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An Investigation of the Differential Effects of Three Relaxation Training Components Versus the Effects of a Combined Training Approach for Inducing Physiologic Low Arousal

Jeffrey D. Pingel  
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AN INVESTIGATION OF THE DIFFERENTIAL EFFECTS OF THREE
RELAXATION TRAINING COMPONENTS VERSUS THE EFFECTS OF A
COMBINED TRAINING APPROACH FOR INDUCING PHYSIOLOGIC LOW AROUSAL

by

Jeffrey D. Pingel

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
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Department of Psychology

Western Michigan University
Kalamazoo Michigan
August 1980

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ACKNOWLEDGEMENTS

I wish to acknowledge the patience and understanding of my wife, Patricia A. Reigle, and the professional support of the staff at the Center for Holistic Medicine.

Jeffrey D. Pingel
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WESTERN MICHIGAN UNIVERSITY, M.A., 1980

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INTRODUCTION

Electromyographic (EMG) feedback from the frontalis muscle (forehead) used as the primary therapeutic tool or in conjunction with relaxation instructions, has been shown to be effective in the treatment of clinical disorders such as muscle contraction headaches (Budzynski, Stoyva, & Adler, 1970; Budzynski, Stoyva, Adler, & Mullaney, 1973; Chesney & Shelton, 1977; Cox, Freundlic, & Meyer, 1975; Epstein & Able, 1977; Haynes, Griffen, & Mooney, 1975; Hutching & Reinking, 1976; Wickramasekera, 1973) and chronic anxiety (Canter, Kondo, & Knott, 1975; Raskin, Johnson, & Rondestvedt, 1973; Townsend, House, & Addario, 1975). Stoyva and Budzynski (1974) specify the frontalis muscle as involved in many anxiety and hyperarousal disorders. The results of their investigation and a more recent study (DeGood & Chisolm, 1977) suggest that tension reduction in this muscle through EMG feedback training, is useful for general bodily relaxation. Other researchers (Alexander, 1975; Alexander, White, & Wallace, 1977; McGowan, Haynes, & Wilson, 1979) have found that EMG feedback training at the frontalis site results in specific muscle control that does not transfer to untrained muscles or generalize to autonomic responses. To what extent this technique alone or in combination with other training components is effective in enhancing generalized relaxation is the central topic of this study.

This modality of biofeedback requires that surface skin electrodes are secured across a subject's forehead in prescribed locations. The muscle activity from the frontalis is amplified, filtered for artifact, and averaged over time. The resulting signal is an integrated value representing an analog of muscle tension which can be "fed back" to the person either visually or auditorily. That is, fluctuating muscle
tension can be represented by a panel of lights that go on and off accordingly, or with a rising and falling audio tone. This feedback loop informs the person of the physiologic response as it happens, a response typically not amenable to subjective awareness; with proper guidance and encouragement most people can learn to manipulate the response.

The widespread use of this modality was recently recognized by Stoyva (1979), who called EMG feedback "the clinical workhorse of the biofeedback area" (p. 92). As mentioned, frontalis (or frontal) EMG feedback has been effective in the alleviation of tension headaches and chronic anxiety, and with these disorders, the reduction of frontal tension serves as a primary intervention. EMG frontal feedback (henceforth referred to as EMG-FF) has been utilized as a secondary or complementary treatment tool with such disorders as essential hypertension (Patel, 1977), asthma (Davis, Saunders, & Creer; 1973) and insomnia (Coursey, Frankel, & Gaarder, 1976; Freedman & Papsdorf; 1976), among other disorders thought to be related to increased muscle tension. Stoyva and Budzynski (1974) have postulated that the use of this method of biofeedback assists the patient in learning "cultivated low arousal." This term refers to a lessening of the patient's sympathetic responding to environmental, interpersonal, or self-generated stimuli; in other words, they suggest a systemic change in physiologic responding to stressors. In popular terms one could accordingly refer to an "anti-stress response." That such a bodily response exists has been hypothesized by the neurophysiologist Gellhorn (1969), who terms this condition as the trophotrophic response and relates it to electrical stimulation of certain areas of the hypothalamus. Muscular relaxation and parasympathetic responding characterize the trophotropic condition.
Malmo (1975) also argues that physiologic hyperarousal characterizes many stress-related disorders, and the overactivation of the musculature has a central role. In the case of chronic anxiety, Malmo found patients had an inability to return to baseline levels of muscle tension after the presentation of a stressor. It is a fact that our muscles are sensitive to the body's emergency preparations for flight-or-fight. The activation of the sympathetic nervous system is related to elevated muscle tension, and it has been hypothesized that stress-linked disorders arise when these survival responses are constantly activated, even when one's life is not threatened (Selye, 1976, 1979; Stoyva, 1977). For example, uncomfortable social and interpersonal situations act as stressors that can elicit maladaptive responding (Brown, 1977; Pelletier, 1977; Stoyva, 1976). Malmo asserts that physiological mechanisms that evolved for short term emergency situations are presently activated for long term social striving. One result is that our muscle tonus can adapt to a "set point" that is too tense or maladaptive for our daily lives. Teaching relaxation serves an important purpose in assisting the body's homeostasis, by restoring the dynamic balance between sympathetic and parasympathetic responding.

Contrary to the popular notions about biofeedback, clinical application does not involve "strapping on the electrodes and letting the machines do the work." Both the novice therapist and the patient soon discover that although the instrumentaton provides a revealing "peek inside the skin," the success of therapy depends on slower process of reeducation about how our emotions and cognitions affect our physiologic responses and vice-versa. To restate this idea, general bodily relaxation is not accomplished by simply "doing biofeedback," but is an integrated process of understanding how sensations, thoughts, and feelings correlate with
certain physiologic responses. Many biofeedback experiments focus on
the technique itself and exclude other important variables necessary for
successful training. An integrated approach has been offered by Meichenbaum
(1976) who suggests three phases are included in the successful biofeedback
training regimen that has as its goal the teaching of general bodily
relaxation. Summarized, the phases of biofeedback training he offers are
as follows:

1) Conceptualization Phase: The therapist provides a
rationale to the patient for the use of biofeedback,
introduces ideas about stress and relaxation, and
discusses expectations.

2) Skills Acquisition Phase: During this stage of
treatment the patient learns to control specific
physiologic processes through biofeedback training.
The patient is shown ways of maintaining these newly
learned skills into their daily lives.

3) Transfer Phase: In this phase the patient is taught
how, when, and where to employ their relaxation
response outside of the clinic.

It can be claimed that much of the research in clinical biofeedback
has focused on the second and third phases of training, as delineated by
Meichenbaum. The paucity of research is noteworthy with respect to the
conceptualization phase of training. Superficial conceptualization phases
are characteristic of many biofeedback studies on relaxation. For example,
many subjects are only instructed to "lower the tone" which represents
"relaxation." Such an approach to biofeedback training is not characteristic
of the clinical situation where various relaxation strategies are implemented
and the rationale of their use are typically explained to the client
(Fair, 1979; Gaarder & Montgomery, 1977; Stoyva, 1979). It is proposed
here that the conceptualization or rationale is a necessary variable in
determining the success or failure in the skill-acquisition and follow-up
phases of training. In the present study the effects of providing conceptualization for enhancing relaxation was investigated.

A further word is appropriate concerning conceptualization. Meichenbaum (1976a) maintains that we commonly engage in "internal dialogue" or "self-statements," the content of which plays a significant role in mediating behavior, especially when learning a new skill. Accordingly, it can be assumed the client in biofeedback therapy creates their own conceptualization of the feedback process, although their internal dialogue may not be appropriate. Indeed, as Meichenbaum (1976b) has stated, "the cognitions that accompany the client's physiological responses, whether they are deliberately enunciated or not, are very much a part of the maladaptive behaviors" (p. 205). That a person's cognitions affect their physiological responding has been demonstrated in an experimental setting. Sternbach (1964) has shown that the instructional sets and expectancies created by the experimenter can differentially affect the subject's physiologic responses even autonomic responses, to a neutral or inert substance. The conclusion arrived at by this experimenter was, that what a subject is told will occur physiologically, say, by ingesting a placebo, can influence their bodily responses in the expected manner. More pertinent to the proposed study, Zappala (1970) showed that students who had better knowledge about muscles and electromyography were able to better control the firing of single motor units.

Another training component typically integrated into the practice of clinical biofeedback is verbal relaxation instructions. The following section will review different approaches to verbal relaxation instruction and studies indicating their enhancing effect for biofeedback-assisted relaxation.
Prior to the development of biofeedback therapy, the most recognized therapeutic systems promoting the clinical benefits of general bodily relaxation were nontechnical and involved verbal instruction: progressive relaxation (Jacobson, 1938, 1942) and autogenic therapy (Schultz and Luthe, 1959, 1969). That neither of these systems achieved widespread acceptance by professionals, even though their efficacy in the treatment of stress-linked disorders seems well documented by the founders, may be accounted for by the intense dedication required by its practitioners and their dependence on the subjective report of the patient. In other words, these techniques need to be constantly practiced, at least initially, and there is no objective account for the reliability of the patient's report that they are relaxed; the demand characteristics of the clinical situation may cause the "relaxation." However, the psychosomatic approach to illness and psychological disturbance, including the terminology and many of the specific relaxation instructions, has been adapted and integrated into the practice of biofeedback therapy (Fair, 1979; Fuller, 1977; Gaarner & Montgomery, 1977; Stoyva, 1979). These verbal techniques are useful for enhancing relaxation and can be neatly interfaced with the "objectivity" of the biofeedback instrumentation. Most biofeedback therapists understand the importance of teaching a "mental exercise" that serves as an adjunct to the physiologic training acquired in the clinic; these verbal relaxation systems, if modified somewhat, seem to be effective devices. Pelletier and Shealy (1979) have written, "none of the clinical biofeedback training devices is adequate alone. And none of them supply the essential missing ingredient--an adequate mental exercise program" (p. 3).

Studies conducted by Reinking and Kohl (1975), Hutchings and Reinking (1976), and Reinking (1976) compared the effects of relaxation instructions
combined with EMG-FF to relaxation instructions and EMG-FF utilized separately. Reinking and Kohl compared four relaxation techniques using a nonclinical population. They found the three groups that had EMG-FF as part of their training to be superior in reducing frontal tension as compared to the fourth experimental group who received "classic Jacobson-Wolpe instructions" and a control group given no instructions and no EMG-FF. Although subjects in the EMG-FF plus relaxation training group demonstrated consistently lower mean values of muscle tension in the second half of training, when compared to subjects in the EMG-FF plus monetary reward (for lower tension levels) and the EMG-FF-only group, no significant differences were found between EMG-FF groups. The authors concluded that EMG-FF training alone was the important variable in reducing frontal tension. This study supports the results of Stoyva and Budzynski (1974) who found EMG-FF to be the crucial variable in reducing frontal tension, even when compared to a group of subjects offered monetary rewards for the same goal. Reinking and Kohl also noted a "floor effect"; that is, subjects in the combined instructions-feedback group learned to maintain extremely low levels of frontal tension (1.5uV or below) for the final four sessions. Owing this effect to the law of initial values the authors suggested that future studies choose subjects who were more tense, as measured from the frontalis, during baseline recordings.

Hutchings and Reinking (1976) conducted a similar experiment with a clinical population. In this study, 19 patients with medically documented tension headaches were randomly assigned to one of the following treatment groups: 1) Jacobson-Wolpe autogenic relaxation training; 2) EMG-FF relaxation training; 3) EMG-FF relaxation training combined with Jacobson-Wolpe autogenic relaxation training. After ten training sessions the
two EMG-FF groups were found to be statistically superior to the verbal instructions group in reducing headache frequency, intensity, and duration, and in decreasing mean frontal tension. In addition, this study again found no significant difference between the two EMG-FF groups and there was apparently no support indicating that the combined EMG-FF plus relaxation instruction was a more efficient treatment method. That is, it appeared that a "mental exercise" or cognitive strategy did not enhance the learning of a relaxation response. However, Reinking (1976) reported in a similar study with thirty patients suffering with tension headaches the following results:

At the end of treatment all but one subject reported some remedial effect with EMG biofeedback, with the feedback plus instruction group being of superior effectiveness. (p. 350)

This report goes on to state that at a follow-up date, treatment effectiveness was dependent on home relaxation practice, regardless of training. The mixed results reported by Reinking and his associates concerning the effectiveness of the EMG-FF plus relaxation instructions approach warrants further investigation.

In two recently published abstracts (Edwards & Murphy, 1979; McSwain & Murphy, 1979) the results indicated that subjects receiving either EMG feedback or relaxation instructions significantly reduced muscle tension, but those subjects who received a combined training package of instructions and EMG feedback produced a more progressive decrease in muscle tension. Double-blind methodology was utilized by Edwards and Murphy to investigate the effects of relaxation instructions on EMG feedback (in this study the feedback consisted of averaged EMG activity of the frontalis and forearm extensor muscles). The study separated subjects into low and high muscle tension groups. Subjects were presented with either EMG
feedback-only or EMG feedback combined with instructions. The dependent measure was the average activity of the frontalis and forearm muscles. The results showed that subjects using the combined approach rapidly decreased their EMG levels and these low tension levels were maintained through the remainder of the study. On the other hand, those subjects receiving EMG feedback-only did not reduce muscle tension as quickly nor were the low levels of tension maintained. The authors concluded:

Previous studies on this area have not found significant differences between EMG-only and combined EMG-relaxation treatments. Results of this study do differentiate between these two conditions. (p. 276)

In a similar double-blind study, McSwain and Murphy divided subjects into three training groups: 1) EMG feedback plus relaxation instructions; 2) EMG feedback-only; 3) relaxation instructions plus a false decreasing tone. This last experimental manipulation sought to control for the placebo influence of listening to a biofeedback audio tone. EMG feedback (and the dependent measures) were based on the average activity of the frontalis and forearm flexor muscles. After the training period subjects in the two groups receiving real EMG feedback showed significant changes across sessions. However, relaxation instructions enhanced the learning process. The researchers summarized:

True feedback with relaxation produced much more orderly and consistent reduction across sessions than the true feedback without relaxation. In conclusion, physiological learning is a necessary but insufficient condition for consistently decreasing EMG levels during biofeedback training. (p. 283)

If relaxation instructions or certain cognitive strategies related to tension reduction are necessary to successful biofeedback training, as the above studies seem to suggest, then the lack of instructions may explain the failure of using only EMG-FF to induce a psychophysiological
state of low-arousal. Most notably, Alexander (Alexander, 1975; Alexander, White, & Wallace, 1977) has conducted studies indicating that EMG-FF has a very specific training effect such that there is no generalization, either to other untrained muscle sites or to autonomic responses like heart rate, respiration, and galvanic skin response. Furthermore Alexander, White, and Wallace found that subjects motivated to relax as best they could on their own were able to induce similar tension levels as subjects receiving three sessions of EMG-FF. The data from both these studies provide a major refutation to the hypothesis that EMG-FF as the sole training tool is sufficient for general bodily relaxation. Rather it is suggested by these studies that a specific control is indicative of EMG-FF; that is, control of muscles in the facial area. These findings seem consistent with a study by Freedman and Glaro (1979) who found a gradient of covariation between a relaxed frontalis muscle and other related muscles. Muscles of closer proximity to the frontalis were more likely to exhibit decreased activity, whereas more distant muscles had a tendency to "dissociate." These authors also concluded from their study that EMG-FF was useful for specific training of facial musculature.

The data on the effects of EMG-FF on cardiovascular measures are also inconclusive. In a design utilizing EMG-FF for one session McGowan, Haynes, and Wilson (1979) found no significant relationship between reduced frontalis EMG activity and heart rate, surface skin temperature, or blood-volume pulse. On the other hand, DeGood and Chisolm (1977) found indications of generalization in measures of heart rate and respiration rate after four training sessions of EMG-FF.

Many of the initial analogue studies on EMG-FF were useful for inducing relaxation (if only for the trained muscle) and compared favorably
with verbal relaxation techniques (Coursey, 1975; Haynes, Moseley, & McGowan, 1975; Reinking & Kohl, 1975). To what extent and how this tool is improved upon by the inclusion of relaxation instructions and conceptualization in the topic matter of this study. As Onoda (1979) has stated clearly:

It remains to be determined if these relaxation approaches, coupled with biofeedback training, enhance, inhibit or have no affect on biofeedback training. Also, there are no definitive data on whether or not relaxation approaches used as a complimentary technique to the training facilitates the generalization of the learned response. Until researchers empirically clarify these issues, clinicians have indicated that these techniques coupled with biofeedback training are helpful. (p. 17)

Because Silver and Blanchard (1978), have questioned whether EMG-FF itself is a more effective tool for inducing relaxation, when compared to other verbal approaches, the first objective of this study will be to assess the differential effects of conceptualization, relaxation instructions, and EMG-FF. The next objective will be to ascertain if any one relaxation training component or a combination of all three components can produce a generalized relaxation response. Studies have been cited that support a combined training package for producing generalization, whereas EMG feedback-only seems to produce a specific effect. However no studies have directly addressed what the contribution of each training component is or whether such generalization (to untrained muscle sites or autonomic responses) is likely.
METHODS

Subject Selection

The subjects were four male and two female volunteers, ranging in age from 18 to 24 years. Subjects were obtained through a notice placed on a bulletin board in the Psychology Department. Each subject was individually interviewed by the experimenter and completed a checklist of any current medical ailments and psychosomatic symptoms. Subjects were pretested for resting frontalis EMG levels using portable biomedical instrumentation. Subjects who did not have a current medical condition or experience psychosomatic symptoms, and demonstrated relatively high frontal muscle tension, were selected for the study.

Subjects were asked to wear loose clothing and not to drink alcohol or coffee six hours prior to any session in order to facilitate accurate physiological recording. Because some of the subjects were acquaintances, they were requested not to communicate with one another concerning their instructions during the sessions.

Setting

The experiment was conducted at the Center for Holistic Medicine, an outpatient facility of Borgess Medical Center. The Center for Holistic Medicine is located in a furnished house accommodating several offices and therapy rooms. A casual and warm atmosphere was provided to subjects at this location. Data collection occurred in the evenings during the week and all day on the weekends and did not interfere with the clinic's daily activities.
The experimental room, approximately 15 feet x 9 feet, contained a large recliner chair, a floor lamp, a coffee table holding several preamplifiers behind closed cabinet doors, and resembled a small den. The room was relatively free of outside noise and room temperature remained constant. The lead wires for the physiological recording and headphones came out of the back of the coffee table and extended to the chair. All other biomedical equipment was located in the adjoining instrument room and was not in sight from the experimental room. The experimental room had three doorways. One doorway was utilized for subjects entering and exiting. A second doorway, which lead to an adjacent therapy room was closed and unused during the experiment. A third doorway opened to the instrument room where the experimenter remained during recording; this door had a one-way mirror for observing subjects during the data recording periods.

Procedure

This analogue study involved the use of a single-case, multiple baseline design and utilized two experimental phases. A similar design, known as a singlet-composite strategy was first proposed by Kendall and Finch (1977). Six subjects were randomly assigned to one of the three procedures and each training procedure included two subjects or dyad. After the Baseline phase, subjects entered Phase I of the training. During Phase I, subjects in Dyad #1 listened to a taped discussion, the conceptualization variable; subjects in Dyad #2 received instruction and practice in the use of a mental device for inducing relaxation; subjects in Dyad #3 were presented with instruction and practice in the use of EMG-FF. In Phase II, Dyads #1, #2, and #3 were presented with instruction
in the remaining training components; thus all subjects in Phase II were exposed to the total relaxation training package. Each subject within a dyad was exposed to training components in the same order, but one subject participated in an extended baseline phase.

Three phases of measurement were used to assess the contribution of each training component versus the effects of the total training package. A schematic view of the multiple baseline procedure for each dyad is shown in Figure 1.

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Recording Blocks (5 minutes)

Figure 1. A schematic representation of the multiple baseline procedure used in this study; for one dyad.

During the Baseline phase of the study, it was the experimenter's discretion to continue measurement on the frontalis EMG activity in order to establish stability or a trend. It was decided prior to data collection that obtaining stability or a trend on all the dependent measures would be too time consuming. Frontalis EMG activity was the sole dependent measure observed in order to decide whether to place the subject in Phase I.

Each subject was interviewed individually to review the experimental procedures and scheduling demands of the study. Subjects were provided an opportunity to ask questions about the procedure, although they were not
informed in detail as to the content of the independent variables. Subjects were informed that the purpose of the study was to assess the effects of different relaxation training techniques, in addition to testing their own natural abilities to relax. Their cooperation and motivation in relaxing completely in all phases of the study was requested. All subjects "toured" the experimental setting and participated in an adaptational session. During this session the dependent physiologic responses were monitored but the data was not entered for analysis. The purpose of this session was to introduce subjects to the setting, instrumentation, and procedures to be used in the physiological recording.

After the adaptation session, subjects began the first session in the Baseline phase. Subjects entered the experimental room and reclined in a semi-supine position. EMG electrode sites were vigorously scrubbed with alcohol "prep" pads and acetone to assure low impedance levels. All physiologic sensors were secured to the skin using adhesive collars or surgical tape. A set of headphones were fitted over the subject's ears and a small microphone clipped to their shirt so that two-way communication was possible. Each subject was asked to relax to the best of their ability and data collection for the baseline session began. Fifteen 100-second trials constituted a Baseline recording session; every three trials equalled one block; five blocks per Baseline session. Ten blocks of data for each subject were recorded before a decision was made to proceed to Phase I of the study. As previously stated, variability in the frontalis EMG data necessitated a longer Baseline phase. One subject within each dyad had a longer baseline phase by design. Five additional blocks of data were required for one subject within each dyad to constitute a multiple baseline.
After the Baseline phase, the remaining sessions of the study were divided between the two experimental phases. Phase I involved the presentation of one relaxation training component, a different one for each dyad, and Phase II included the presentation of all three components; that is, for Phase II each dyad was presented with the two remaining components. Procedures prior to data collection for these sessions were similar to the Baseline session. In both Phases I and II, each session began with verbal instructions to the subject to relax to the best of their ability; this instruction was followed by one block of pre-baseline recording. The instructions prior to each Baseline session and each pre-baseline recording period in Phases I or II were as follows: "Given your present understanding and ability to relax, allow yourself to relax deeply without going to sleep for the next five (or thirty for Baseline sessions) minutes." Each experimental session concluded with a two block post-baseline period. Each subject was again asked to allow themselves to relax fully, utilizing the technique or information learned from the training period. After each session, in all sessions of the study, a Relaxation Training Sheet (Fee & Girdano, 1978) was administered to and completed by each subject to assess the degree of subjective relaxation (see Appendix A). Assessment of subjective relaxation was not included in the discussion of results.

The training procedures in Phase I and II will be described next.

During Phase I, subjects in Dyad #1 were presented with the conceptualization variable. This variable was a tape recorded discussion, the content of which focused on the psychophysiological differences between relaxation and distress (see Appendix B). To insure that both subjects had a basic understanding of the ideas presented in the monologue, a short
questionnaire was administered (see Appendix C). Successful completion of the questionnaire allowed each subject to participate in the post-baseline segment of the session. Successful completion of the questionnaire was defined as a score of nine answers correct or better. If a subject was unable to successfully complete the questionnaire, they were asked to listen again to the tape recorded discussion. Repeating the training component was referred to as recycling. Figure 2 illustrates the procedure for Dyad #1 in Phase I.

Pre-baseline .................. 5.0 minutes/1 block
Taped Discussion ............. 12.5 minutes/2.5 blocks
Questionnaire .................. 5.0 minutes/1 block
Recycle ?
Post-baseline .................. 10.0 minutes/2 blocks

Figure 2. Time sequences for Dyad #1 in Phase I

The following statement was read to each subject and signaled the beginning of the post-baseline period, for all sessions in Phases I and II: "Given your present understanding and ability to relax, and applying what you have learned from these sessions, allow yourself to relax deeply without going to sleep for the next ten minutes."

Subjects in Dyad #2 listened to tape-recorded instructions on the use of a mental device for inducing physiologic changes associated with relaxation (see Appendix D). The technique was developed by Benson (1975) and his colleagues (Beary, Benson, & Klemchuk, 1974). Each subject was asked to practice the technique for ten minutes. Each subject was also requested to gently "tap" or extend their right foot for every exhalation, so that it could be assumed the technique was being practiced.

Recycling occurred if the subject stopped repetition of the foot tapping. At that time the experimenter established communication and
reminded the subject to utilize the counting technique. The counting procedure provided assurance that each subject participated in this technique in a similar manner. Figure 3 shows the procedure that was followed.

Pre-baseline .................. 5.0 minutes/1 block
Introduction to Mental Device .... 5.0 minutes/1 block
Monitored Practice ............. 10.0 minutes/2 blocks
Recycle ?
Post-baseline .................. 10.0 minutes/2 blocks

Figure 3. Time Sequences for Dyad #2 in Phase I

Dyad #3 received biofeedback training from the frontalis in Phase I after brief taped instructions were presented. The content of the taped instructions were brief and adapted from Fee and Girdano (1978). See Appendix E for the content of these instructions. A practice period followed during which subjects listened to an analog feedback tone representing frontalis muscle tension. The procedures utilized for this dyad are shown in Figure 4.

Pre-baseline .................. 5.0 minutes/1 block
Introduction to EMG-FF .......... 2.5 minutes/.5 block
Monitored Practice ............. 10.0 minutes/2 blocks
Post-baseline .................. 10.0 minutes/2 blocks

Figure 4. Time Sequences for Dyad #3 in Phase I

In Phase II, subjects were introduced to the remaining two relaxation training components. In Phase I, subjects were presented with one of the independent variables and in Phase II they were presented with an integration of all three independent variables. Dyad #1 was informed as to how the use of a mental device and EMG-FF would assist them in relaxing, as discussed in the conceptualization discussion. Practice time with both components was also provided (see Figure 5).
Pre-baseline ............................................ 5.0 minutes/1 block
Introduction to Mental Device ............. 2.5 minutes/0.5 block
Monitored Practice ................................. 7.5 minutes/1.5 block
Introduction EMG-FF ............................... 2.5 minutes/0.5 block
Practice .................................................. 7.5 minutes/1.5 block
Post-baseline ........................................... 10.0 minutes/2 blocks

Figure 5. Time Sequences for Dyad #1 in Phase II

Dyad #2 listened to a shortened taped discussion on conceptualization (see Appendix F) and was administered the same questionnaire used by Dyad #1 in Phase I. Also, this dyad was introduced to EMG-FF and allowed to practice with the audio tone (see Figure 6).

Pre-baseline ........................................... 5.0 minutes/1 block
Taped discussion .................................. 10.0 minutes/2 blocks
Questionnaire ....................................... 2.5 minutes/0.5 block
Recycle ?
Introduction to EMG-FF ............. 2.5 minutes/0.5 block
Practice .................................................. 7.5 minutes/1.5 block
Post-baseline ........................................... 10.0 minutes/2 blocks

Figure 6. Time sequences for Dyad #2 in Phase II

Dyad #3 was introduced to the conceptualization variable and then to the mental device variable. Participants in this dyad were required to take the questionnaire and also had monitored practice using the verbal relaxation technique, as illustrated in Figure 7.

Pre-baseline ........................................... 5.0 minutes/1 block
Taped Discussion ............................... 10.0 minutes/2 blocks
Questionnaire ....................................... 2.5 minutes/0.5 block
Recycle ?
Introduction to Mental Device ............. 2.5 minutes/0.5 block
Monitored Practice ............................... 7.5 minutes/1.5 block
Post-baseline ........................................... 10.0 minutes/2 blocks

Figure 7. Time sequences for Dyad #3 in Phase II

Data Acquisition

EMG activity was detected by surface skin electrodes (Beckman silver-silver chloride) attached at standard locations on the forehead and forearms. Forearm flexor EMG activity was recorded across the left flexor
digitorum superficialis muscle and forearm extensor EMG activity across the right extensor digitorum muscle. Each site required two active electrodes and a referent (or ground) electrode was located equidistant between the electrodes on the frontalis. The electrodes were secured to the skin by adhesive collars and Beckman electrode paste was employed at the electrode-skin interface. Impedance values were determined for each active electrode, and judged acceptable if below 10,000 ohms at the frontalis locations and below 20,000 ohms at the forearm sites.

The EMG activity detected at each site was increased by a gain factor of 10,000 through the use of two physiological amplifiers (all biomedical instrumentation utilized in this study was manufactured by Med Associates, Inc., Box 47, East Fairfield, VT, 05448). Each physiological amplifier was optically isolated so that it was impossible for an electric current to be reversed and transmitted to the subject. Each EMG signal was filtered at a bandpass of 90 - 1000 hz and prevented cardiac interference. The EMG signals were integrated at a time constant setting of .4 milliseconds.

Peripheral surface skin temperature was measured by taping a thermistor to the fleshy aspect of the index finger at the proximal phalanx. The thermistor consisted of electrical properties that were sensitive to changes in skin temperature with a 1/10 of a degree fahrenheit. The signal detected by the thermistor was modified electronically so that the absolute temperature in degrees fahrenheit was measured and recorded.

Heart rate was detected indirectly through the measurement of blood volume pulse in the external carotid artery system. The blood volume pulse was measured by a photoplethysmograph. A photosensitive electrode was attached at the right temple area of the head and measured blood
volume changes in the superficial temporal artery. The validity of this measurement was checked before and after each recording session by manually determining a subject's pulse. Invalid measurement periods were not entered for data analysis. For three subjects, invalid recording periods required relocating the sensor at the right side of the neck and blood volume changes were measured at the common carotid artery.

EMG, surface skin temperature, and heart rate values were recorded at the end of each trial. All physiologic activity was converted to digital pulses so that each response could be counted, averaged over time, and displayed in digital form. The average digital values for each measure per 100 seconds, constituted the data for one trial. The averages for each recording site was differentially displayed. Each data value for every trial was labeled and printed out on a strip recorder; averages for each block and each session were computed manually.

EMG analog feedback from the frontalis was provided to subjects through a constant audio tone; the pitch of the tone changed in proportion to the frontalis muscle activity. The bioelectrical signal from the frontalis is amplified and integrated as previously described. The signal was programmed into a voltage controlled oscillator (VCO) that produced a change in the output signal as a function of the input signal. An audio amplifier using a 1/2 watt of power provided the current to relay the VCO output through to the headphones; this constituted the feedback tone. The audio feedback tone, in addition to all verbal and recorded instructions to the subjects, were received through Pioneer stereo headphones. The use of these headphones by subjects reduced external noise.
RESULTS

The design features of the study determined the total number of recording sessions for each subject. The number of sessions ranged from ten to twelve. All subjects, with the exception of Subject 4, participated in four training sessions in Phase I and four training sessions in Phase II. A decision was made to equalize the number of training sessions within each phase because of time constraints reported by a number of subjects. This procedure allowed proper assessment of the independent variables, while adequately fulfilling the requirements of a singlet-composite design. Subject 4 reported feeling bored and frustrated with the taped discussion in Phase I, and was advanced to the next phase in order to maintain motivation.

Mechanical malfunction in single subject strategies involving physiologic recording results in the lost of data points or values. A problem developed in the present study in the recording of heart rate; some heart rate data failed the post-session, manual validity checks. This problem was related to poor attachment of the sensor to the skin. In the line graphs and percentage deviation tables presented below, unreported heart rate data reflect this problem. Heart rate data for Subject 6 was too often invalid, the reason due to periodic gross body movement and coughing, and will be unreported.

The criterion for advancing subjects from the Baseline phase to the training phase focused on frontalis EMG activity. During the Baseline phase, the desirable criteria was stable frontalis EMG activity across two or more sessions, or a trend of increasing values across two or more sessions. An attempt to obtain stability or measures changing in a
desirable direction on all physiologic measures may have been too time consuming, if not impossible.

Reduction of Data

The raw data in this study consisted of the printed digital values for each 100 second period. The numerical values for each block were computed by averaging the three trial scores for each physiologic measure. Numerical scores for muscle activity and surface skin temperature were rounded to the nearest one hundredth, and heart rate was rounded to the nearest whole number. Further averaging of the blocks in the Baseline sessions was done in order to determine mathematical means for an entire session. Mathematical means for the entire session were not determined for sessions in Phases I and II. Instead, post-baseline blocks were averaged only, to be compared to the prebaseline block. The latter operation was done in order to aid in the across-and within-session analysis, as further explained below.

In order to determine within-session variations, changes in the physiologic measures, between the first recording block and the last two recording blocks of each session, were computed. Within-session changes in EMG activity were calculated in percentages. Variations for surface skin temperature and heart rate were accomplished by simple subtraction, and presented, respectfully, in degrees and heartbeats per one hundred seconds. The deviation values for each subject and each session are presented in deviation bar graphs.

In order to compute the deviation values for the Baseline sessions, the first block was compared to the averaged value of the last two blocks. The data from the middle two blocks in the baseline sessions were ignored.
Thus, within-session changes during the Baseline phase could be examined in a similar manner to changes in Phases I and II.
Dyad #1

Subjects 4 and 6 were randomly assigned to Dyad #1. Subject 6 participated in three baseline sessions and Subject 4 in four baseline sessions, and the design requirements were thus fulfilled. Following the Baseline phase, each subject was presented with the Conceptualization variable in Phase I, and then frontalis EMG feedback and instruction in the mental device for relaxation in Phase II. Session averages for the frontalis EMG measures in the Baseline phase for both subjects demonstrated a stable or slightly increasing trend, an acceptable criterion for implementing Phases I and II. After listening to the conceptualization monologue, both subjects answered the questionnaire items in a satisfactory manner. No recycling was necessary in the experimental phases.

Across-session Analysis

The changes in the muscle and cardiovascular measures across each phase for Subject 4 and 6 can be viewed in Figures 8 and 9. The overlap from phase to phase on the frontalis EMG measure is considerable, making interpretation difficult. However, a slight downward trend is evident for both subjects on frontalis EMG measures in Phase I and the lowest frontalis EMG value for all sessions occurs in Phase I. For Subject 6, Baseline trends on the forearm EMG measures are stable and the myoelectrical activity is small. This pattern contrasts with the highly variable EMG forearm measures for Subject 4 in the Baseline phase. The variability is somewhat reduced on the forearm EMG measures across the experimental phases for Subject 4 and a gradually decreasing trend can be discerned; in particular, the forearm flexor activity in Phase I is more stable and the microvoltage values are significantly smaller. This suggests the
Figure 8: Line graph showing across-session changes in muscle activity for Subjects 4 and 6; Dyad #1.
Figure 9: Line graphs showing across-session changes in two cardiovascular measures for Subjects 4 and 6; Dyad #1. Dotted line shows invalid heart rate data.
Conceptualization variable aided this subject in attaining reduced muscle activity. Also noteworthy for Subject 4 is the reduced variability between the three muscles in the last session of Phase I and II. This suggests the subject was putting into practice what was learned from the experimental variables, since the reduced variability did not occur after four Baseline sessions.

The forearm EMG activity across sessions for Subject 6 can be summarized as mostly inconsistent, although the values are slightly higher in Phases I and II.

An across-session analysis of surface skin temperature for both subjects defies an identification of trends. No consistent change is evident in prebaseline block values for the experimental sessions. The absolute temperature scores were unaffected by the relaxation training.

As previously mentioned, heart rate data was not available from Subject 6. Heart rate changes for Subject 4 are somewhat variable with a very slight upward trend. Noteworthy within-session changes are occurring, but the present analysis reveals no specific effect by the independent variables.

**Within-Session Analysis**

The within-session changes are shown in the deviation bar graphs in Figure 10 and 11. Decreases in frontalis EMG activity are not always correlated with changes indicative of low arousal. Session 1 in Figure 10 shows frontalis EMG activity is reduced by about 19% while flexor EMG activity increases by almost 20%, and skin temperature decreases by more than a degree. Session 9 in this figure shows another pattern of dissociation.
Figure 10: Deviation bar graphs for Subject 6 showing pre-baseline to post-baseline changes in each physiologic measure.
Figure 11: Deviation bar graphs for Subject 4 showing pre-baseline to post-baseline changes in each physiologic measure.
In this session, frontalis EMG activity increases by approximately 11%, as both flexor and extensor EMG activity decrease markedly by about 27% and 61.1%, respectfully. Similar examples of such patterns of dissociation, although not as dramatic, can be seen in Sessions 2, 8, and 11 in Figure 10.

In sessions when all recorded muscle activity decreases, cardiovascular variables do not consistently change in the direction of low arousal. In Figure 10 a noteworthy example of this occurrence is in Session 4. It can be seen that decreases in all EMG measures were accompanied by a decrease in surface skin temperature of more than four and a half degrees.

Other within-session results suggest a low arousal pattern characterized by reduced muscle tension and heart rate, and increasing surface skin temperature. In Figure 10 this pattern can be viewed in Sessions 7 and 10. Examples of a low arousal pattern exist in Figure 11. The cardiovascular changes are impressive. Sessions 6 and 7, to a lesser extent Sessions 10 and 11, indicate physiologic changes associated with low arousal. Further, in Sessions 3, 5, 9, 10, and 11 in Figure 11, large cardiovascular changes toward relaxation are associated with large decreases in activity in at least one muscle, or smaller decreases in activity of all three muscles.

Summary

The Conceptualization variable aided in the slight reduction of the frontalis EMG activity, but did not have significant effects on the other dependent measures. The composite of independent variables presented in Phase II were not distinguished in changing physiologic activity. In one case, the variability and magnitude of EMG measures were similarly
reduced in the last session of each experimental phase. The within-session analysis showed that as often as not reductions in frontalis EMG activity were related to a pattern of dissociation. However, data for Subject 4 showed large cardiovascular changes indicative of low-arousal associated with decreases in muscular activity.
Dyad #2

Subjects 2 and 5 were randomly assigned to Dyad #2. Subject 5 was involved in two baseline sessions and Subject 2 in four baseline sessions. Results from the Baseline phase demonstrating stability was established on frontalis EMG measures. During the Phase I sessions each subject listened to tape instructions on the use of a mental device for inducing hypometabolism. Neither subject had to be reminded to continue the "foot tapping" to insure their use of the mental device. During Phase II each subject listened to a shortened version of the Conceptualization monologue, in addition to practicing to relax with the aid of EMG frontal feedback. In the initial session of Phase II each subject successfully completed the questionnaire and no recycling periods were instituted.

Across-Session Analysis

The muscle and cardiovascular data across each phase for Subjects 2 and 5 are presented in Figures 12, 13, and 14. The overlap and stability in the frontalis EMG measures across the sessions is noteworthy and the effects of the independent variables cannot be distinguished. The independent effects on the forearm EMG data are more distinct. The activity of the flexor EMG measures for Subject 5 shows some overlap. Although a trend in Phase I is not clear, a decrease in this measure does occur and the change is stabilized in Phase II. This pattern suggests that the combination of training variables aided in the reduction and stabilization of the flexor EMG response. This is similar to the flexor EMG measures for Subject 2, although overlap between phases is more evident.

Reduced activity and increased stability occurring in Phase II also can be observed in the extensor EMG data for both subjects. The extensor
Figure 12: Line graph showing across-session changes in muscle activity for Subjects 5 and 2; Dyad #2.
Figure 13: Line graph showing across-session changes in heart rate for Subjects 5 and 2. Dotted line shows invalid heart rate data.
Figure 14: Line graph showing across-session changes in surface skin temperature for Subjects 5 and 2.
EMG data, however, has interpretation difficulties, because of the decreasing trend in the Baseline phase for Subject 5 and the steep reduction occurring in Phase I for Subject 2. Nonetheless, the forearm EMG data indicates that the composite of variables presented in Phase II sustained decreases in the forearm activity, and at least in one case, reduced and stabilized forearm activity as compared to Baseline and Phase I.

Turning to the cardiovascular variables, one is impressed by the differences in responding across sessions by the two subjects on the surface skin temperature measures. Subject 2 offers a picture of stability across phases, indicative of no effects by the independent variables. The surface skin temperature changes for Subject 5 are wide ranging and variable. In the experimental phases, with the exception of Session 10, it is possible to discern a warming trend in the temperatures. The analysis of across session temperature trends for Subject 5 is clouded by the sharp decrease in the Baseline phase.

The heart rate data is another case of noticeable overlap with one exception. Interpretation is difficult for Subject 2 because of this overlap. An interesting pattern is revealed in the heart rate data for Subject 5. The Baseline sessions show an increasing trend and in Phase I a stable trend, but Phase II indicates a moderate to sharp decrease in the heart beats per 100 seconds. The composite effects of all three variables suggest a result of decreasing heart rate.

Within-Session Analysis

The within-session deviations for Subject 5 and 2 are shown below in Figure 15 and 16, respectively. Several sessions include reductions of
Figure 15: Deviation bar graphs for Subject 5 showing pre-baseline to post-baseline changes in each physiologic measure.
Figure 16: Deviation bar graphs for Subject 2 showing pre-baseline to post-baseline changes in each physiologic measure.
frontalis EMG activity of more than 10% accompanied by equal or larger reductions in the forearm EMG measures (see Session 1 in Figure 15 and Sessions 1, 4, and 5 in Figure 16). With the exception of Session 1 in Figure 15, these decreases in EMG activity are associated with substantial decreases in heart rate. Also of interest, the surface skin temperature in Session 5 for Subject 2 showed the largest deviation, an increase of more than two degrees. Other surface skin temperature changes for this subject are of smaller magnitude. These sessions indicate a low arousal pattern. For both subjects prominent reductions in frontalis EMG activity (10% to 15%, or more) is related to a pattern of low arousal. In Sessions 2 and 10 in Figure 15 and Session 7 in Figure 16 smaller frontalis EMG reductions are also related to considerable forearm EMG decreases. These sessions, with one exception, show a response pattern characteristic of low-arousal, too.

Sessions that show a pattern of dissociation with respect to the EMG measures will be discussed next. Although the deviations on the frontalis EMG measure are no more than 5% in either direction, Sessions 5 and 7 in Figure 15 are examples of dissociation patterns. Other examples of dissociation include Sessions 2 and 3 in Figure 16. The cardiovascular responses related to these four sessions are inconsistent and small in magnitude, and not affected strongly in one direction.

The surface skin temperature increases for Subject 5 are conspicuous in Sessions 2, 4, and 8. Two of these sessions are linked with slight decreases in heart rate. Only one of these sessions is related sizable to decreases in muscle activity. Sessions 3 and 7 in the same figure are notable because they show almost no change in surface skin temperature and are associated with varying patterns of dissociation on the EMG measures.
The changes in heart rate in Figure 16 show that half of the sessions involved decreases of five beats or more. Four of these six sessions are associated with patterns of reduced muscle activity. In Session 12, which shows the largest decrease of fourteen heart beats, there is a pattern of dissociation in the muscle activity; however, the magnitude of the deviations are relatively small and the absolute values of the EMG activity for that session are all below four microvolts. No pattern is evident between these heart rate reductions and the surface skin temperature changes.

Summary

No reliable effects could be detected for the independent variables on frontalis EMG activity or surface skin temperature. The combination of all three independent variables presented in Phase II sustained reduced EMG variability and activity, and in one case, produced a decrease in heart rate. Evidence was presented indicating that sizeable within-session reductions in frontalis EMG activity was associated with similar reduction in forearm EMG activity and cardiovascular changes indicative of low arousal. Patterns of dissociation were also evident but the magnitude of the deviations were not impressive. Large increases in surface skin temperature for one subject were not typically associated with decreases in muscle activity or heart rate.
Dyad #3

Subjects 1 and 3 were randomly assigned to Dyad #3. Subject 1 was involved in two Baseline sessions, the results of which indicated an increasing trend on frontal EMG activity. Subject 3 participated in three Baseline sessions and an upward trend was also established on the frontal EMG measure. These results determined each subject's entry to the experimental phases. During Phase I, each subject listened to a brief introduction on the concept of biofeedback, followed by a practice period with an audio feedback tone representing frontal EMG activity. In Phase II, each subject listened to a shortened version of the Conceptualization monologue, and were introduced to and practiced with the mental device for relaxation. Both subjects scored perfectly on the questionnaire items addressed to the Conceptualization monologue, and no recycling periods were needed in Phase II.

Across-Session Analysis

Muscle and cardiovascular measures across each phase for Subject 1 and Subject 3 are presented in Figures 17 and 18. In Figure 17 a slight decrease is shown in the frontal EMG measure in Phase I. This is one of the few phases in the entire study where a reduction in this measure is reported. For Subject 1, the EMG feedback tone was apparently useful. In Phase II these slightly reduced frontal EMG measures were not maintained. For Subject 3, the frontal EMG measures resemble patterns seen in other graphs: the measures appear stable with notable overlap between phases. No trend can be detected on this measure for this subject. The forearm EMG measures for Subject 1 establish a decreasing trend in Phase I.
Figure 17: Line graph showing across-session changes in muscle activity for Subjects 1 and 3; Dyad #3.
Figure 18: Line graphs showing across-session changes in two cardiovascular measures for Subjects 1 and 3; Dyad #3.

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In particular, the flexor EMG measure demonstrates a discernable decreasing trend. The extensor EMG measure in Phase I also shows a downward trend, but is more variable. An across-session analysis of the forearm EMG activity for Subject 1 is complicated by the decreasing trend for both measures in the Baseline phase. Also, the variability is amplified in the extensor EMG measure in Phase II. For Subject 1, it can be cautiously stated the EMG-FF aided in the gradual reduction of frontalis muscle tension, and although forearm tension was reduced, it is not known if these effects are beyond those established without EMG-FF.

The forearm EMG measures for Subject 3 offer a different picture. The Baseline phase shows extensor EMG activity that is extremely variable, but this variability becomes smaller across Phases I and II. The muscle tension is also reduced. In Phase II a moderate degree of stability appears for all three EMG measures. Overlap is evident for the flexor EMG data between Phases I and II. However, the data here suggests the effect of all three independent variables was to "quiet" muscle activity for Subject 3; to allow generalized muscle relaxation.

The heart rate measures for Subject 1 are noteworthy in Phase I. In contrast to the Baseline phase which shows an upward trend, Phase I heart rate measures decrease, a trend similar to the frontal EMG measures in Phase I. This heart rate trend is not maintained in Phase II. That a correlation exists between reduced frontalis muscle tension and heart rate is a possibility indicated by these results. Considerable overlap between phases prohibits a precise analysis of the heart rate data for Subject 3.

No significant trends in surface skin temperature can be detected for either subject. Subject 3 has temperature values that are stable
across each phase. The surface skin temperature values for Subject 1 are characterized by increased variability in Phase II.

**Within-Session Analysis**

The changes within each session for Subjects 1 and 3 are shown in Figures 19 and 20 respectively. It can be noted that significant decreases in all three muscles occur in many sessions. For example, Sessions 2, 5, 7, and 10 in Figure 19 exhibit decreases in all three muscles and two of these sessions are accompanied by impressive decreases in heart rate. Smaller decreases in frontalis EMG activity occurs with a significant decrease in at least one forearm site in Sessions 8 and 9. Session 9 is associated with cardiovascular changes indicative of low arousal and Session 8 is not. In Figure 20, similar large decreases in muscle activity can be observed in Sessions 4, 5, 6, 7, 8, 9, 10, and 11. Only two of these sessions relate to significant reductions in heart rate; surface skin temperature changes were very small for each session for this subject and no interpretation can be made with respect to muscle activity.

Patterns of muscular dissociation can be viewed in Sessions 3 and 6 in Figure 19 and Sessions 2 and 3 in Figure 20. The effects of this dissociation on the cardiovascular variables are not uniform.

Decreases in heart rate occurred in all sessions except three and more often than not were associated with reduced muscle activity. One notable exception is Session 1 in Figure 19 which shows a decrease of fourteen heart beats and an increase of more than four degrees in surface skin temperature and is related to dissociation of the muscles, though the deviations are small in magnitude. Overall large heart rate decreases were not associated with comparable increases in surface skin temperature.
Figure 19: Deviation bar graphs for Subject 1 showing pre-baseline to post-baseline changes in each physiologic measure.
Figure 20: Deviation bar graphs for Subject 3 showing pre-baseline to post-baseline changes in each physiologic measure.

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Summary

In one case frontalis EMG measures were reduced slightly by the introduction of EMG-FF and in another it was not. Reductions in frontal EMG for Subject 1 across Phase I were accompanied by a similar trend of reduced heart rate. Forearm EMG measures showed reductions within each phase and for Subject 3 a moderate degree of stability occurred for all three EMG measures in Phase II. No significant trends were evident for the surface skin temperatures. Within-session changes demonstrated large decreases in muscle activity that were often related to heart rate decreases, but had no relation to the measure of surface skin temperature.
DISCUSSION

The results suggest that EMG-FF was no more effective in reducing frontalis muscle tension than instructions to relax or the other independent variables. A within-session analysis indicated that reduced frontal muscle tension does not reliably produce a physiologic pattern of low arousal. The introduction of the independent variables did not reliably change the activity of the cardiovascular variables, although significant decreases in muscular activity were usually accompanied by reductions in heart rate. Though forearm EMG measures often showed a decreasing trend in the Baseline phase and Phase I, reduced variability and activity often characterized the results in Phase II, suggesting the composite of variables was useful in enhancing generalized muscular relaxation.

The finding of the present study, that EMG-FF was not distinguished in the experimental phases in reducing frontal EMG measures, supports the results of Alexander, White, and Wallace. That is, if subjects are appropriately motivated and involved in the experimental process, then EMG-FF is no more effective than instructions to relax. One explanation for the results of the present study is the use of an adaptation session and at least two baseline sessions, each lasting thirty minutes. Future studies utilizing EMG-FF as an independent variable should implement as many baseline sessions as are needed to establish that any subsequent reductions in frontal tension are not the result of habituation. Measurements of frontal tension on different days and times of the day would be advisable.

That none of the independent variables showed much effect on the frontalis EMG values points to the possibility of a "cellar effect" or "floor effect." A cellar effect would occur if a physiological parameter
reached its lower limit of responding. In this study, subject screening procedures were in part directed toward obtaining subjects who demonstrated higher than average frontalis EMG activity. Future research efforts utilizing the independent variables in the present study should select subjects with higher tension levels, perhaps a clinical population.

The finding in the present study, that within-session reductions in frontal EMG activity did not relate reliably to a low-arousal pattern, is consistent with recent research cited earlier in this study. It should be noted that more than a few sessions did show changes representative of a low arousal pattern. However, there was an equal number of sessions characterized by a dissociation pattern although a decrease in frontal tension occurred. On the other hand, generalized muscle relaxation, as indicated by tension reduction in all three muscles, seemed related in most cases to a slowed heart rate. DeGood and Chisolm (1977) produced a similar finding. This correlation is worthy of further investigation.

It could be argued that a valid test of the relationship between decreased frontalis EMG and a low arousal pattern eluded the present study because control of frontalis EMG was not attained. This is a plausible assertion. Researchers who suggest that such a pattern can be attained with EMG-FF must demonstrate effects beyond those produced by habituation. Also, the possibility exists that single-subject designs will not exhibit the "powerful effects" in psychophysiological investigations, effects that demonstrate significance, at least visually. Psychophysiological studies encompassing several dependent variables may show statistical significance in a between-groups design, but not in a within-subject design. The inevitable
variations that occur in psychophysiologic measurement, variations that cannot typically be controlled by the experimenter, are especially problematical in single-subject designs.

The finding that the composite of variables presented in Phase II was frequently more effective than the singlet components in reducing muscle tension is noteworthy, if problematical. On one hand, the implication is that a single relaxation technique, without the addition and integration of other components, such as conceptualization, results in limited effectiveness. It is hypothesized that the inclusive relaxation training package produces more powerful effects, which may account for studies that show EMG-FF only resulting in specific muscle training. On the other hand, it is not known whether similar reductions in muscle tension would have occurred had the number of sessions in Phase I been extended. That is, if the effects of the relaxation training components presented in Phase I had been monitored for eight sessions, would the results have shown the same reductions? A similar study with a multiple baseline design conducted over a longer period of time may answer this question.

Finally, the results of this study show individual differences in physiologic responding. A limitation of research in this area is the assumption that relaxation training will have a uniform effect, regardless of the individual response patterns for manifesting relaxation and anxiety. For example, individuals who manifest anxiety primarily in a cognitive mode may be frustrated by a relaxation technique focusing on muscular or somatic responses. It is suggested here that if an individual's response pattern is not known, a more inclusive relaxation training package is preferred.
Relaxation Training Sheet As Adapted From Fee and Girando (1978)

Name _______________________________ Date ____________________________ Session ________________________

1. Did you feel your muscles relax?
   YES  NO  SOMewhat

2. Were you able to quiet your mind?
   YES  NO  SOMewhat

3. Did you lose your sense of physical space?
   YES  NO  SOMewhat

4. Did you notice any change in your breathing?
   YES  NO  SOMewhat

5. Did your limbs feel numb?
   YES  NO  SOMewhat

6. Did your thoughts disturb your concentration?
   YES  NO  SOMewhat

7. Were you aware of outside noise?
   YES  NO  SOMewhat

8. Have you noticed any changes or differences in yourself since you started training, i.e., more anxious, more tranquil, have more energy, change in sensation of pain, amount of sleep, eating patterns, etc.?

9. Do you feel that there is any relationship between your training and any of the changes you listed above?

10. Please list any other types of feelings, thoughts, or emotions that you might have had during relaxation training.
Content for the Long Version of the Conceptualization Monologue

For the next fifteen minutes I am going to speak to you about how our bodies change when we are feeling anxious or tense, and how our bodies change when we feel very relaxed or calm. I want you to know how, physiologically and psychologically, anxiety and relaxation are different. Of course, you may know the difference between anxiety and relaxation subjectively, and after listening to the following discussion, you'll know some of the differences as measured objectively. Try to listen closely to the content of the discussion because a short questionnaire will be administered at the conclusion and you'll want to answer most of the questions correctly in order to go on to the next phase of the study.

Let's begin by first focusing the discussion on the emotion of anxiety or distress. Such feelings often arise when something occurs that is unexpected and we are startled or when some demand is made upon us that is perceived as threatening. For example, we may become anxious or distressed if we have to make a speech to a group of twenty people or if we are suddenly threatened by a stranger on the street or when we are "psyched up" for sports competition. The ideas of demand and threat are important to understanding the emotions of anxiety and distress. Interestingly, your body has a stereotypic or patterned way of reacting to situations that are perceived as threatening. Your body undergoes certain changes involuntarily to prepare you to meet the demand of a threatening situation. This bodily reaction is popularly know as the fight-or-flight response. The fight-or-flight response is the body's Red Alert or Emergency Response and prepares you to exert great energy in order to run away from the threat or to meet the threat and in a sense, "fight it." The fight-or-
flight response is really a survival mechanism and this mechanism has remained intact as Man has evolved over the past millions of years.

Now I'll repeat some of these ideas. First, the emotions of anxiety and distress relate to perceived threats or demands from one's environment. Secondly, we have an automatic response that prepares us to meet the demand or threat; it is commonly known as the fight-or-flight response. Next, I want to inform you as to the physical changes that occur when the fight-or-flight response is activated in the body. Although the following description speaks about the changes in specific body systems, it should be noted that the fight-or-flight response is a systemic or integrated or total response by the body.

On the simplest level, we can talk about the bodily changes in terms of increases and decreases. If we imagine for a moment that our body is at a resting state or baseline level, then the following changes occur during the fight-or-flight response. There is an increase in muscle tension, an increase in breathing or respiration rate, an increase in heart rate or pulse, and an increase in blood pressure. At the same time, there is a decrease in surface skin temperature in our hands and feet. Basically, these changes are necessary so that our bodies can metabolize nutrients faster. More oxygen and quick energy sugar substances are needed for our fleshy muscles in the arms and legs. This accounts for the increase in heart rate and respiration. Although more blood is being pumped from the heart, the veins and arteries in the hands and feet are actually getting smaller or constricting. The blood is not needed in peripheral areas of the body; and the less blood flow to these areas, the cooler becomes the surface skin temperature as measured by a thermistor. Less blood flow means cooler hands. Another reason for less blood being
pumped to the hands and feet is that if you were actually fighting for your life to survive and received cuts or lacerations on your hands, you would not lose as much blood.

Now I would like to turn your attention to the fact that the fight-or-flight response can be activated at times when your life is not necessarily in danger. A few examples were given before. Driving in rush hour traffic in a major city would be enough to trigger fight-or-flight responding in most of us; or if we are suddenly confronted by something we fear, for example snakes, that could be enough to trigger such a response in some people. The point being made here is that typically we are not confronted with the life and death situations that the response originally evolved for. The fight-or-flight response is a survival mechanism and yet is can be triggered in some people by thinking or picturing a fearful situation or person. This paradox is resolved when we take into account man's recent addition to his nervous system: the cortex of the brain, that part of the brain in which we think and reason and imagine. This part of your brain allows you to behave and respond to certain environmental and interpersonal stressors as if your life were threatened. Thus we could think about and imagine tomorrow's rush hour traffic in an obsessive manner, and the result would be that your body will begin to change as if the threat were immediate. Of course, this type of thinking is at the heart of worrying--that is, becoming preoccupied at some event that we have little or no control over. The important thing to remember is that we can trigger degrees of the fight-or-flight response by thinking about or imagining threats.

Let's move on to a discussion of relaxation or calmness. Relaxation is perhaps an overused word, and the phrase "just relax and try not to worry
about it" has been offered to people for centuries as a way of therapy, usually with no benefit. The problem is that until recently there has not been any objective description of relaxation or any reliable way of teaching such a skill. Simply stated, most of us don't know how to "just relax." Of course, we may term many activities as being "relaxing." For the present let's focus on the subjective and objective state of relaxation. Let's talk about relaxation in the same manner we spoke of anxiety and distress.

First, I want to inform you that deep relaxation is a very different state than sleeping. Researchers are finding that sleep actually can be a very active physiological state with varied bodily movements and a wide range of electrical activity originating from our brains. For example, you may have mornings when you awaken and still feel tired, though you have been sleeping for eight hours. One explanation is that your sleep was restless or the content of your dreams was upsetting and distubing. It is not too farfetched to think that certain dreams, you may call them nightmares, actually trigger the Emergency Response in our bodies. It would be fair to say that sleep is restful when it contains the objective elements common to deep relaxation.

I want you to think for a moment how you feel and think when you are totally relaxed. Of course, each of us will experience relaxation in a slightly different way, but I can tell you what many people report when they feel relaxed. Such sensations as heaviness and warmth in the arms and legs are common sensations. Some people report feeling as if they are floating and are as light as a feather. Tingling sensations are also reported. Emotionally, you might feel relieved, satisfied, contented, settled, or centered. Mentally, the essence of relaxation is not striving
too hard to relax; ideally, one takes a very passive and accepting attitude toward any changes that occur in one's body. Relaxation is "letting go." I am sure you have your own account of relaxation, and it is important to note that I am not suggesting a person should feel any particular sensation or emotion when relaxed. Rather, there are some reported commonalities and there are also very individual reactions. However, most subjective feelings do correspond to certain objective changes that are occurring.

A review of the objective correlates of relaxation suggest a straightforward picture, one which you may be aware of already. That is, the changes in the body during deep relaxation are opposite of the changes during fight-or-flight. Thus, heart rate, breathing or respiration rate, muscle tension, and blood pressure all decrease; while surface skin temperature in the hands and feet increase. Relaxation can be described accurately as a hypometabolic state. That is, the metabolism or activity in the body is slowed considerably. The heart does not beat as fast. Breathing becomes deep and rhythmic, and lungs fill with air from the bottom to the top in an almost effortless manner. The veins and arteries dilate or enlarge so there is more blood flow to the hands and feet, which relates directly to increasing skin temperature and decreasing blood pressure. Simply, the activity of the body is slowed down and there is time for the restorative and healing processes of the body to become active.

Unfortunately many of us have lost this ability to relax deeply and to reliably get into this hypometabolic state. As children we all reacted to distress and anxiety with a relaxation and quieting period, thus balancing out the effects on our bodies. It seems as if growing older, we ignore this ability to relax and this skill becomes rusty and dormant.
Most importantly, health care professionals have suggested that frequent triggering of the fight-or-flight response will lead to stress-related disorders unless relaxation periods occur to balance off the activation of the body. That is, disorders such as high blood pressure, headaches, ulcers, and backaches--problems that are in part due to anxiety and distress--may be helped if the person can learn deep relaxation. Relaxation seems to counteract the effects of frequent triggering of the fight-or-flight response and, as such, is an important preventative and therapeutic tool in treating disease and illness.

This discussion will conclude now, and I hope you found it of interest. You will have the opportunity to listen again to this discussion no matter how well you finish on the questionnaire. However, in order that it can be shown that everyone has the same basic understanding of the ideas just presented, please complete this questionnaire as best you can within the next five minutes.

Given your present understanding and ability to relax and applying what you have learned from these sessions, allow yourself to relax deeply without going to sleep for the next ten minutes.
Questionnaire Addressed to the Conceptualization Monologues

Name ____________________________
Date ____________________________

(Choose the best answer for each statement; circle your selection.)

1. The fight-or-flight response is activated when:
   a. one expresses love and caring to another person
   b. a person feels depressed and lonely
   c. a person feels threatened or perceives that too many demands are being made on them

2. The physiologic changes that accompany the fight-or-flight response include:
   a. peripheral skin temperature decreases; muscle tension, heart rate, breathing increase
   b. heart rate decreases; skin temperature and muscle tension and blood pressure increases
   c. peripheral skin temperature increases; muscle tension, blood pressure, heart rate, breathing all decrease

3. Which of the following emotions accompany the fight-or-flight response:
   a. uptight, threatened, panicky, frightened
   b. bewildered, disorganized, mixed up, uncertain
   c. foolish, humiliated, disgraced, apologetic
   d. amused, carefree, enthusiastic, pleased, satisfied

4. Which of the following situations would be most likely to trigger fight-or-flight responding:
   a. a person plays a friendly game of tennis
   b. a person becomes involved in a heated argument which almost erupts into fisticuffs
   c. on a hot, sunny day a person decides to take off his or her clothes to jump into a lake and swim

5. The manner in which we think about or perceive a certain situation can trigger fight-or-flight responding:
   a. true
   b. false
6. The physiological changes that occur during fight-or-flight responding are opposite to changes during relaxation:
   a. true
   b. false

7. Relaxation is known as a "hypometabolic" state because:
   a. subjectively, we feel satisfied or calm
   b. blood pressure usually decreases
   c. in a sense, the activity of the body slows down

8. The physiological changes that occur during relaxation include:
   a. pupils constrict, skin temperature decreases, blood pressure is constant
   b. the changes during relaxation are no different from the changes that occur during sleep
   c. increases in skin temperature, decrease in muscle tension, breathing, heart rate, and blood pressure

9. Some health care professionals have recommended that deep relaxation can serve to balance off the stressful effects of fight-or-flight responding:
   a. true
   b. false

10. I found the taped discussion:
    a. difficult to understand
    b. interesting
    c. not interesting
Instructions for the Mental Device for Inducing Relaxation

For the next five minutes I am going to speak to you about a simple way to quiet your mind and relax your body. This technique was developed to help people turn off the many distracting thoughts that maintain bodily tension and to induce a state of hypometabolism; that is, a physiological state when the activity of the body, such as breathing, heart rate, and blood pressure decrease or slow down. You may think of this technique as a mental device to induce relaxation. The instructions are as follows:

(1) Sit quietly in a comfortable position and close your eyes.

(2) Try to relax deeply all the muscles in your body from your feet progressing up to your face; keep your muscles deeply relaxed.

(3) When you exhale on your breathing, say to yourself the word, "ONE." Continue to say to yourself the word "ONE" each time you exhale, until you are told to stop. Gently tap your foot each time you exhale and say "ONE" to yourself so that it can be observed you are practicing this method. Remember to gently tap your foot each time you exhale.

(4) Maintain a passive attitude by not worrying about how well you are doing. Allow the relaxation to occur on its own pace and if you have intruding thoughts, repeat the word "ONE" as soon as you become aware of them.

Go ahead now and practice this technique for the next ____ minutes.

Given your present understanding and ability to relax and applying what you have learned from these sessions, allow yourself to relax deeply without going to sleep for the next ten minutes.
Instructions for EMG Frontal Feedback

I am going to introduce you to the concept and practice of biofeedback. Biofeedback refers to the idea of receiving information about a bodily response and then using cognitive processes to alter or manipulate the response. Commonly, this is known as using the mind to control the body. If you were to monitor your heart rate by putting your hand over your chest, and then used some mental strategy to speed up or slow down the beating of your heart, then you would be practicing a form of biofeedback. A mental strategy may include using certain feelings, images, or thoughts in order to regulate the bodily response.

The modality of biofeedback that you will utilize today involves using an audio tone in order to receive information on your muscle tension. Now you will hear an audio tone that will give your feedback on muscle tension.

During this training try to relax. Try to make the audio tone become very low in pitch. Wrinkle your forehead. Do you hear the change in the tone? Do you hear the tone become low in pitch? Do you hear the tone slow down? This is relaxation. Recall various thoughts, feelings, and images to see which thoughts and feelings help you to relax. Try to keep the tone as low and as slowed down as you can.

Given your present understanding and ability to relax, and applying what you have learned from these sessions, allow yourself to relax deeply without going to sleep for the next ten minutes.
Content for the Short Version of the Conceptualization Monologues

For the next ten minutes I am going to speak to you about how our bodies change when we are feeling anxious or tense and how our bodies change when we feel very relaxed or calm. I want you to know how, physiologically and psychologically, anxiety and relaxation are different. After listening to the following discussion, you'll know some of the differences as measured objectively. Try to listen closely to the content of the discussion because a short questionnaire will be administered at the conclusion.

Let's begin by first focusing the discussion on the emotion of anxiety or distress. Such feelings often arise when something occurs that is unexpected and we are startled or when some demand is made upon us that is perceived as threatening. For example, we may become anxious or distressed if we have to make a speech to a group of twenty people or if we are suddenly threatened by a stranger on the street. The ideas of demand and threat are important to understanding the emotions of anxiety and distress. Interestingly, your body has a stereotypic or patterned way of reacting to situations that are perceived as threatening. Your body undergoes certain changes involuntarily to prepare you to meet the demands of a threatening situation. This bodily reaction is popularly known as the fight-or-flight response. The fight-or-flight response is the body's Red Alert or Emergency Response and prepares you to exert great energy in order to run away from the threat or to meet the threat and in a sense, "fight it." The fight-or-flight response is really a survival mechanism and this mechanism has remained intact as Man has evolved over the past millions of years.

Now I'll repeat some of these ideas. First, the emotions of anxiety and distress relate to perceived threats or demands from one's environment.
Secondly, we have an automatic response that prepares us to meet the demand or threat; it is commonly known as the fight-or-flight response. Next, I want to inform you as to the physical changes that occur when the fight-or-flight response is activated in the body. It should be noted that the fight-or-flight response is a systemic or integrated or total response by the body.

On the simplest level, we can talk about the bodily changes in terms of increases and decreases. If we imagine for a moment that our body is at a resting state or baseline level, then the following changes occur during the fight-or-flight response. There is an increase in muscle tension, an increase in breathing or respiration rate, an increase in heart rate or pulse, and an increase in blood pressure. At the same time, there is a decrease in surface skin temperature in our hands and feet. Basically, these changes are necessary so that our bodies can metabolize nutrients faster. More oxygen and quick energy sugar substances are needed for our fleshy muscles in the arms and legs; this accounts for the increase in heart rate and respiration. Although more blood is being pumped from the heart, the veins and arteries in the hands and feet are actually getting smaller or constricting. The blood is not needed in peripheral areas of the body; and the less blood flow to these areas, the cooler becomes the surface skin temperature, as measured by a thermistor. Less blood flow means cooler hands.

Now I would like to turn your attention to the fact that the fight-or-flight response can be activated at times when your life is not necessarily in danger. A few examples were given before. Driving in rush hour traffic in a major city would be enough to trigger fight-or-flight responding in most of us; or if we are suddenly confronted by something we fear, for
example, snakes, that could be enough to trigger such a response in some people. The point being made here is that typically we are not confronted with the life and death situations that the response originally evolved for. The fight-or-flight response is a survival mechanism, and yet it can be triggered in some people by thinking or picturing a fearful situation or person. The cortex of the brain, that part of the brain in which we think and reason and imagine, allows you to behave and respond to certain environmental and interpersonal stressors as if your life were threatened. Thus we could think about and imagine tomorrow's rush hour traffic in an obsessive manner and the result would be that your body will begin to change as if the threat were immediate. Of course, this type of thinking is at the heart of worrying; that is, becoming preoccupied at some event that we have little or no control over.

Let's move on to a discussion of relaxation or calmness. Relaxation is perhaps a misunderstood concept and the phrase "just relax and try not to worry about it" has been offered to people for centuries as a way of therapy, usually with no benefit. The problem is that until recently there has not been any objective description of relaxation or any reliable way of teaching such a skill. Simply stated, most of us don't know how to "just relax."

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blood pressure. Simply, the activity of the body is slowed down, and there is time for the restorative and healing processes of the body to become active.

Unfortunately, may of us have lost this ability to relax deeply and to reliably get into this hypometabolic state. As children we all reacted to distress and anxiety with a relaxation and quieting period. It seems as if growing older, we ignore this ability to relax and this skill becomes rusty and dormant.

More importantly, health care professionals have suggested that frequent triggering of the fight-or-flight response will lead to stress-related disorders unless relaxation periods occur to balance off the activation of the body. This is, disorders such as high blood pressure, headaches, ulcers, and backaches--problems that are in part due to anxiety and distress--may be helped if the person can learn deep relaxation. Relaxation seems to counteract the effects of frequent triggering of the fight-or-flight response, and as such is an important preventative and therapeutic tool in treating disease and illness.

This discussion will conclude now. In order that it can be shown that everyone has the same basic understanding of the ideas just presented, please complete this questionnaire as best you can in the next five minutes.

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