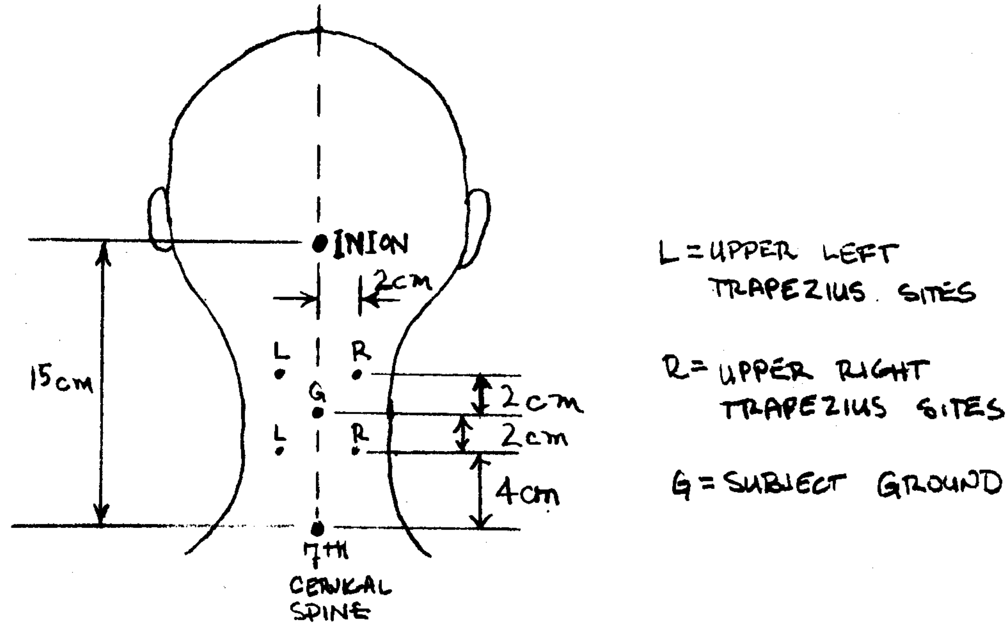
Just let all the parts of your body become very, very heavy; very quiet; and very calm. Just let yourself go.

- - -

Let your whole body become very, very heavy; free of any tension, any tightness. Just let yourself go. Let your whole body become very, very passive and very limp. Let yourself become very relaxed.

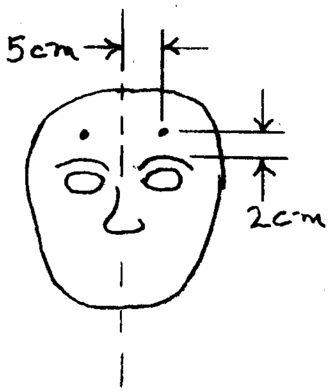
Appendix IX

Electrode Site Templates



BACK OF NECK ELECTRODE TEMPLATE

SUBJECT BENDS HEAD FORWARD OR BACK SO THAT DISTANCE BETWEEN 7TH CERVICAL SPINE AND INION IS 15 cm WHEN TEMPLATE IS LAID ALONG THE CURVE OF THE BACK OF THE NECK.



FRONTALIS ELECTRODE SITES

Appendix X

Biofeedback Instructions

BIOFEEDBACK INSTRUCTIONS

The electrodes I will put on the back of your neck and on your forehead "listen" to muscle activity. The signals that the electrodes on the back of your neck pick up are converted into a tone. The tone varies in pitch. A high-pitched tone indicates muscle tension, and a low tone indicates muscle relaxation.

During the training period today, try to relax all your neck muscles so that the tone is as low as possible, and then keep the tone low.

If the tone goes off, that's good. It means you've gotten your muscles very relaxed. If the tone doesn't go off, that's O.K., too. Just try to get the tone as low as possible by doing whatever you can to relax your neck muscles.

After the electrodes are put on, you will sit in the chair, and I'll turn on the biofeedback set-up. Then press your head back against the chair and then relax so that you get a feeling for how the pitch varies with the tension in your neck muscles.

After this, the training session will begin. First there will be a five minute rest period with no tone, then a five minute training period with the feedback tone coming from the left side of your neck, then a two minute silent rest period, then a five minute training period with feedback from the right side of your neck, then another two minute rest, then five minutes from your left side again, another rest, and, finally, five minutes from your right side again. Don't worry about these time periods. Just keep the tone as low as you can whenever the tone comes on.

Occasionally, people can hear a thumping sound in the tone which coincides with their heartbeat. If that happens, it's O.K. It's just some of the signal of your hearbeat getting through. Don't let it distract you. Just keep on relaxing and keeping the tone as low as possible.

Appendix XI

Instructions for Practicing Relaxation at Home

INSTRUCTIONS FOR PRACTICING RELAXATION AT HOME

Set aside a 15-minute daily relaxation practice time. Practice once and only once for 15 minutes each day, except that you should not practice at home on days when you come to the lab for a trainning session. After this study is over, you may practice relaxation at home as often as you want.

You should practice in a place which is free of loud noises and distractions. Low noises are all right. Just regard them as only passing vibrations, like small, occasional ripples on a quiet lake.

Loosen or remove any constricting items of clothing, such as a tight belt or tight shoes, before you sit down to relax.

Do your practice in a comfortable arm chair. A chair that reclines slightly is best. Rest your arms on the arms of the chair. If your chair has a foot rest, rest your feet there. Keep them about a foot apart. If your chair has no foot rest, settle your feet flat on the floor with about a foot between them.

Keep your eyes gently closed when you practice, but do not sleep. The state your are cultivating is one in which your mind is awake and clear, but your body is completely relaxed -- a state of deeply relaxed but awake clearness.

Settle down comfortably in your chair; take a few long, deep, gentle breaths; and begin your relaxation. Focus your attention on each area of your body in turn, and quietly tell yourself that those muscles are getting heavier, warmer, longer, etc. Use the techniques that will be shown to you in your training sessions in the lab. Focus on an area of your body and repeat your relaxation techniques until that area is noticeably relaxing. Then go on to the next area and relax it. Continue until your whole body is relaxing. Then tell yourself and feel that your whole body is sinking deeper and deeper into relaxation. Then go over each of your body areas again and relax them more. Pay particular attention to those areas which are most tense. Then go back to relaxing your whole body. Etc. Continue like this through all of your relaxation practice period.

There may be days in which you feel that you just don't have time to practice relaxation. But the days in which your relaxation practice will be most helpful to you are often those days when you feel most rushed. So sit down and practice anyway. Don't be misled by your emergency state of mind.

As you continue your daily practice you will find that your states of relaxation gradually get deeper and more and more complete. Even though this relaxation may appear simple and only slightly effective at first, in the long run it can become a very powerful technique.

Appendix XII

Tables of Scores and Measurements

TABLE A: MEAN HEADACHE INTENSITIES FROM DAILY RECORD REPORTS

Combined Treatment Subjects	Periods Adjustment	Pre-training	Early Training	Late Training	Post-training
CR (female)	0.5	0.2	0.6	0.4	0.5
RR (male)	1.4	1.8	1.4	1.1	1.2
TV (female)	1.5	1.0	2.1	0.2	0.6
Verbal Treatment Subjects					
MC (female)	1.2	1.1	1.8	0.5	0.2
MF (female)	1.9	2.1	2.4	1.6	2.3
Mean of means	1.3	1.2	1.7	0.8	1.0
Standard deviation	0.5	0.7	0.7	0.6	0.8

TABLE B: SESSION HEADACHES, STAI-STATE SCORES, AND EMG LEVELS

Combined Treatment Subjects	Individual Session Scores 1 Change	1 Post-	2 Change	2 Post-	3 Change	3 Post-	4 Change	4 Post-	5 Change	5 Post-	6 Change	6 Post-
CR (female)												
Session H'dache	...	...	...	...	-1.0	0.0	0.0	0.0	-0.5	0.0	+0.5	1.0
STAI-State	-29	25	+11	54	...	...	...	...	...	...	-17	39
Forehead EMG	-1.7	5.0	+1.0	10.9	-0.7	5.4	-0.8	6.6	+1.8	7.8	+1.8	5.8
Neck EMG	-6.0	3.0	+0.1	4.5	-2.5	3.8	+0.9	4.0	+0.7	3.3	-1.6	3.4
RR (male)												
Session H'dache	...	...	...	...	-0.5	0.0	0.0	0.0	-1.0	0.0	-1.0	0.0
STAI-State	-10	32	-4	30	...	...	...	...	...	...	-15	34
Forehead EMG	+0.6	5.2	+0.9	9.3	-7.6	3.6	-0.1	7.8	+1.5	5.8	-0.5	6.8
Neck EMG	+0.9	4.4	-0.1	3.2	-0.2	2.0	+1.5	3.0	+0.6	2.6	+0.2	2.1
TV (female)												
Session H'dache	+1.0	0.5	0.0	0.5	-0.5	1.0	0.0	0.0	0.0	0.0	-0.5	0.0
STAI-State	-12	27	-5	33	...	...	...	...	...	...	-7	28
Forehead EMG	-18.3	6.4	-3.5	7.2	-0.8	5.7	-2.5	7.2	+1.8	5.8	-1.6	4.1
Neck EMG	+7.6	11.6	+0.1	3.7	+1.1	3.3	-0.8	3.7	+2.1	3.8	-1.4	4.2
Verbal Treatment Subjects												
MC (female)												
Session H'dache	...	...	...	...	-1.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0
STAI-State	...	...	-4	27	...	...	...	...	...	...	-1	42
Forehead EMG	-20.9	7.4	-12.2	10.1	-23.6	8.7	-22.8	17.2	-11.9	12.4	-21.6	11.0
Neck EMG	-9.3	4.3	-7.6	3.5	-8.3	10.0	+0.5	11.6	-2.0	4.1	+12.0	24.3
MF (female)												
Session H'dache	...	...	...	...	+1.0	2.0	-0.5	1.5	+0.5	2.0	0.0	1.0
STAI-State	-5	39	+5	44	...	...	...	...	...	...	+1	35
Forehead EMG	+1.0	10.1	-5.0	11.7	+1.2	12.1	+1.0	14.6	-3.3	7.0	-13.0	7.1
Neck EMG	-0.3	16.4	+0.1	7.5	-2.3	12.8	+3.6	13.8	+1.9	10.1	+1.0	16.3
COMBINED TREATMENT MEANS												
Session H'dache	...	...	...	...	-0.7	0.3	0.0	0.0	-0.5	0.0	-0.3	0.3
STAI-State	-17	28	+1	39	...	...	...	...	...	...	-13	34
Forehead EMG	-6.5	5.5	-0.5	9.1	-3.0	4.9	-1.1	7.2	+1.7	6.5	-0.1	5.6
Neck EMG	+0.8	6.3	-0.0	3.8	-0.5	3.0	+0.5	3.6	+1.1	3.2	-0.9	3.2
VERBAL TREATMENT MEANS												
Session H'dache	...	...	...	...	-0.3	1.5	-0.3	0.8	+0.3	1.0	0.0	0.5
STAI-State	...	...	+1	36	...	...	...	...	...	...	0.0	39
Forehead EMG	-10.0	8.8	-8.6	10.9	-11.2	10.4	-10.9	15.9	-7.6	9.7	-17.3	9.1
Neck EMG	-4.8	10.4	-3.8	6.5	-5.3	11.4	+2.1	12.7	-0.1	7.1	+6.5	20.3
COMBINED & VERBAL MEAN OF MEANS												
Session H'dache	...	...	...	...	-0.5	0.9	-0.2	0.4	-0.1	0.5	-0.2	0.4
STAI-State	...	...	+1	38	...	...	...	...	...	...	-7	37
Forehead EMG	-8.3	7.2	-4.6	10.0	-7.1	7.7	-6.0	11.6	-3.0	8.1	-8.7	7.4
Neck EMG	-2.0	8.4	-1.9	5.2	-2.9	7.2	+1.3	8.2	+0.5	5.2	+2.8	11.8

Sessions 1,3,5 = biofeedback sessions for combined treatment subjects
Sessions 2,4,6 = verbal instruction sessions for combined treatment subjects
Change = post-session score minus pre-session score
Post- = post-session score
Session H'dache = headache report at beginning/end of laboratory session
STAI-State test is transient anxiety measure

TABLE C: I-E (LOCUS OF CONTROL) SCALE SCORES AND STAI-TRAIT INVENTROY SCORES

	Rotter's I-E Scale		STAI-Trait Inventory	
Subjects	Raw scores	Percentile	Raw scores	Percentile rank
CR	12	82	47	86
RR	11	77	39	57
TV	17	98	51	91
MC	14	92	42	73
MF	11	77	36	45
Mean	13		43	
Standard deviation.	2.6		6.0	

Ohio State students:
Mean 8.29
S D 3.97
(Rotter 1966)

College undergradustes:
Mean 38.25
S D 9.14
(Spielberger, Gorsuch, & Lushene 1970)

Appendix XIII

Beginning- and End-of-Session EMG Measurements

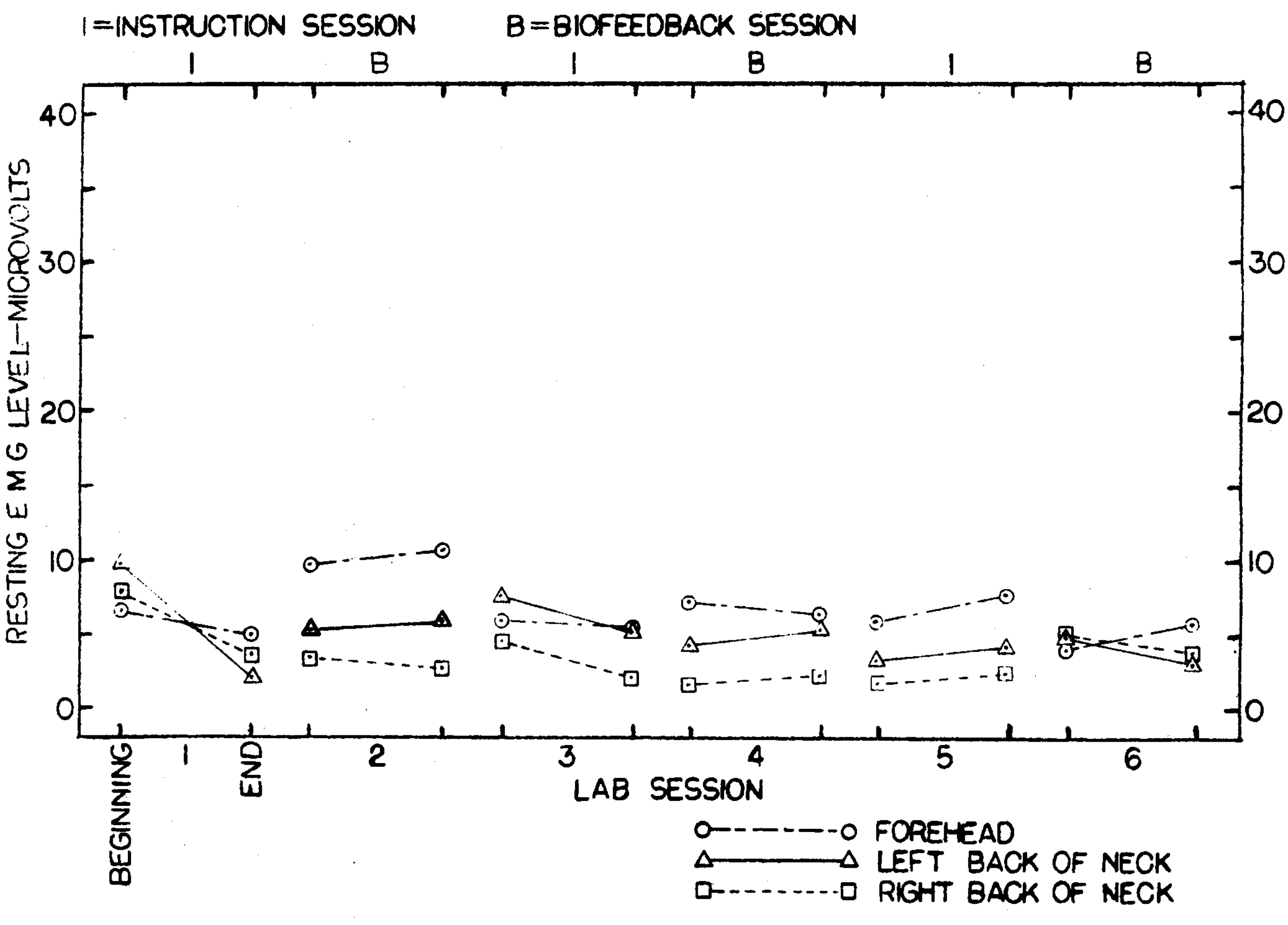


Figure 16. Resting EMG Levels for Subject CR.

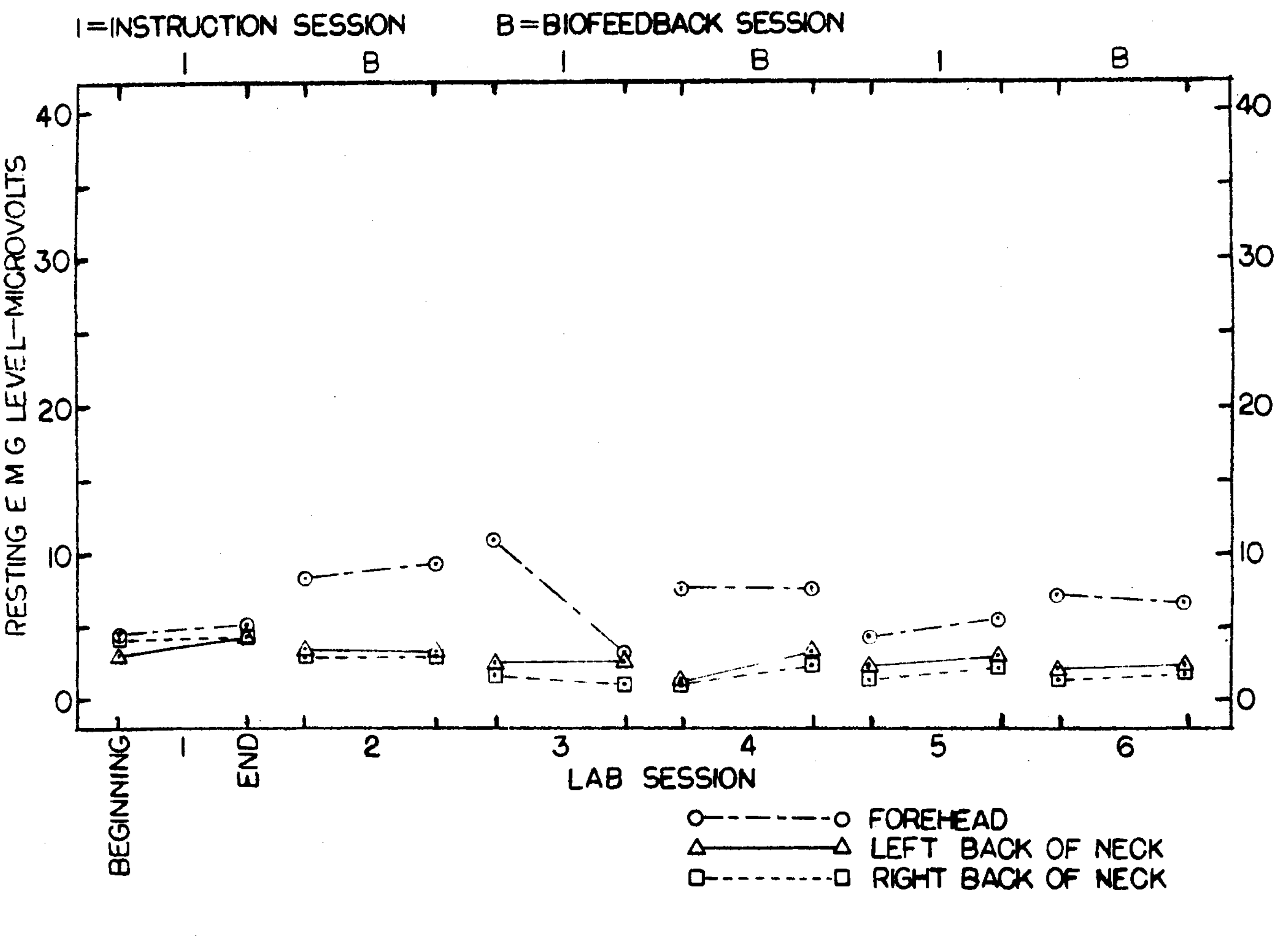


Figure 17. Resting EMG Levels for Subject RR.

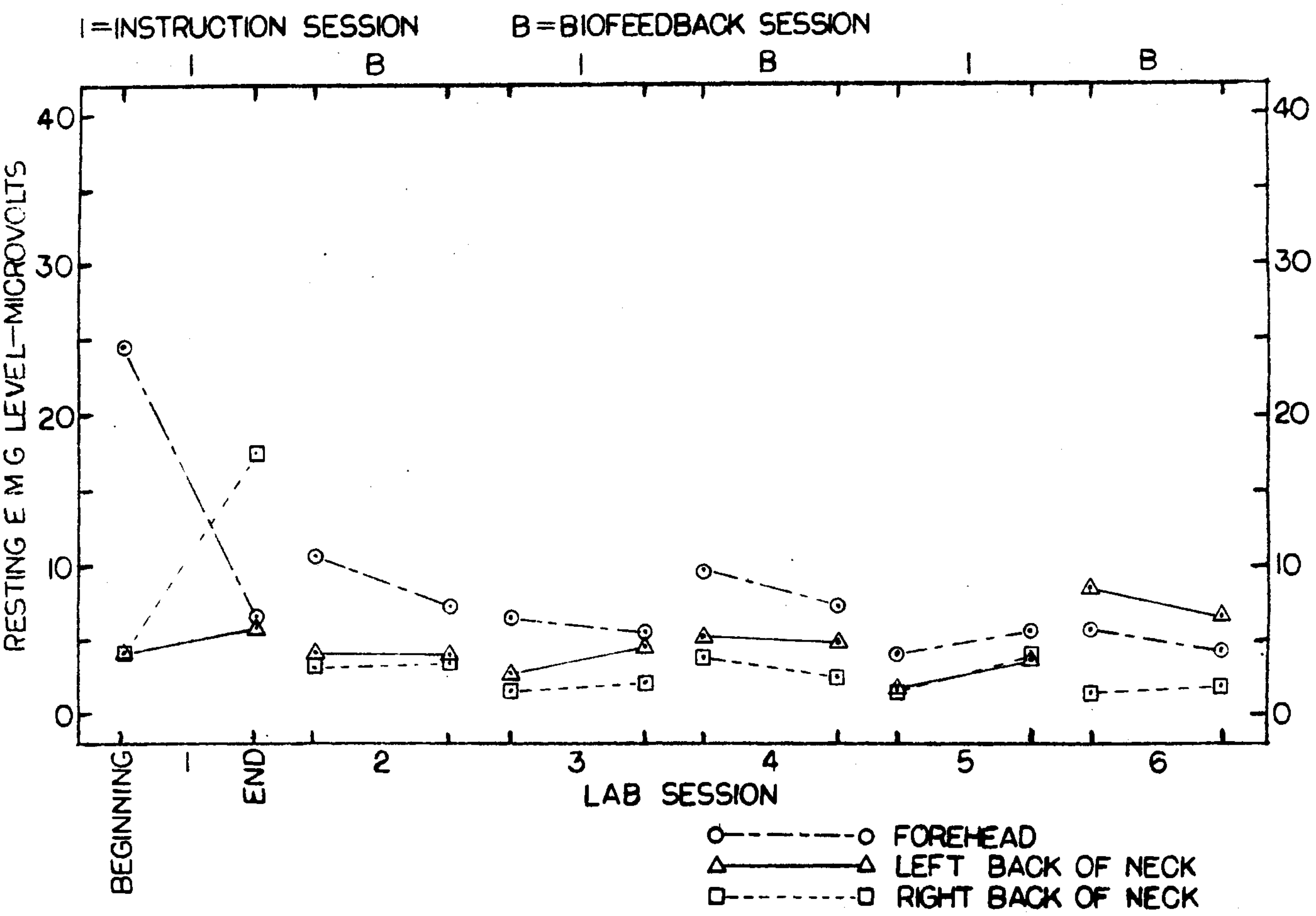


Figure 18. Resting EMG Levels for Subject TV.

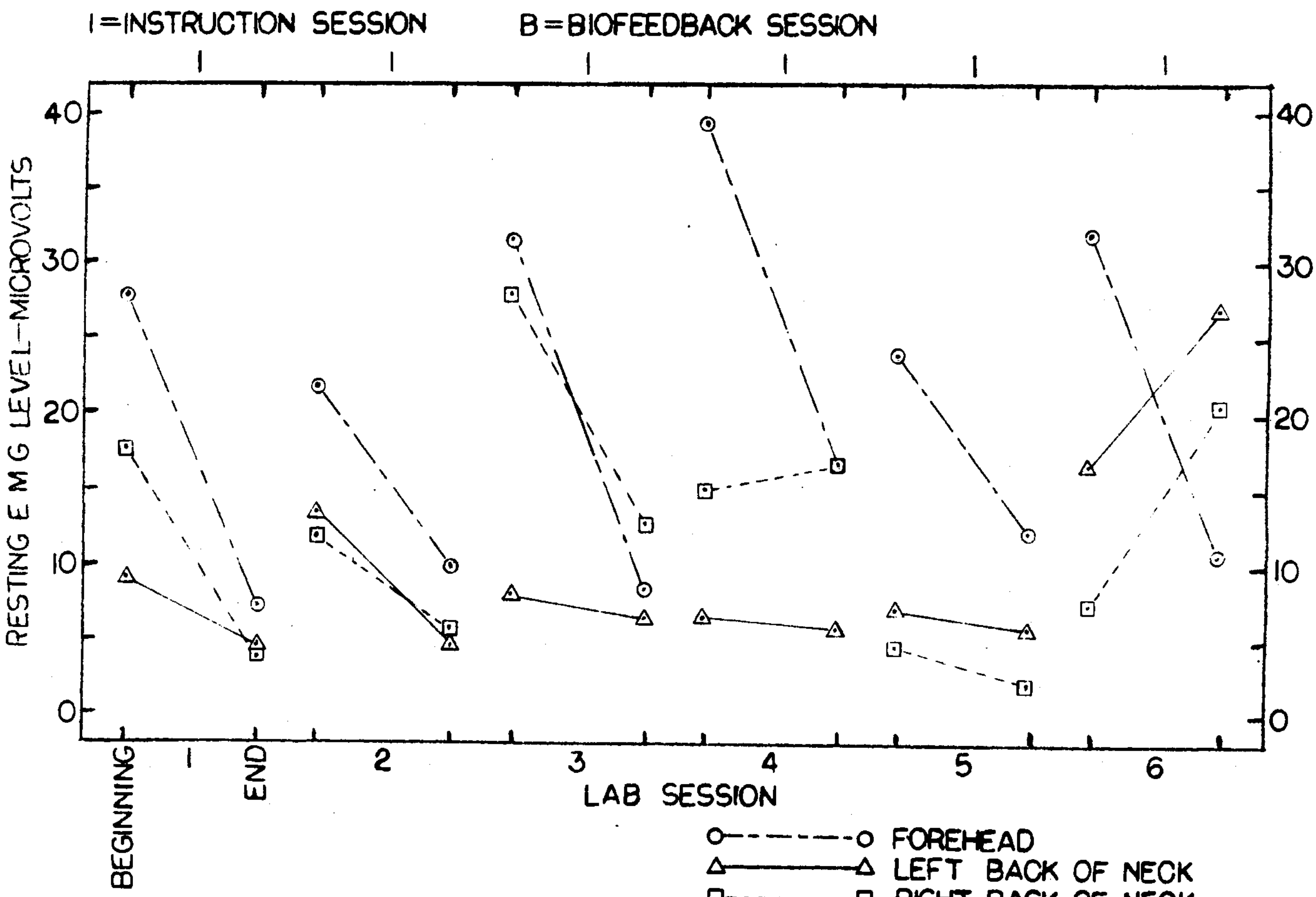


Figure 19. Resting EMG Levels for Subject MC.

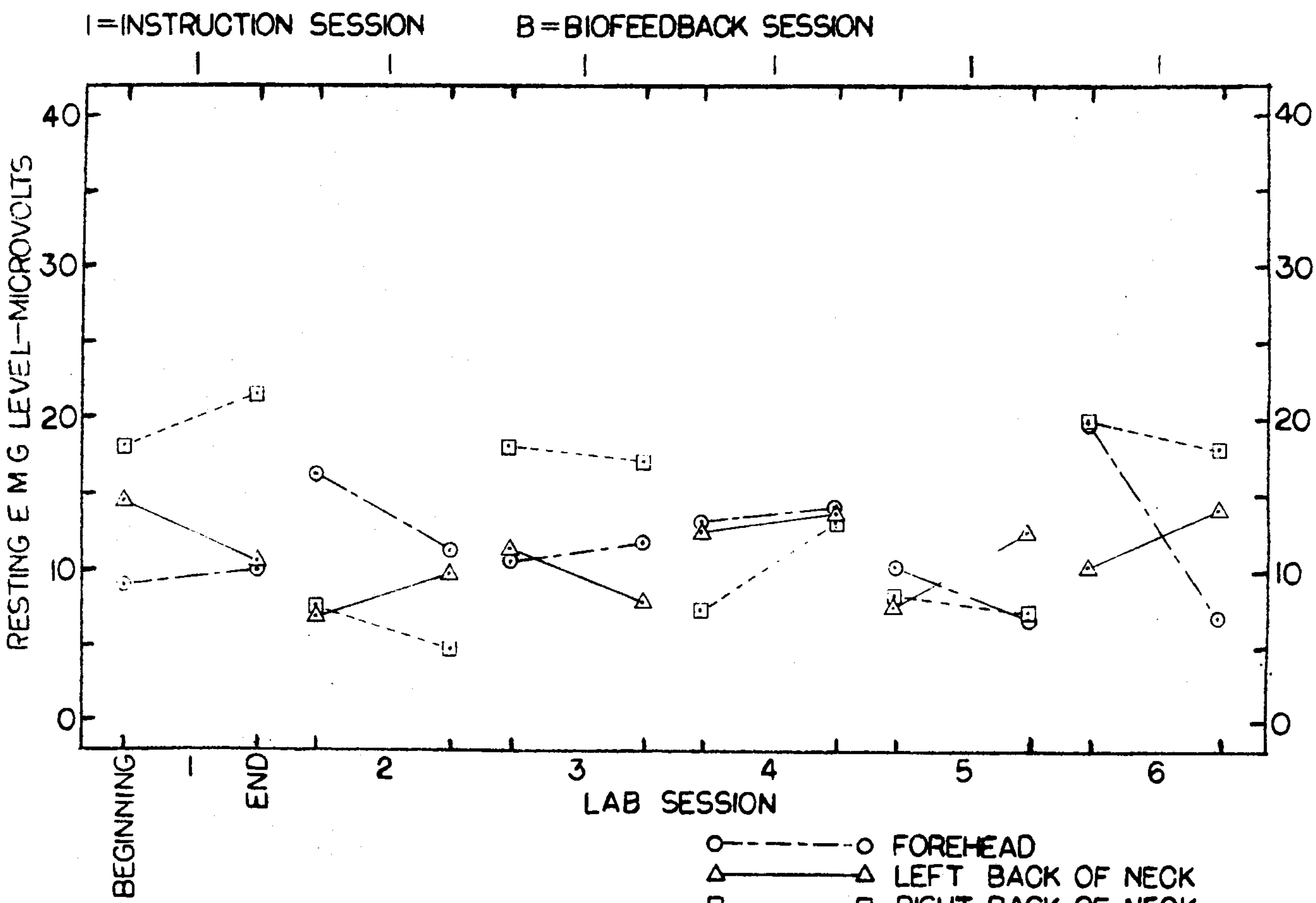


Figure 20. Resting EMG Levels for Subject MF.