THE UNIVERSITY OF MANITOBA

THE ROLE OF LOCUS OF CONTROL IN ELECTROMYOGRAPHIC FEEDBACK AND ABBREVIATED PROGRESSIVE RELAXATION TRAINING PROCEDURES

by

Cynthia J. Jordan

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE

Master of Arts

Department of Psychology
Winnipeg, Manitoba

September, 1974

THE ROLE OF LOCUS OF CONTROL IN ELECTROMYOGRAPHIC FEEDBACK AND ABBREVIATED PROGRESSIVE RELAXATION TRAINING PROCEDURES

by

Cynthia J. Jordan

A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF ARTS

ACKNOWLEDGEMENTS

The existence of this thesis is marked by the help and support of many people. I would first like to thank Dr. John Schallow for his advice, his patience, his flexibility, and particularly for his story about science and the potato chip bag at Schultz's bar. Both his academic and personal support sustained me numerous times in continuing and completing this thesis. Great appreciation is also due Dr. Lorna Sandler for her suggestions and criticisms and for her personal concern. Her enthusiasm and interest in the subject area was greatly responsible for my selection of a topic. Thanks, too, to Dr. Richard Mezoff for his interest and his criticisms which contributed new perspectives in viewing the data. I would also like to thank Dr. Michael Thomas for his assistance and especially for his thoughtfulness in helping with the equipment. All of the members of my committee somehow managed to be both skillful advisors and helpful friends when I needed them throughout the thesis procedures. Thanks.

I would also like to thank Jay Brolund, commiserate in all phases of thesis thinking, running, and writing activities. His conviction that one could actually finish a thesis and his humor when the situation seemed humorless were very important. Thanks, too, to Phil Abrami for his statistical assistance and to Ann Gerson for her personal support and her work as a pilot subject. Her expertise as a subject was exceeded only by that of John Schallow.

I would like to extend special thanks to Dr. David Martin for the prolonged use of his laboratories and his help in their modification. His technical assistance with various equipment problems was greatly appreciated.

Thanks, too, to Mrs. Donna Brigham for typing well in a hurry.

I could not have completed this thesis or, perhaps, would not have even started it, were it not for the confidence and continuing tolerance of Larry Jordan. Thank you, Larry, for never asking why it was taking so long, for continuing to live with me, and for the roses.

ABSTRACT

It was the purpose of the present investigation to compare the relative effectiveness of electromygraphic feedback and an abbreviated version of progressive relaxation as relaxation training procedures in the context of individual differences. Literature from the areas of personality, physiology, and learning suggested that Rotter's construct of Internal-External locus of control might be useful in accounting for some of the individual differences observed in obtaining both objective (frontalis-EMG) muscle relaxation as well as subjective feelings of relaxation by the two techniques.

Fifty-seven female subjects, selected on the basis of their quartile scores on the I-E Scale were randomly distributed among three treatment conditions: biofeedback, progressive relaxation, and control. Subjects participated individually in two sessions held five to seven days apart. Session I was divided into three periods comprising baseline, treatment, and post-treatment phases. An affect rating scale and strategy questionaire were administered after session I. Session II was conducted in order to investigate retention of training. Additionally, an anticipatory or preparatory response phase, commencing 30 seconds before the treatment proper, was assessed for the two training groups.

Results indicated baseline differences attributable

to locus of control, treatment condition, and the interaction of treatment and locus of control. As predicted, the frontalis EMG levels of Externals exceeded that of Internals. Subjects in both the biofeedback and progressive relaxation procedures exhibited elevated muscle activity to that of subjects in the control condition. The frontalis tension of Internals in the progressive relaxation condition was significantly lower than that of Externals in progressive relaxation and all subjects in the biofeedback procedure. It did not differ from that of control subjects.

The prediction that Internals would exhibit greater preparatory responses because of their presumed higher motivation in a skilled task failed to be confirmed. However, results indicated that subjects in the biofeedback procedures signficantly elevated their frontalis tension in response to a signal indicating that treatment would begin in 30 seconds. Subjects in the progressive relaxation condition did not.

Overall treatment results indicated significant effects due to treatment, interaction of treatment and locus of control, and trials. In terms of the magnitude of frontalis MAP's, biofeedback proved to be least effective for all subjects. No difference was found among Internals and Externals in the biofeedback condition and Externals in progressive relaxation. The frontalis levels of these three groups exceeded that of the other three, among which no differences were found. However, Internals in both training procedures significantly decreased their MAP's over trials, while only Externals in progressive relaxation did so. Neither Externals in the biofeedback condition nor the control groups significantly decreased muscle activity over trials. Although all groups decreased MAP's significantly from baseline to treatment, only Internals in the two training procedures were able to maintain a level of relaxation in post-treatment significantly lower than baseline.

Overall results from the affect rating scale indicated that internals rated themselves as more relaxed, less tense, and experiencing less anxiety than Externals. No difference was found between Internals and Externals in the control groups. There was also no difference between Internals and Externals in terms of subjective anxiety in the biofeedback condition. The strategy questionaire results indicated that subjects in the two training procedures "thought more about muscle activity" than subjects in the control conditions.

When divided by treatment groups, correlational results indicated that the frontalis levels of subjects in the biofeedback group correlated significantly with their subjective tension and relaxation. All four frontalis measures of progressive relaxation subjects correlated with their ratings of relaxation and anxiety. Relaxation and anxiety failed to significantly correlate for Internals across all treatment conditions.

Results were discussed in terms of the role of individual differences in the relative efficacy of biofeedback and progressive relaxation. The relationship between frontalis tension and subjective assessments of relaxation was emphasized.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

THE ROLE OF LOCUS OF CONTROL IN
ELECTROMYOGRAPHIC FEEDBACK AND ABBREVIATED PROGRESSIVE
RELAXATION TRAINING PROCEDURES

While the critical and complex role of reinforcement in the acquisition and maintenance of behavior has been long recognized, the relatively recent development of biofeedback procedures has added a challenging new dimension to its study. Biofeedback is a technique which provides the individual with immediate sensory information regarding his physiological activities via an amplified index, and which may facilitate the voluntary conditioning of certain responses (Barber, Dicara, Kamuja, Miller, Shapiro & Stoyva, 1971a; Barber, Dicara, Kamuja, Miller, Shapiro & Stoyva, 1971b). Viewed from within the context of an operant conditioning paradigm, this augmented sensory information or "feedback" functions as both discriminative stumulus and reinforcement. However, just as some individuals learn particular molar behaviors more efficiently than do others under ostensibly identical reinforcement conditions, the issue of individual differences in the effectiveness of reinforcement appears to have equally significant implications for the operant conditioning of bioelectrical activity (Church, 1964).

In the area of muscular relaxation, electromyographic (EMG) feedback conditioning increasingly is being considered as a training technique comparable to, or even interchangeable with, Jacobson's (1938) progressive relaxation procedure (Alexander, French & Goodman, 1974). Individual differences in the ability of persons to control muscular activity by progressive and abbreviated relaxation methods are observed by Jacobson (1970): "some understanding patients do well without practicing at all, but like any other skill, tension control develops particularly with practice (p. 61)." It is the purpose of the current study to compare the relative effectiveness of electromyographic feedback conditioning and an abbreviated version of progressive relaxation (Paul, 1966) in the context of individual differences). Literature from the areas of personality, physiology, and learning suggest that Rotter's (1954, 1966) construct of internal-external locus of control may be useful in accounting for some of the individual differences observed in attaining both objective (EMG) muscle relaxation as well as subjective feelings of relaxation by the two techniques.

Two recent investigators (Ray, 1971; Fotopoulos, 1970) have demonstrated the effect of Rotter's (1954, 1966) construct of internal-external locus of control on biofeedback heart-rate (EKG) conditioning. According to social learning theory, on which the I-E concept is based, individuals with differential reinforcement histories can be distinguished by the degree to which they attribute reinforcement to their own behavior as opposed to less predictable external sources. The perception of this causal relationship is not an all or nothing event, but is measured on a continuum: the more externally controlled individual views himself as being less in control of his own reinforcement and frequently at the mercy of such forces as chance, fate, or powerful others. Rotter (1966) suggests and subsequent data appears to adequately support (Joe, 1971) the position that a generalized expectancy of locus of control can be measured by a self-report instrument (see Appendix A) sampling attitudes in a wide variety of situations. It is further suggested that an I-E score will be indicative of consistent individual differences reflected in both the nature of the learning process and the particular situation. Rotter postulates that when an internally-controlled person perceives reinforcement as being contingent upon his own actions, the occurence of either a positive or negative reinforcement respectively, will increase or decrease the probability of that behavior recurring in the same or similar situations. The externally-controlled individual, on the other hand, will not respond so effectively nor consistently to such reinforcement as a result of his belief that it is beyond his realm of influence. Several studies (Joe, 1971; Seeman & Evans, 1962) support hypotheses that Internals not only will exert more initiative and effort in influencing their external environments but also will manage to control their own impulses such as smoking, more effectively than Externals (James, Woodruff & Werner, 1965; Straits & Sechrest, 1963). In an extensive review of relevant research employing the I-E scale, Joe (1971) concludes that while there is some evidence supporting Rotter's (1966) prediction that Internals will generally perform more efficiently under skilled conditions while Externals will excel in chance or luck situations, the data are currently inconclusive.

In the Fotopoulos (1970) investigation of heart rate increase, Internals exhibited superior control of their heart-rate to that of Externals under both the no-feedback "thinking" condition and the oscilloscope information feedback condition. However, when Externals were the dually reinforced by both visual information feedback and an experimenter-operated buzzer contingent upon heart-rate increase, their performance exceeded that of Externals receiving only information feedback and approached that of Internals. It appears, then, that Internals and Externals differ not only in the degree to which they are able to utilize internal cognitive resources and proprioceptive feedback to increase heart rate as demonstrated by the "thinking" condition but also in what constitutes effective reinforcement. While the buzzer signal had a significantly greater effect in producing an increase in heart-rate than non-reinforcement over all subjects, visual information concerning one's own skill provided sufficient reinforcement for Internals while the additional external influence of the Experimenter was necessary for Externals to attain a similar level.

Ray's (1971) study investigated conditioning of both heart-rate increase and decrease by Internals and Externals, yielding results supportive of the Fotopoulos (1970) finding that Internals are better able to increase heart-rate than Externals. However, Externals proved to be significantly more proficient at decreasing heart-rate than Internals. This strong interaction effect between locus of control and conditioning of heart-rate direction suggests that the hypothesis of Internal superiority in skilled learning cannot simply be extended to the control of physiological responses. On the contrary, there probably exists a complex and intimate interrelationship among the subtleties of the personality variable, the modality and level of the physiological index, and the learning process.

Self-report measures in the Ray (1971) study indicated that Internals and Externals adopted different strategies for control of their heart-rates. Externals reported that they "looked at objects in the room" significantly more during the deceleration task than during the acceleration task, and Internals reported less time than Externals observing the room during both tasks. In assessing a number of studies supporting situational stereotypy, Libby, Lacy, and Lacy (1972) observe that a task requiring close attention to the environment is accompanied by a depressor component, whereas "mental work" facilitates an acceleratory and pressor component. Specifically, they found that cardiac slowing increased as the attention-interest value of stimuli increased. The presumably divergent approaches to the conditioning task taken by the External, who theoretically relies on the external environment for a frame of reference, and the Internal, who attempts to exert cognitive control, may be psychophysiologically associated with their relative success on heart-rate decrease and increase tasks.

Additionally, Libby, Lacey, and Lacey (1972) found that heart-rate decrease was linearly related to a pleasantness dimension, with unpleasant stimuli provoking the greatest slowing. Although Ray (1971) found no affect to be associated with successful performance on both the increase and decrease tasks, the unpleasant affects of "annoyed" and "irritated" were significantly negatively associated with successful performance on the heart-rate increase task. The Externals rated that they were annoyed, irritated, anxious, discouraged, and bored during the tasks significantly more than did Internals. Whether negative affect facilitates cardiac deceleration, inhibits cardiac acceleration, or is merely a component in a complex patterning of psychophysiological activity is unclear.

The evidence that Internals and Externals may differentially learn to control their heart rates cannot necessarily be directly applied to conditioning of the skeletal musculature. Although research focusing on the relationship of muscle tension and autonomic reactivity with certain aspects of personality has proceeded for decades, Goldstein (1972) reports that no discrete traits can be associated with either physiological index. However, some evidence for individual differences in response modality does merit attention. Goldstein (1964) found that individuals could be differentiated on the basis of a consistent tendency to exhibit an elevated response of either the autonomic nervous system as measured by heart-rate and blood pressure or of the skeletal muscular system. Supporting this finding is an investigation by Kempe (1956) in which he describes a person who responds to stress primarily through the skeletal musculature as being more aloof and intellectual in his approach to life while the autonomic responder is assessed as being more emotionally sensitive and concerned with social acceptance. Balshan (1962) reports correlations of muscle tension with Guilford-Zimmerson personality traits, connoting a person with heightened muscle tension as somewhat impulsive and spontaneous. Houston (1972) found, contrary to expectation but consistent with Ray's (1971) results, that externally-oriented subjects assumed to hold general feelings of helplessness manifested less physiological arousal in terms of heart-rate during stress than internally-oriented persons. It seems, although the modality of response may suggest an idiosyncratic reactivity, it does not, in itself, illuminate the learning process when the specific physiolocal index is the response which one is to modify. Research conducted on the psychophysiology of anxiety appears to be relevant regarding the relationship of personality and relaxation training procedures.

The most direct association between physiological phenomena and the subjective state of anxiety, or tension, was advanced by the James-Lange hypothesis: essentially, it states that experience of muscular tension (and autonomic activity) is what actually constitutes the emotion. Malmo and Shagass (1949) described anxiety as a "heightened state of expectation reflected primarily in the skeletal muscular system (p. 21)." Although opposing views of the directional causal relationship frequently have been postulated, a generally accepted postion is that muscular tension, as measured by electromyography, may provide a useful correlate to subjective tension without implying causality (Lader & Matthews, 1971). Several studies (Williams & Williams, 1967; Davis, Malmo & Shagrass, 1954; Sainsbury & Gibson, 1954) have differentiated anxious patient populations from normals by means of elevated muscle action potentials (MAP). However, Balshan (1962) found that only muscular activity during stress discriminated between groups of normal female subjects selected on the basis of extreme scores on two manifest anxiety scales. She (Goldstein, 1964) later reported that autonomic measures were successful in differentiating normal females from anxious female patients and supported the earlier (Balshan, 1962; Martin, 1956) findings that skeletal muscular activity discriminates between anxious and non-anxious subjects more readily during a stress condition than during a resting period. Shipman, Oken and Heath (1970) investigated an outpatient population during periods of rest and two stress conditions, white noise and a contrived danger. No personality differences were demonstrated during rest; however, in response to white noise depressed patients exhibited a considerable increase in frontalis muscle tension as did persons described as field dependent. Contrary to what may have been expected by Lacey (1967) the latter also showed an increase in heart-rate. Those patients with the lowest forehead tension during white noise, conversely, appeared to be generally active people with high ego strength and high achievement drive. The psychological stress condition of the contrived danger more dramatically elevated most muscles and most autonomic measures considered by the authors to be highly related to the amount of subjective anxiety developed by the individual.

The weight of the evidence from these investigations largely employing heterogeneous patient groups suggests that physiological reactivity is more evident during periods of stress than rest and, additionally, that the kind of stress may be an important factor. Responding to generalization difficulties from patient groups to normals and serious criticism confronting earlier EMG technology (Grossman & Weiner, 1966), two investigators (Smith, 1973; Matus, 1974) have recently studied muscle tension differences among normals at rest. Smith (1973) found that resting frontalis EMG levels positively correlated both with measures of trait anxiety and external locus of Control. Matus (1974) found resting frontalis EMG levels to correlate significantly with the exvia-invia factor from Catell's IPAT and with the Maudsley extraversion. Although frontalis muscle activity was not significantly associated with field dependence as measured by the rod and frame test, resting forearm extensor muscles correlated with field dependence in the Matus study. It seems clear that even though the individuals in the Smith and Matus studies were not subjected to any manipulated stress variable, they differentially responded physically to the experimental situation in a manner consistent with the psychological tests. On the basis of investigations conducted with greatly varying subject groups and numerous operational definitions of anxiety, it appears that subjective anxiety may be reflected in both skeletal tension and autonomic reactivity. Although stress conditions may emphasize individual differences in psychophysiological reactivity, personality variables may also be associated with EMG levels at rest.

The somatoautonomic relationship and its association with the psychologically defined responses of anxiety and stress-perception have long been the subjects of considerable speculation and, recently, of some controversy. On the grounds of available neurophysiological evidence, Jacobson (1938) postulated that decreased muscle activity should facilitate reduced autonomic, particularly sympathetic, activity through a centrally mediated feedback system. Wolpe (1958), following Jacobson's position, and viewing anxiety as a response characterized by high levels of muscle tension and sympathetic arousal, proposed that muscle relaxation could thus be expected to be incompatible with, or to reciprocally inhibit, anxiety. Wolpe specifically anticipated reduced sympathetic nervous system activity to accompany the successful use of voluntary muscle relaxation in the presence of stress-producing fear stimuli (1958, pp. 72-73, 135). Although Wolpe's position has received impressive clinical support from a number of sources, investigations manipulating either the anxiety or muscle tension level, or both, have shown little support for a simple version of the reciprocal inhibition hypothesis. Wilson and Wilson (1970), dividing male subjects among three anxiety levels and three muscle tension conditions, expected that muscle relaxation instruction preceding a stressful paired-associate learning task would improve learning in highly anxious subjects by decreasing debilitating reactivity to the learning situation. However, they found that, regardless of anxiety level, muscle tension subjects were superior in learning to those in the muscle relaxation condition and, further, that high and medium anxious subjects did not differ in learning efficiency, both being significantly superior to low anxious subjects. The data seemed to suggest, as well, that the physiological "coping" response to stress may vary among individuals according to their anxiety level: the learning of high anxious subjects was superior in the induced muscle relaxation condition. Supporting this is evidence presented by Grim (1971) in an investigation studying the effect of self-induced muscle tension and relaxation aided by auditory feedback of breath sounds on anxiety level. Grim found that masseter tension increased the self-reported anxiety of individuals with low initial anxiety and decreased that of persons with high initial anxiety. Although respiration feedback decreased anxiety at all but the lowest levels, Grim noted that tensing, in addition to relaxation, should be explored as an anxiety-reducing technique for highly anxious subjects in desensitization therapy. Sue (1972) found no difference in the effectiveness of desensitization of snake phobia in female subjects under both muscle tension and autonomic activity are necessary components of the anxiety response or are part of an effort to control anxiety and cope with the perceived stress remains obscure.

The programing or sequence of the stress situation itself may be of significance when considering the problem of anxiety and psychophysiological responsivity. In reviewing the literature on learning and muscle activity as measured by electromyography, Goldstein (1972) reports a complex relationship among attentiveness, increased effort and high motivational level--all of which augment muscle action potentials. She notes that one cannot, in practice, differentiate those effects on muscle tension that are due to motivation from the effects of effort and from set. The preparatory period and that immediately following a task appear to be of particular importance in distinguishing normals from anxious subjects. With normal subjects, Davis (1939) observed an initial increase in forearm and calf MAP's at the onset of mental work, followed by a quick drop to a level somewhat above that of a resting condition, and then a more gradual increase. Malmo and Smith (1955) reported that the most reliable tensional differences between psychiatric patients and controls were to be found in the preparatory period. Although there were equivalent autonomic preparatory responses in both groups, the patient group exhibited far greater somatic preparatory responsivity. Theoretically consistent with Eason's (1959) observation that muscle activity varies with subjective feelings of effort rather than with the degree of applied physical force, the psychiatric patients in Malmo, <u>et al</u>'s study required greater arm tension in a rapid discrimination task than controls. Additionally, the persistance of this greater tension (in the absence of initial differences) characterized the psychoneurotic from the other patients. Wind (1969) found greater forearm tension in anxious subjects than controls before and after but not during a similar task. Martin (1956), conversely, found that the EMG levels of patients differed from controls only during stressful interviews. In general, it appears from electromyographic studies that anxious individuals may experience anticipation, subjective effort, and inability to rest after a task to a greater extent than normals.

Related to this observation, and to the data linking anxiety with muscle tension, is the correlational evidence associating anxiety with externality. Ray and Katahn (1968) report that Rotter's I-E Scale and the Taylor Manifest Anxiety Scale are significantly correlated but are assessing conceptually different variables. The authors conclude that the association could not be attributed to a hidden anxiety variable in the I-E Scale. Feather (1967) noted the significant trend of externally oriented subjects of both sexes to report more debilitating anxiety and neurotic symptoms; and Tolor and Regnikoff (1967) report externality to be related to death anxiety in college students. However, several of these investigators (Feather, 1967; Ray & Katahn, 1968) raise the question of whether the belief in external control precipitates anxiety or whether anxiety facilitates a belief in external control.

In addition to Rotter's social learning theory on which the I-E concept is based, another perspective in the differentiation of individuals according to their perceived relationship to the environment comes from the study of perceptual field dependence. Assessing two decades of findings in the field of perception, Witkin and Oltman (1967) contend that salient features of a given individual's perception, where direct sensory stimulation is involved, are equally characteristic of his intellectual mode of functioning. They suggest, additionally, that perceptual and intellectual activities together constitute a pervasive and stable approach to the environment, a distinctive cognitive style. Perceptual field dependence, measured by such instruments as the rod-and-frame test (RFT), the embedded figures test (EFT), and draw-a-person test, is based upon the degree of differentiation the individual makes between himself and the external environment, as well as among environmental stimuli. Although field dependence and locus of control have failed to significantly correlate in some studies (Feather, 1967), the two are conceptually consistent to the extent that both field dependent and externally-controlled individuals rely to a greater extent upon the environment to provide them with cues regarding their behavior than do field independent and internally-controlled persons. The findings of investigations using field dependence measures may be particularly relevant to the current study: subjects learning to control their muscle activity during a novel training procedure must be able to coordinate internal proprioceptive cues with accurately perceived external information.

Studies on perceptual field dependence suggest that field independent persons not only possess greater body articulation but also are better able to control their psychophysiological reactivity under various conditions. Field independent individuals demonstrated greater identification accuracy and had significantly lower thresholds for experiencing letter stimuli on the forehead and the back of the hand than field dependent subjects (Silverman, Cohen, Shmavonian & Greenberg, 1961). Although both field dependent and field independent persons began sensory isolation confinement with a high level of physiological arousal, field independent individuals gradually adapted, while field dependent subjects did not (Cohen, Silverman & Shmavonian, 1963). Zuckerman (1968) found that field dependent persons exhibited equally high arousal levels to both sensory isolation and social isolation in a furnished room. The field independent subjects, however, demonstrated high arousal to sensory isolation only. With particular reference to muscle activity, two studies (Escalona & Heider, 1959; Dyck, Witkin & Oltman, 1967) have reported that differences noted in the four to 32-month period of life seemed predictive of the degree of field dependence in the six to eight year period. Infants later assessed as field independent exhibited moderate levels of body activity with predominantly low levels of muscle tension. Field dependent children, on the other hand, had demonstrated extremely high or low activity levels and were often tense, with the latter being the more striking difference. Employing a number of measures other than field dependence, Shipman _et al_ (1970) observed an increase in both heart rate and muscle tension during white noise in "...environmentally oriented, socially dependent...stimulus bound (persons) lacking internal reference points (p. 364)." It appears that field independent individuals, as well as Internals, may react more appropriately and deliberately to stressful and novel situations; whereas field dependent persons and Externals seem to be more psychophysiologically reactive to environmental, particulary social, stimuli.

As discussed earlier, the personality factor of internal-external locus of control appears to substantially influence the conditioning of heart-rate. Subsequent discussion cumulatively suggests that one might expect equally profound individual differences in ability to condition the level of skeletal muscular activity by electromyographic (EMG) feedback and other relaxation procedures. However, there currently seems to be some discrepancy concerning the importance of such differences among EMG-biofeedback investigations conducted to date with subjects unselected on any personality variable.

Basmajian (1972) notes that a small minority of normal subjects experience difficulty in relaxing; but he emphasizes that EMG's from normal human muscles generally indicate that relaxation occurs completely and almost instantaneously when subjects are asked to relax. Although Basmajian (1972) found no common characteristic distinguishing the small number of subjects who performed poorly on the conditioning of single motor units from those who performed well, Green, Walters, Green & Murphy's (1969) data suggest less confidence in dismissing a hypothesis of individual differences. From 21 subjects, seven were able to attain zero firing or single motor unit firing in less than 20 minutes: 11 achieved low tension levels with feedback, and three who did not succeed at all exhibited some evidence of strain. Alexander (1973) notes that while EMG feedback trained subjects as a whole demonstrated statistically significant evidence of frontalis tension reduction over trials, only seven of nineteen individuals could confidently be assessed as having met a strong criterion of learning. In observing individuals prior to progressive relaxation training, Jacobson (1967) reports that many persons cannot relax upon request; instead they contract in the effort and often are not able to accurately report a relaxed state confirmed by EMG.

The relationship between a subjectively relaxed state and actual level of muscle tension also merits investigation in terms of individual differences. If indeed, as Grim (1971) suggests, some individuals actually increase muscle tension as a sort of coping response to anxiety, one would expect a negative association between a self-reported relaxed feeling and EMG level. It may be that the relative merit of biofeedback and progressive relaxation procedures should be viewed not only from the perspective of efficiency in reducing muscle tension but also from their efficacy in aiding the individual to experience subjective relaxation.

The demonstrated relationship of Rotter's I-E locus of control construct to the conditioning of heart rate and the cumulative data concerned with individual differences in the ability to relax suggests that future research in the area is warranted. A matter of importance in relating evidence from heart-rate conditioning studies to control of somatic responses is the question of skeletal and/or cognitive mediation of autonomic responses in operant conditioning procedures. Skinner (1938) expressed doubt that autonomic nervous system responses could be operantly conditioned; and Smith (1954), in a review, proposed that all autonomic conditioning is an artifact of skeletal muscle responding. More recently, the debate has been forwarded by Katkin and Murray (1968) and Crider, Schawartz and Shindman (1969). Emphasizing alternative explanations of positive findings on the instrumental conditioning of various autonomic responses, Katkin and Murray (1968) suggest that the apparently voluntary control exercised over autonomic activities such as heart-rate may not be direct, but linked instead to a mediating voluntary operant. They propose that the subject is actually being reinforced for somatic, verbal, or cognitive activity, and that it is this response that may serve as either a conditioned or unconditioned stimulus for autonomic nervous system responding. Crider et al (1969) forcefully responded to many of Katkin and Murray's arguments against the direct instrumental conditioning of autonomic responses; however, they conceded that while Church's (1964) position was inappropriately applied to punishment and avoidance paradigms, potential sources of bias should be attenuated by controlling for individual differences in the effectiveness of the reinforcer in a reward paradigm.

In a recent article, Miller and Dworkin (1972) report the considerable difficulty in replicating studies from their laboratory performed with curarized rats, studies considered to be the "...truly definitive series of experiments establishing the phenomenon of instrumental conditioning of autonomically mediated responses (Katkin & Murray, 1968, p. 65.)" Other reports (Lisina, 1965; Rice, 1966) yield conflicting results concerning the nature of the somatoautonomic relationship in learning; and the issue remains unresolved. While the question of skeletal mediation in the instrumental learning conditioning of autonomic responses may not be so ostensibly crucial with regard to practical applications, it may be scientifically imperative to determine whether the effect should be framed in terms of classical or instrumental conditioning, or both. The role of reinforcement and its relative effectiveness in controlling the behavior of an individual are inextricably involved in the distinction of learning processes. Not only the biofeedback conditioning process itself but also its implications for therapeutic effects (Miller & Dworkin, 1972; Goldstein, 1972; Green et al, 1969) necessitate a more adequate understanding of the autonomic and skeletal components of a response pattern and of their relationship in terms of transfer of training (Miller & Dworkin, 1972). Clearly at this point in our comprehension of the psychophysiological processes involved in biofeedback conditioning, careful observation of skeletal muscle activity is required.

Research in the overlapping area of physiology, personality, and learning suggest that individual differences in the effectiveness of reinforcement are reflected in an interaction of all three. Moreover, cumulative evidence appears to support a relationship among a generalized expectancy concerning the control of reinforcement as measured by Rotter's I-E Scale, the physiological index of EMG, and the learning processes involved in relaxation training. Hypotheses are outlined below.

Hypothesis I: Baseline. Because externally-oriented individuals may be expected to exhibit a greater degree of anxiety and psychophysiological arousal in a novel situation than Internals, EMG recordings under instructions to relax during the initial period should indicate greater MAP's for Externals.

Hypothesis II: Preparatory response. Because internals hold the belief that they are able to exert more control over their environment and, therefore, presumably have a higher level of motivation in a skilled task they should exhibit higher MAP's during the preparatory period signalled just before the initiation of both training procedures.

Hypothesis III: Treatment. (A) Because Internals are generally expected to perform more successfully on perceived skilled tasks, they will be better able to decrease their MAP's in the biofeedback procedure than Externals.

(B) In addition to their anticipated superiority in skilled tasks, Internals are expected to be more sensitive to proprioceptive cues and better able to respond appropriately in a novel situation. Therefore, the performance of Internals should exceed that of Externals in the abbreviated progressive relaxation procedure.

(C) The muscle tension for subjects in both treatment techniques is expected to decrease over trials, while that of the control groups will not. Because of the brief duration of the training sessions and lack of literature comparing the two techniques, no predictions are forwarded concerning the relative efficiency of abbreviated progressive relaxation and biofeedback. No hypothesis is proposed expecting differences in the two procedures for Externals.

Hypothesis IV: Session II. (A) Generalization and durability of the relaxation effect will be explored in a second retention period. It is expected that the EMG levels of all subjects will be reduced from baseline levels in Session I because the experimental situation will no longer be novel. This difference is expected to be greater for Externals than for Internals.

Hypothesis V: Self-Report Measures. In general, Internals are expected to report greater subjective relaxation and less anxiety than Externals at the end of Session I. Subjects in the training procedures are expected to report greater relaxation than those in the control groups.

Differences in self-reported strategies will be tested among groups; however, no specific predictions are made.

Additionally, relationships among subjective and objective measures of relaxation will be explored in the context of both locus of control and treatment condition.

METHOD

Subjects. The subjects were 57 female undergraduate students at the University of Manitoba selected on the basis of their quartile scores on the Rotter (1966) I-E Scale (see Appendix A). Subjects in the first quartile (mean = 16.79, S.D. = 1.68) of the original distribution were referred to as Externals or E's and those scoring in the fourth quartile (mean = 6.17, S.D. = 1.34), as Internals or I's. None of the subjects had previously participated in a psychophysiological experiment and were unfamiliar with the procedure of recording from electrodes. The subjects were randomly distributed among the three treatment groups as follows: I - Biofeedback (N = 10); I - Progressive Relaxation (N = 9); I - Control (N = 10); E - Biofeedback (N = 10); E - Progressive Relaxation (N = 10); and E - Control (N = 8). Analyses of variance performed on the scores of Internals and of Externals by treatment condition supported randomization ($F_{2,26} = .78$; $F_{2,25} = .50$, respectively). The data from several subjects had to be discarded due to some muscle-related physical impairment or failure to complete all phases of the experiment. The subjects were also administered an affect rating scale (see Appendix B) and a strategy questionaire (see Appendix C) similar to those employed by Ray (1971).

Apparatus. The experiment was conducted in two adjacent rooms. The subjects received the training procedure in a 5x5 ft. chamber padded with black-covered fiberglass. The temperature was maintained at 75°F (24°C) (cf. Goldstein, 1972) and a small light installed to prevent the room from being entirely black. A chair with adjustable arm and head-rests, on which the subject could comfortably recline, was positioned in the center of the room.

Subjects in both the biofeedback and progressive relaxation conditions received auditory training information through earphones. Although there is some evidence that auditory and visual feedback are equally effective in EMG biofeedback training (Harrison & Mortensen, 1962), studies specifically comparing the two modalities find better performance produced by auditory feedback (Leibrecht, Lloyd & Pounder, 1973; Carlsoo & Edfeldt, 1963). Additionally, continuous feedback has been found to be superior to intermittent averaging procedures for EMG training (Rubow & Smith, 1971). Therefore, subjects in the biofeedback training condition heard a tone with a frequency proportional to the bioelectric isotonic activity generated in the muscle. A high-pitched tone was indicative of a high level of activity and, conversely, as MAP's decreased, the tone lowered in frequency. The subjects in the progressive relaxation condition listened to tape-recorded instructions similar to those of Paul's (1966) version of abbreviated progressive relaxation. Control subjects also wore earphones on which the only sound was a tone to signal the commencement and termination of periods.

The recording leads were fed into an adjacent room, where integrated EMG recordings were made using a Feedback Myograph BFT 401, the output of which will be led to an MFE dual channel strip chart recorder through a BFT 231 optical isolator.

Procedure. Each subject in the experiment participated individually in two sessions separated by five to seven days. The first 30 minute session consisted of three periods divided as follows: Period 1 - baseline or initial resting level; Period 2 - treatment condition (EMG feedback, progressive relaxation, or control); and Period 3 - resting post-treatment phase. Additionally, subjects in the two treatment conditions of biofeedback and progressive relaxation received a signal indicating that the training phase of the experiment would begin in 30 seconds: this was referred to as the preparatory or anticipatory period. The affect rating scale and strategy questionaire patterned after those employed by Ray (1971) were administered immediately following Session I. The second fifteen minute session consisted only of instructions to relax as much as possible to investigate retention in the following week. See Table I for graphic representation of design and time breakdown.

The subjects were informed of the experimental procedure, according to treatment group, by the Experimenter prior to the application of electrodes. In general, the

TABLE I

EXPERIMENTAL DESIGN

Treatment	Locus of Control	4 min 30 sec	30 sec	25 min	5 min	15 min
Biofeedback	I	BASELINE	PREPARATORY PERIOD	TRAINING	POST-TREATMENT	SESSION II
	E					
Progressive Relaxation	I					
	E					
Control	I					
	E					

two treatment groups of biofeedback and progressive relaxation were asked to relax for four minutes and 30 seconds at which time they would receive a signal denoting that the training phase would begin in 30 seconds. After the 20 minute training period, they were to remain relaxed for five additional minutes. In order to micmic the different phases in the two training procedures, the control groups were instructed to relax for five minutes and, upon hearing a tone, to "deeply" relax for 20 minutes. A second tone indicated that they were to remain relaxed for five minutes. See Appendix D for specific training instructions.

Beckman surface EMG electrodes were applied to the prepared (Basmajian, 1967) skin over the frontalis muscle in the position described by Tippold (1967, pp. 284-285). DC resistances between action and reference electrodes were maintained between two thousand and ten thousand ohms. The selection of this muscle was made for a number of reasons. Voas (1952) found test-retest reliability co-efficients averaged over a variety of conditions to be as high as .95 for the frontalis while that for several other muscles was substantially lower. Goldstein (1972), in her extensive review of electromyography, asserts that the reliability of MAP's from this muscle is high enough to merit its utility in measuring differences between individuals. It seemed, as well, that the frontalis muscle was particularly warranted in a study comparing subjects in terms of both a personality variable and differential instructional sets. Travis and Kennedy (1948) speculated that the frontalis was most sensitive to expectation and often relaxes once the event occurs. Shipman (1970a) observed that tension in six other muscles was related to personality at a rate expected by chance while a striking association appeared to exist between the frontalis and a depression--high-ego-strength continuum. Frontalis tension in this study best discriminated among individuals during both white noise and psychological stress conditions. Additionally, Shipman, Cken, and Goldstein (1964) found that the frontalis often had its highest correlations with skin conductance as opposed to other muscles. This is an interesting observation in the context of expected anxiety and tension differences in the current study. Frontalis muscle tension was found to decrease significantly in response to relaxation instructions, as opposed to directions to plan a new home program (Matthews & Gelder, 1969). Although the differences were not statistically significant, fear scenes resulted in more frontalis muscle activity than neutral scenes in a desensitization procedure (Grossberg & Wilson, 1968).

After both sessions were completed the subject was briefed on the objectives of the study and her questions answered as fully as possible at that point. Results were made available to all subjects upon request after the completion of study.

RESULTS

A time-sampling procedure was employed to obtain measures of electromyographic activity during the various stages of the experiment. During Session I, muscle action potentials (MAP's) were sampled at 10-second intervals during the third and fifth minutes of the 5-minute initial resting period; during the last five minutes of the 20-minute treatment period; and during the last two minutes of the 5-minute post-treatment period. Those samples were then averaged to yield three scores representing the three major phases of Session I. A fourth measure, the preparatory response, was calculated in the biofeedback and progressive relaxation conditions during the last 30-seconds succeeding a warning signal and preceeding the treatment proper. A similar method was also applied to the electromyographic data of Session II. The means and standard deviation are presented in Table II.

Baseline. Analysis of variance (see Table III) performed on baseline or initial resting level scores yielded significant main affects for locus of control and treatment as well as a significant interaction effect (see Table III). Externals demonstrated elevated frontalis muscle activity relative to that of internals during this period; and individuals in both the biofeedback and progressive relaxation treatment conditions exhibited greater muscle tension than those in the control condition. Post-hoc

TABLE II

FRONTALIS LEVELS (IN METER READINGS) OF GROUPS OVER TRIALS

TREATMENT	LOCUS OF CONTROL	BASELINE		TREATMENT		POST-TREATMENT		SESSION II	
		MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
BIOFEEDBACK	I (N = 10)	23.89	7.09	21.98	4.18	21.92	3.51	19.28	2.45
	E (N = 10)	21.32	4.48	19.06	4.95	20.75	4.51	16.58	6.71
PROGRESSIVE RELAXATION	I (N = 9)	16.34	3.43	15.92	3.41	14.64	2.72	10.46	3.61
	E (N = 10)	23.34	9.65	19.70	6.86	21.29	8.14	18.29	7.30
CONTROL	I (N = 10)	14.97	3.47	12.86	3.98	15.26	3.41	13.75	3.86
	E (N = 8)	15.34	6.11	11.92	5.91	15.94	10.61	12.94	7.19

TABLE III

ANALYSIS OF VARIANCE-BASELINE RESTING LEVELS

Source	Df	Sum Squares	Mean Squares	F
I-E	1	14.233	14.233	4.20^{*}
Treatment	2	44.894	22.447	6.63^{**}
Interaction	2	25.903	12.951	3.82^{*}
Error	51	1629.092	31.943	
		Adjusted Error	3.387	
Total	56	2438.715		

$^{*}p < .05$

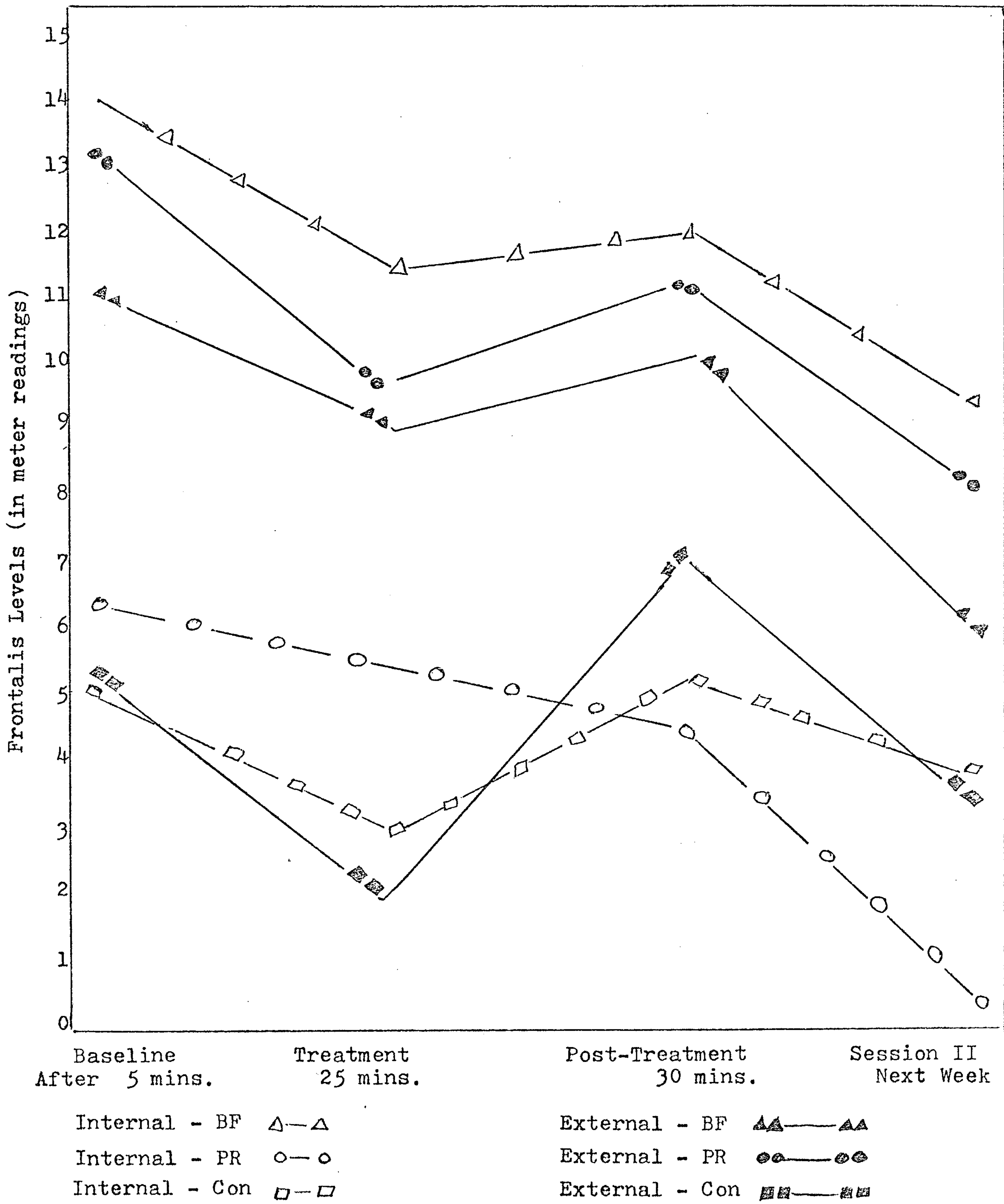
$^{**}p < .005$

comparisons by independent sample t tests demonstrate that the interaction can be attributed to the fact that Internals in the progressive relaxation condition exhibited significantly lower MAP's than did Internals in the biofeedback condition ($t = 4.34$, $p < .002$) and Externals in both the biofeedback ($t = 2.67$, $p < .05$) and progressive relaxation conditions. No differences were found between the two control conditions nor between Internals in the progressive relaxation treatment and either control group. (see Figure 1).

Preparatory. Employing the measure of muscle activity for the thirty seconds preceding the warning signal as covariante, an analysis of covariance for the anticipatory response showed no significant differences for locus of control or treatment. However, because it seemed reasonable that possible differences may have been masked by an analysis of covariance measuring only differences in amplitude over a very short period of time, a non-parametric test was also performed. Individuals in the biofeedback condition demonstrated elevated MAP's in the thirty seconds succeeding the warning signal and preceeding the treatment proper ($x^2 = 12.5$, $p < .01$). No significant change was observed in subjects in the progressive relaxation condition receiving a similar warning signal, and no difference was found between Internals and Externals in their anticipatory response to treatment.

FIGURE I

MUSCLE ACTIVITY OF GROUPS OVER TIME



Treatment. An analysis of variance for repeated measures was performed on the electromyographic values representing the baseline, treatment, post-treatment, and Session II scores (see Table IV). Significant effects were found for treatment, the interaction of treatment and locus of control, and trials. Post-hoc comparisons of treatment differences by independent sample t tests indicated that subjects in the biofeedback condition exhibited higher muscle tension than did those in both the progressive relaxation and control conditions ($t = 1.99$, $p < .05$; $t = 4.189$, $p < .001$, respectively). Individuals in the progressive relaxation treatment also demonstrated elevated frontalis measures compared to control subjects ($t = 2.18$, $p < .01$). In order to further investigate the interaction effect between treatment and locus of control, post-hoc comparisons were made among all six groups (see Table V). No difference was found among both Internals and Externals in the biofeedback condition and Externals in progressive relaxation. The muscle tension measures of each of these three groups significantly exceeded those of each of the remaining three groups, among which no differences were found.

Because the Treatment x Trials interaction also approached significance ($F_{6,153} = 2.08$, $p < .06$), an analysis of simple effects was performed according to Kirk (1969) on each of the six groups over trials (see Table VI). Adjusting for family-wise error rate, it was

TABLE IV

REPEATED MEASURES ANALYSIS OF
VARIANCE ON ELECTROMYOGRAPHIC
DATA OVER TRIALS

Source	df	Sum Squares	Mean Squares	F
Locus of Control	1	95.66	95.66	1.07
Treatment	2	1552.01	776.00	8.74**
IE - Trt	2	754.68	377.34	4.25*
W/in Cell	51	4530.47	88.83	
Trials	3	513.53	171.176	16.94**
I-E - Trl	3	28.80	9.60	.95
Trt - Trl	6	126.11	21.02	2.08
IE - Trt - Trl	6	33.47	5.58	.552
W/in Cell	153	1546.05	10.10	
Total	227	9177.0352		

** $p < .001$

* $p < .025$

TABLE V

T-VALUES - DIFFERENCES AMONG FRONTALIS LEVELS OF GROUPS OVER TRIALS

	Biofeedback	Progressive Relaxation	Control
Biofeedback	X	1.99[a]	4.19[e]
Progressive Relaxation		X	2.18[c]
Control			X

		Biofeedback		Progressive Relaxation		Control	
		I	E	I	E	I	E
Biofeedback	I	X	1.08	3.37[d]	0.47	3.54[e]	3.41[d]
	E		X	2.32[b]	0.61	2.46[b]	2.38[b]
Progressive Relaxation	I			X	2.92[d]	0.07	.13
	E				X	3.07[d]	2.96[d]
Control	I					X	0.07
	E						X

[a] $p < .05$

[b] $p < .025$

[c] $p < .01$

[d] $p < .005$

[e] $p < .001$

TABLE VI

ANALYSIS OF VARIANCE FOR SIMPLE
MAIN-EFFECTS - FRONTALIS LEVELS
OF TREATMENT GROUPS OVER TRIALS

Source	df	Sum of Squares	Mean Square	F
Trials	3	513.5	171.2	16.94**
Trial - BF_I	3	103.1	34.4	3.40*
Trial - PR_I	3	204.4	68.1	6.74*
Trial - Con_I	3	36.2	12.1	1.20
Trial - BF_E	3	35.3	11.8	1.17
Trial - PR_E	3	136.8	45.6	4.51*
Trial - Con_E	3	88.0	29.3	2.90
Trt - Trials	6	126.1	21.0	2.08
IE - Trt - Trials	6	33.4	5.6	.055
Error	153	1546.1	10.1	

** $p \leq .001$

* $p < .01$

found that the frontalis muscle tension of Internals in the biofeedback and progressive relaxation conditions significantly decreased over trials as did that of Externals in the progressive relaxation condition. Neither the two control groups nor Externals in the biofeedback condition significantly lowered their muscle activity over the four trial measures.

In order to specifically test differences among the three muscle activity measures of Session I, correlated t tests were performed for the six groups (see Table VII). Results indicated that all groups, with the exception of Internals in the progressive relaxation condition, significantly lowered their frontalis muscle activity during treatment from initial baseline levels. No significant changes were observed between treatment and post-treatment scores (correlated t values in Table VII). However, in spite of the fact that five of six groups demonstrated significant differences between baseline and treatment measures, only Internals in the biofeedback and progressive relaxation conditions varied significantly from initial baseline level to post-treatment of Session I.

<u>Session II</u>. Analysis of variance performed on baseline scores of Session II indicated a main treatment effect and interaction between treatment and locus of control (see Table VIII). Subjects who had been in the biofeedback condition during Session I exhibited significantly greater muscle activity to those previously in the progressive

TABLE VII

CORRELATED T-VALUES FOR GROUPS OVER TRIALS OF SESSION I

Treatment	Locus of Control	Baseline to Treatment	Treatment to Post-Treatment	Baseline to Post-Treatment
BIOFEEDBACK	I (N = 10)	6.56[d]	-.48	2.70[b]
	E (N = 10)	3.04[c]	-1.06	.2997
PROGRESSIVE RELAXATION	I (N = 9)	1.07	1.84	2.16[a]
	E (N = 10)	2.63[c]	-1.14	1.04
CONTROL	I (N = 10)	2.79[c]	-1.39	-.17
	E (N = 8)	2.93[c]	-2.11	-.81

[a] $p < .05$ (one-tailed)
[b] $p < .0125$ (one-tailed)
[c] $p < .01$ (one-tailed)
[d] $p < .0005$ (one-tailed)

TABLE VIII

ANALYSIS OF VARIANCE - INITIAL LEVELS OF SESSION II

Source	Df	Sum Squares	Mean Squares	F
I-E	1	37.032	37.032	1.41
Treatment	2	202.697	101.349	3.85*
Interaction	2	287.652	143.826	5.46**
Error	51	1342.256	26.319	
Total	56	1868.383		

** $p < .001$

* $p < .05$

relaxation or control conditions. In contrast to the corresponding initial resting measures during Session I, there was no difference attributable to locus of control. However, the interaction effect appears to be similar. Post-hoc comparisons by independent sample t tests indicate that Internals who had been in the progressive relaxation condition during Session I were significantly more relaxed in terms of muscle activity than were Internals and Externals previously in the biofeedback condition ($t = 6.29$, $p < .001$; $t = 2.95$, $p < .01$, respectively) and Externals in the progressive relaxation condition ($t = 3.07$, $p < .01$). No significant differences were found among Internals previously in progressive relaxation and the two control conditions.

<u>Self-report measures</u>. Analyses of variance were performed on the Affect Rating Scale yielding main effects of locus of control for Relaxed ($F_{1,51} = 7.97$, $p < .005$), Tense ($F_{1,51} = 10.50$, $p < .001$), and Anxious ($F_{1,51} = 3.26$, $p < .05$). Externals rated themselves as feeling less relaxed, more tense, and greater anxiety than did Internals immediately following Session I. However, post-hoc comparisons by independent sample t tests revealed that there were no differences between Internals and Externals in the control conditions on these three affects. Although Internals in the progressive relaxation and biofeedback condition reported feeling significantly more relaxed and less tension than did Externals in these conditions, there was no difference in reported anxiety between the two biofeedback conditions.

Internals in the progressive relaxation condition indicated less subjective tension than did Internals in the biofeedback condition ($t = 2.15$, $p < .05$).

Analysis of variance also yielded a significant main affect of locus of control for Engaged in Thought ($F_{1,51} = 6.17$, $p < .005$) as well as for treatment ($F_{2,51} = 4.08$, $p < .025$) and an interaction ($F_{2,51} = 3.85$, $p < .05$). Externals were more thoughtful than were Internals following progressive relaxation, and no difference was found between Internals and Externals in either the biofeedback or control conditions. Additionally, a main treatment effect for Enthusiastic ($F_{2,51} = 4.00$, $p < .025$) was indicated, with biofeedback being less preferred to both the progressive relaxation and control conditions, between which there was no difference. No differences were found on the Affect Rating Scale for the variables of Interested, Alert, Drowsy, Bored, or Pleasant (see Table IX).

Analysis of variance performed on the Strategy Questionaire yielded a significant treatment effect for "thought about muscle activity" ($F_{2,51} = 6.38$, $p < .01$). Subjects in the biofeedback and progressive relaxation condition spent more time thinking about muscle activity than did control subjects. No other differences among strategies were found.

Relation of objective and subjective measures of relaxation. Pearson product moment correlation coefficients were calculated among baseline treatment, post-treatment

TABLE IX

AFFECT RATING SCALE - MEANS AND STANDARD DEVIATIONS OF GROUPS

Affect	I-E	Biofeedback Mean	Biofeedback S.D.	Progressive Rel. Mean	Progressive Rel. S.D.	Control Mean	Control S.D.	F-Value
Relaxed	I	8.20	.92	8.67	.50	7.70	1.34	I-E
	E	7.10	2.47	6.80	2.20	7.00	1.31	F=7.97[b]
Tense	I	1.10	.32	1.11	.33	1.80	1.23	I-E
	E	3.30	3.09	3.20	2.44	2.25	1.58	F=10.50[a]
Anxious	I	1.50	1.58	1.33	.71	2.90	1.45	I-E
	E	2.00	2.00	3.50	2.68	2.88	1.96	F=3.26[d]
Enthusi-astic	I	4.60	1.84	5.44	2.70	5.50	1.35	Treatment
	E	3.60	1.26	5.90	2.13	5.88	2.42	F=4.00[c]
Engaged in Thought	I	4.60	2.80	3.22	1.30	5.30	1.70	IE F=6.17[b] Trt F=4.08[c]
	E	3.90	2.18	6.40	2.12	7.13	2.64	Interaction F=3.85[d]
Pleasant	I	7.60	1.26	7.78	1.30	5.50	2.22	Non-signifi-cant
	E	5.70	1.34	6.70	2.06	6.38	2.13	
Alert	I	4.60	1.26	4.89	2.67	5.50	1.78	Non-signifi-cant
	E	3.80	1.69	5.40	2.01	5.88	2.42	
Drowsy	I	6.40	2.37	6.11	2.89	4.70	3.23	Non-signifi-cant
	E	5.90	2.69	6.40	3.13	4.50	2.56	
Bored	I	1.30	0.67	2.11	1.96	1.80	1.23	Non-signifi-cant
	E	2.70	1.89	1.60	1.35	1.25	0.46	
Inter-ested	I	6.80	1.32	6.78	2.22	6.50	1.27	Non-signifi-cant
	E	5.70	2.00	7.50	1.51	7.50	1.31	

[a] $p < .001$
[b] $p < .005$
[c] $p < .025$
[d] $p < .05$

Note: Rating Scale 1-9;
Slightly -1,
Moderately -5,
Strongly -9

and Session II frontalis EMG levels and self-report affect ratings of Relaxed, Tense, and Anxious. As expected, when the correlations of the seven variables were performed over all subjects, those among the four muscle activity scores were highly significant as were those among the three subjective variables, all exceeding a probability of less than .001 (see Table X). However, no significant correlations were found between any of the objective and subjective measures. Because there had been significant main effects for locus of control in several previous analyses of both frontalis measures and affect ratings, correlation matrices were also composed separately for Internals and Externals (see Table XI). These yielded similar results to those presented for all subjects, with highly significant correlations among the EMG measures for both Internals and Externals and among the affect ratings for Externals. For Internals, the rating of Anxious failed to reach significance when correlated with ratings of Relaxed and Tense ($r = -.27$, $p < .25$; $r = .34$, $p < .10$, respectively).

Because consistent treatment differences were found throughout much of the data analyses, correlation matrices were also compiled for each of the three treatment conditions (see Table XII). In addition to the generally highly significant correlations observed respectively among objective and subjective measures in the previous matrices, significant correlations were found between

TABLE X

CORRELATION MATRIX OF OBJECTIVE AND SUBJECTIVE MEASURES OF RELAXATION FOR ALL SUBJECTS

	1	2	3	4	5	6	7
1	1.00						
2	0.91*	1.00					
3	0.76*	0.73*	1.00				
4	0.76*	0.65*	0.62*	1.00			
5	-0.09	-0.10	-0.18	-0.14	1.00		
6	-0.02	-0.03	0.09	0.02	-0.81*	1.00	
7	0.07	-0.00	0.03	0.12	-0.63*	0.68*	1.00

* $p < .001$ N = 57

Variable Description

1 Baseline frontalis measure
2 Treatment frontalis measure
3 Post-treatment frontalis measure
4 Session II frontalis measure
5 Relaxed rating
6 Tense rating
7 Anxious rating

TABLE XI

CORRELATION MATRICES OF OBJECTIVE AND SUBJECTIVE MEASURES OF RELAXATION BY LOCUS OF CONTROL

INTERNALS (N = 29)

	1	2	3	4	5	6	7
1	1.00						
2	0.94*	1.00					
3	0.80*	0.70*	1.00				
4	0.75*	0.63*	0.63*	1.00			
5	0.04	-0.02	0.06	-0.16	1.00		
6	-0.22	-0.18	-0.11	0.02	-0.62*	1.00	
7	-0.21	-0.30	-0.25	0.01	-0.27	0.34	1.00

EXTERNALS (N = 28)

	1	2	3	4	5	6	7
1	1.00						
2	0.90*	1.00					
3	0.79*	0.84*	1.00				
4	0.75*	0.67*	0.65*	1.00			
5	-0.08	-0.13	-0.25	-0.08	1.00		
6	-0.03	-0.01	0.13	-0.05	-0.82*	1.00	
7	0.18	0.15	0.19	0.14	-0.74*	0.77*	1.00

* $p < .001$

<u>Variable Description</u>

1 Baseline frontalis measure

2 Treatment frontalis measure

3 Post-treatment frontalis measure

4 Session II frontalis measure

5 Relaxed rating

6 Tense rating

7 Anxious rating

TABLE XII

CORRELATION MATRICES OF OBJECTIVE AND SUBJECTIVE MEASURES OF RELAXATION BY TREATMENT GROUP

Biofeedback (N = 20)							
	1	2	3	4	5	6	7
1	1.00						
2	0.93***	1.00					
3	0.80***	0.67***	1.00				
4	0.30	0.25	0.39[a]	1.00			
5	0.02	0.12	-0.36[a]	0.09	1.00		
6	-0.01	-0.18	0.48*	0.15	-0.78***	1.00	
7	-0.06	-0.21	0.32	0.19	-0.61***	0.74***	1.00

Progressive Relaxation (N = 19)							
	1	2	3	4	5	6	7
1	1.00						
2	0.92***	1.00					
3	0.81***	0.80***	1.00				
4	0.84***	0.80***	0.83	1.00			
5	-0.37[a]	-0.49*	-0.44*	-0.45*	1.00		
6	0.20	0.33	0.30	0.18	-0.86***	1.00	
7	0.57**	0.64**	0.49*	0.54**	-0.87***	0.76***	1.00

Control (N = 18)							
	1	2	3	4	5	6	7
1	1.00						
2	0.82***	1.00					
3	0.65***	0.60**	1.00				
4	0.87***	0.65**	0.41	1.00			
5	0.18	-0.05	0.21	0.03	1.00		
6	-0.30	-0.19	-0.31	-0.17	-0.84***	1.00	
7	-0.31	-0.18	-0.39	-0.29	-0.28	0.41[a]	1.00

*** $p < .001$ (t-t)
** $p < .01$ (t-t)
* $p < .05$ (t-t)

[a] $p < .10$ or $p < .05$ (one-tailed)

(con't.)

TABLE XII (con't)

<u>Variable Description</u>

1	Baseline frontalis measure	5	Relaxed rating
2	Treatment frontalis measure	6	Tense rating
3	Post-treatment frontalis measure	7	Anxious rating
4	Session II frontalis measure		

frontalis level and affect ratings in both the biofeedback and progressive relaxation matrices. The post-treatment frontalis measure significantly correlated with the self-report rating of Tense ($r = .48$, $p < .025$, one-tailed) and with that of Relaxed ($r = -.36$, $p < .05$, one-tailed) among subjects in the biofeedback condition. However, the results of the progressive relaxation matrix proved more dramatic: the subjective assessment of Relaxed significantly correlated with all four frontalis measures ($r = -.37$, $p < .05$; $r = -.49$, $p < .025$; $r = -.44$, $p < .025$; $r = .45$, $p < .025$, one-tailed, respectively) and as did that of Anxious ($r = .57$, $p < .005$; $r = .64$, $p < .005$; $r = .49$, $p < .025$; $r = .54$, $p < .005$, one-tailed, respectively). Regression analyses performed on these objective and subjective measures in the progressive relaxation condition indicated that ratings of Relaxed, Tense, and Anxious accounted for a significant amount of the variance in the treatment EMG score and in the Session II measure (see Table XIII). In contrast to the two treatment groups of biofeedback and progressive relaxation, no significant correlations were observed between any of the objective and subjective measures of relaxation in the control group.

TABLE XIII

REGRESSION ANALYSES PREDICTING FRONTALIS LEVELS OF PROGRESSIVE RELAXATION SUBJECTS FROM SELF-REPORT MEASURES

Treatment Score from Ratings of Relaxed, Tense & Anxious

Source	df	Sum Squares	Mean Squares	F
Regression	3	274.30	91.43	4.43*
Deviations	5	309.41	20.63	
Total	18	583.71		

R = .686; RSQ = .47

Session II Score from Ratings of Relaxed, Tense & Anxious

Source	df	Sum Squares	Mean Squares	F
Regression	3	400.97	133.66	4.80*
Deviations	15	417.82	27.86	
Total	18	818.79		

R = .70; RSQ = .49

* $p < .05$

DISCUSSION

In his comprehensive review of studies investigating the validity of the internal-external locus of control dimension, Rotter (1966) suggests that the most important kind of data to assess involves the attempts of people to control their environments. The development of biofeedback techniques aiding in the potential control of certain aspects of the internal environment has broadened the arena of responses for which the I-E construct may have significant implications (Fotopoulos, 1970; Ray, 1971). When applied to the conditioning of EMG levels, particularly of the frontalis muscle, biofeedback is often viewed as a relaxation training method similar to that of progressive relaxation. However, although the aim of both EMG feedback and progressive relaxation is to enable the individual to attain both objective and subjective relaxation, it may be that the two techniques are differentially effective to different persons.

Frontalis EMG levels under instructions to relax during the 5-minute baseline period were higher for Externals than for Internals, as predicted. In the novel and presumably stressful experimental situation, the elevated muscle activity of Externals may be explained in terms of their tendency to experience greater relative anxiety and tension (Joe, 1971). Additionally, Internals may be more sensitive to the proprioceptive feedback from their muscles and, therefore, able to attain greater relaxation. However, the differences in initial resting levels cannot be attributed solely to locus of control. Instructions for the training phase of the experiment were given prior to the baseline measure, a factor which appears to have had a complex influence on the resting levels. Those subjects in both treatment conditions exhibited greater frontalis tension than subjects in the control condition. While there were no significant differences between Internals and Externals in either the biofeedback and control conditions, Internals in the progressive relaxation treatment demonstrated significantly lower EMG levels than Internals in biofeedback and closely resembled control levels.

Although the relationship among attentiveness, increased effort, and motivational level were considered of central importance in the design of the experiment, these differences were expected to be exhibited in the signalled preparatory period, 30-seconds prior to the beginning of relaxation training. Relevant studies on performance which have related changes in muscle action potential to effort, motivation, and success in mental tasks (Goldstein, 1972) observed these variations in terms of seconds. However, it appears as if anticipation of the training phase may have been reflected in higher EMG levels for individuals in both treatment groups relative to control subjects. The fact that Internals in the progressive relaxation condition exhibit significantly lower frontalis levels than subjects in the other three training groups, suggests an explanation in terms of both treatment and locus of control. The more complex and perhaps more novel instructions of the biofeedback technique may have affected the anticipation of Internals to a greater extent than progressive relaxation instructions. Compared to progressive relaxation, biofeedback may have been perceived as more of a skilled task by Internals and, therefore, as one requiring greater effort and motivation. An alternative explanation may be that the imminent commencement of a skilled task, as such, was considered as more threatening to Internals. Malmo, Boag, and Smith (1957) discovered differential muscle responses to supportive and threatening situations: muscle action potentials in speech muscles markedly decreased during rest following praise and remained high after criticism. The fact that no difference was observed between Externals in the two training conditions appears to be consistent with supposition that externally-oriented individuals experience heightened anxiety and physiological reactivity in response to novel situations.

Although no differences attributable to locus of control were found in the preparatory period, there is some limited evidence supporting the suggestion that the two training conditions may be differentially perceived. A significantly greater number of subjects in the biofeedback condition raised their muscle action potentials just prior to the beginning of training than those whose MAP's either remained the same or decreased. No such elevation of frontalis tension was observed in progressive relaxation subjects. Because it would be generally expected that muscle activity would decrease gradually over time with adaptation to the experimental situation, it seems that the EMG increase of biofeedback subjects can best be explained in terms of a preparatory response, getting ready to perform a novel task.

The basic prediction for the I-E dimension in the learning paradigm suggests that Internals will excel when confronted with a task requiring skill; whereas Externals will perform more effectively in situations determined by chance (Joe, 1971). Because both the biofeedback and progressive relaxation theoretically require some degree of differential skill, Internals were expected to be able to reduce their EMG levels more efficiently than Externals. This hypothesis was strongly confirmed only for Internals in the progressive relaxation treatment, there being no apparent differences between Internals and Externals in either the biofeedback or control conditions. However, due to the significant differences in baseline levels, the results of treatment effectiveness and interaction with locus of control are more difficult to evaluate.

Overall treatment results indicate that subjects in the progressive relaxation condition exhibited lower frontalis tension than subjects in the biofeedback condition but that EMG levels were lowest among control subjects. The superiority of the control condition, which was essentially visual and auditory deprivation, was unexpected even though much of the variance may be attributed to initial resting level differences. With the exception of investigations focusing on single motor units, it is difficult to find a study in the EMG feedback literature employing a control group. The vast majority of the evidence supporting the effectiveness of the technique has come from clinical reports in hypertension (Miller, 1972) and chronic tension headache (Budzynski, Stoyva & Adler, 1970; Budzynski & Stoyva, 1971; Wickramakera, 1972). In a recent study, Alexander and Hanson (1974) observed no difference in the frontalis tension of EMG feedback trained subjects and control subjects. When testing for lowering of frontalis EMG level over the seven sessions, they found the performance of the experimental subjects to exceed that of untrained individuals.

Similar results for change over trials were also found in the current study: subjects in the biofeedback and progressive relaxation conditions significantly reduced EMG levels while control subjects did not. Further differences were observed in the differential effectiveness of biofeedback and progressive relaxation in terms of locus of control. While both Internals and Externals in progressive relaxation significantly lowered their EMG levels over trials, only Internals in the biofeedback condition were able to do so. Howarth and Eysenck (1968) observe that it is meaningless to speak of "conditioning" as a personality test without giving due consideration to the parameters required by the theory. In the context of the I-E dimension and two kinds of relaxation training, it seems as if one of the more important parameters is the kind of reinforcement. Basmajian (1967) notes that EMG feedback subjects are frequently impressed by the reaction of the signal to their slightest efforts. In biofeedback, information is continuous, contingent upon behavior, and easily accessible through sensory channels; however, this information becomes reinforcement only if it is perceived as such on some level by the individual. In the Fotopoulos (1970) study on heart-rate increase, it was demonstrated that information regarding one's own behavior was sufficiently effective reinforcement for Internals while Externals required the additional stimulus of an experimenter-operated buzzer to attain comparable proficiency. Similarly, Externals may not respond so effectively to the reinforcement afforded by the biofeedback procedure as to the combined stimuli of specific instructions and proprioceptive feedback in progressive relaxation techniques.

The suggestion that Externals require more, or different, kinds of reinforcement that Internals may also be framed in the context of retention of training. While all groups, with the exception of Internals in the progressive relaxation condition, significantly lowered their frontalis EMG from baseline to treatment, only Internals in the two treatment groups were able to maintain the relaxed state during the post-treatment period at a level significantly lower than the initial resting period. The reduction of muscle activity in progressively relaxed Internals was more gradual but proved to be continuous with the first session.

Retention of training, however, may also be assessed from results of the Session II, conducted approximately a week later. The effect of locus of control observed in the baseline data is no longer present; and, although biofeedback subjects continue to demonstrate higher frontalis levels than progressively relaxed and control subjects, there is no difference between the latter two groups. The interaction of treatment and locus of control, however, appears similar with significant differences in EMG levels between Internals and Externals in the progressive relaxation condition. It appears that when the experimental situation is more familiar, Externals reflect less frontalis tension than previously and do not significantly differ from Internals. The subjects in progressive relaxation condition, no longer exhibiting greater muscle tension than control subjects, perhaps have become more attuned to their proprioceptive feedback and are able to utilize it. It may be equally as likely, however, that this difference is accounted to the greater familiarity of the experimental procedure.

Regardless of the effectiveness of any of the three treatment conditions in terms of frontalis magnitude and reduction, the subjective feeling of relaxation experienced by the subjects is of central importance in assessing their relative merit. From the overall ratings of various affects immediately following Session I, it appears that the degree to which the subjects feel relaxed, tense, or anxious is as closely related to locus of control as to actual frontalis levels. Internals significantly differed from Externals on each of these three affects, reporting greater relaxation, less tension, and less anxiety than externals. Subsequent analyses revealed that Internals in the progressive relaxation condition reported feeling more relaxed and less tension than progressively relaxed Externals and EMG trained Internals, as one would expect from their varying frontalis levels. However, Internals in the biofeedback condition, who exhibited no difference in muscle tension from Externals in that treatment, also reported feeling significantly more relaxed and less tension. This may be related to the fact that these Internals successively reduced frontalis EMG over trials, while the Externals did not. There was no difference in reported anxiety between the two biofeedback groups and no difference between the control groups on any of the three affects. Although the differences were not significant, control group subjects reported levels of relaxation and tension between those of Internals and Externals in the training conditions and greater anxiety than Internals but somewhat less than Externals. Externals in the progressive relaxation condition reported being "engaged in thought" to a greater extent than progressively relaxed Internals; but, because the two groups differed in the affects of relaxed, tense, and anxious, it appears that the thoughtfulness of Externals may have a negative connotation. In ratings of enthusiastic, only a treatment effect was present: biofeedback was not only the least effective in terms of actual frontalis magnitude but also the least preferred.

In order to further investigate this complex relationship between subjective feelings of relaxation and level of frontalis tension, correlational data was compiled for the four electromyographic measures and the three affects of Relaxed, Tense, and Anxious. Over all subjects, while there were strong associations among the EMG scores as well as among the affect ratings, there was no significant correlation between them. With the exception of the affect Anxious failing to significantly correlate with Tense and Relaxed among Internals, the correlation matrices divided among Internals and Externals revealed a similar pattern to that exhibited over all subjects. However, matrices composed by treatment group revealed that subjective feelings of tension and relaxation were associated with the post-treatment EMG score for subjects in the biofeedback condition. The affects of Relaxed and Anxious were significantly correlated with all four EMG measures for progressively relaxed subjects, and analyses revealed that a significant association between affect ratings and EMG levels in the control group.

It appears from the cumulative weight of the evidence in this experiment, at least, that the very act of participating in a relaxation training procedure, as opposed to a control situation, may serve to increase the individual's sensitivity to the association between muscle tension and subjective tension and anxiety. The only difference among groups reported on the Strategy Questionaire was the fact that individuals in the training conditions "thought more about muscle activity" than control subjects. However, a number of serious discrepancies remain to be considered.

Reports concerning a general tension factor, demonstrating a close relationship between feelings of relaxation and the EMG level of a particular muscle appear to be quite divergent and generally negative. Nidever (1959) and Balshan (1962) indicate that in both men and women muscle tension was found to be concentrated about the limb musculature with only the muscles of head and neck appearing to be unrelated. In contrast, Budzynski and Stoyva (1969) have reported that subjects trained to lower frontalis EMG levels perceived deep muscle relaxation generalized to other muscles of the body, especially the upper body and head musculature. In specifically testing the assumption that conditioning of one muscle to relax will generalize to other muscle groups, Alexander (1973) found that the subjects who were most successful in reducing frontalis EMG exhibited greater tension in the arm EMG over sessions than those who manifested less lowering. Indeed, Grim (1971) suggests that "...attending to proprioceptive stimuli, which is probably necessary in the preliminary phase of learning to relax, particularly a single muscle, may cause a tensing increase in other muscles (p. 16)." Shipman et al (1970b) found that one-half of their subjects demonstrated consistent tendency for maximal response in one muscle (predominantly the frontalis and calf muscle) during the stress conditions of their experiment. In a general review of electromyography, Goldstein (1972) concluded that many individuals characteristically respond to stress idiosyncratically through a single muscle or group of muscles.

The relationship of the autonomic nervous system to subjective states appears to be equally complex. Observing that correlation among autonomic phasic responses are commonly low and highly variable, even in direction, Lacey (1967) argues against the sagacity of assuming a unidimensional "arousal theory" which can be equivalently measured by any one of several physiological measures. The fact that there was no significant correlation between the affects of Tense and Anxious for Internals suggests the possibility of differential physiological connotations of two feelings for some individuals.

Although they emphasize that no conclusions concerning retention of training, subjective tension, and anxiety can be drawn, Lader and Matthews (1971) contend that most evidence supports the efficacy of brief progressive relaxation training in producing reductions of EMG within training sessions. The results of the current experiment confirm this general observation and further suggest that reduced frontalis levels attained by abbreviated progressive relaxation are significantly related to subjective feelings of relaxation. It may be that subjective states are more strongly associated with frontalis measures during progressive relaxation than biofeedback because all muscles of the body are systematically tensed and relaxed. Although biofeedback was not so effective in lowering actual frontalis EMG levels as progressive relaxation, it appears to be almost as effective in producing subjective feelings of relaxation in Internals.

The importance of EMG feedback procedures, however, seem currently to lie in the area of specific training rather than inducing general relaxation.

Assessing the dominant psychosomatic approach to medicine as having emphasized stress as the major causal factor in dysfunction and pathological change, Sargent *et al* (1972) suggests that biofeedback training holds the promise of accelerating psychosomatic self-regulation. Indeed, Leibrecht et al (1973) found that augmented auditory feedback produced quantitative changes in learning to control single motor units. When groups were trained to criteria, the nature and retention of learning did not appear to be affected; however, the auditory feedback group exhibited learning six times faster. Several studies have contributed evidence supporting the potential of biofeedback as a therapeutic measure in hypertension (Miller, 1972) and chronic tension headache (Budzynski, et al, 1970; Budzynski et al, 1971 & Wickramaskera, 1972).

Electromyographic biofeedback procedures have also produced striking results in the control of subvocalization (Hardyck, et al, 1966), a major impediment to reading speed. The procedure holds, as well, some promise for aiding in the understanding and control of neuromuscular deficit in spasticity (Harrison & Connolly, 1971) and muscularly injured patients (Jacobs & Felton, 1969).

The relevancy of relaxation procedures to the behavioral modification technique of systematic desensitization (Wolpe, 1958) and the current controversy surrounding the necessity of an incompatible response such as relaxation to stressful imagery (Paul, 1969; Matthews & Gelder, 1969; Grossberg & Wilson, 1968; Sue, 1972) must be re-evaluated. It appears that for some individuals the absolute level of muscle tension is unrelated to a subjective feeling of relaxation.

Matus (1974) warns against the temptation to drawn conclusions about the connections between "ill-defined personality variables and subtle physiological responses (p. 91)" on the basis of a few studies. Apparently much can be learned about the basic physiological and psychological processes involved in relaxation training. It seems clear that, in order for the potential of such procedures to be realized therapeutically, individual differences that determine the effectiveness of a reinforcer cannot be overlooked.

REFERENCES

Alexander, A. Barney. Generalization to other muscles during EMG Biofeedback training of the frontalis. Proceedings of the Thirteenth Annual Meeting of The Society for Psychophysiological Research: Galveston, Texas, 1973.

Alexander, A. Barney; French, C.A. & Goodman, N.J. A comparison of auditory and visual feedback in biofeedback assisted muscular relaxation training. Psychophysiology, in press.

Alexander, A. Barney & Hanson, Donald G. An experimental test of assumptions relating to the use of EMG biofeedback as a general relaxation training technique. Proceedings of the Biofeedback Research Society: Colorado Springs, Colorado, 1974.

Balshan, I.B. Muscle tension and personality in women. Archives of General Psychiatry, 1962, 7, 436-448.

Barber, T; DiCara, L.V.; Kamiya, J.; Miller, N.E.; Shapiro, D., & Stoyva, J. (Eds.) Biofeedback & self-control. Chicago: Aldine-Atherton, 1971 (a).

Barber, T.; DiCara, L.V.; Kamiya, J.; Miller, N.E.; Shapiro, D. & Stoyva, J. (Eds.) Biofeedback & self-control. Chicago: Aldine-Atherton, 1971 (b).

Basmajian, J.V. Muscles alive: their functions revealed by electromyography. (2nd ed.) Baltimore: Williams & Wilkins, 1967.

Basmajian, J.V. Electromyography comes of age. Science, 1972, 176, 603-609.

Brandt, K., & Fenz, W.D. Specificity in verbal and physiological indicants of anxiety. Percpetual and Motor Skills, 1969, 29, 663-675.

Budzynski, T.H., & Stoyva, J.M. An instrument for producing deep muscle relaxation by means of analog information feedback. Journal of Applied Behavioral Analysis, 1971, 2, 231-237.

Budzynski, T.; Stoyva, J., & Adler, C. Feedback-induced muscle relaxation: application to tension headache. Journal of Behavioral Therapy and Experimental Psychiatry, 1970, 1, 205-211.

Carlsöö, S., & Edfeldt, A.W. Attempts at muscle control with visual and auditory impulses as auxiliary stimuli. Scandinavian Journal of Psychology, 1963, 4, 231-235.

Church, R.M. Systematic effect random error in the yoked control design. Psychological Bulletin, 1964, 62, 122-131.

Cohen, S.I.; Silverman, A.J., & Shmavonian, B.M. Psychophysiological studies in altered sensory environment. Journal of Psychosomatic Research, 1963, 6, 259-281.

Crider, A.; Schwartz, G.E., & Shnidman, S. On the criteria for instrumental autonomic conditioning: a reply to Katkin and Murray. Psychological Bulletin, 1969, 71(6), 455-561.

Davis, J.F.; Malmo, R.V., & Shagrass, G. Electromygraphic reaction to strong auditory stimulation in psychiatric patients. Canadian Journal of Psychology, 1954, 8, 177-186.

Dyk, R.B., & Witkin, A.A. Family experiences related to the development of differentiation in children. Child Development, 1965, 36, 21-55.

Eason, R.G. An electromyographic study of impairment and estimates of subjective effort associated with voluntary muscular contractions. U.S. Naval Electronics Laboratory, Rep. No. 898, 1959.

Escalona, S., & Heider, G.M. Prediction and outcome. New York: Basic Books, 1959.

Feather, N.T. Some personality correlates of external control. Australian Journal of Psychology, 1967, 19, 253-260.

Fotopoulos, Sophia. Internal versus external control: increase of heart rate by thinking under feedback and no-feedback conditions. Dissertation Abstracts, 1970, B, 3703.

Goldstein, I.B. Electromyography: a measure of skeletal muscle response. In S. Greenfield and R. Sternback (Eds.) Handbook of Psychophysiology. New York: Harper and Row, Inc., 1972, 329-365.

Goldstein, I.B. Physiological responses in anxious women patients. Archives of General Psychiatry, 1964, 10, 382-388.

Green, E.E.; Walters, E.D.; Green, A.M., & Murphy, G. Feedback technique for deep relaxation. Psychophysiology, 1969, 6(3), 371-377.

Grim, Paul F. Anxiety change produced by self-induced muscle tension and by relaxation with respiration feedback. Behavioral Therapy, 11, 1971, 11-17.

Grossberg, J, & Wilson, H. Physiological changes accompanying the visualization of fearful and neutral situations. Journal of Personality and Social Psychology, 1968, 10, 124-133.

Hardyck, C.D.; Petrinovich, L.F., & Ellsworth, D.W. Feedback of speech muscle activity during silent reading: rapid extention. Science, 1966, 154, 1467-1468.

Harrison, V.F., & Mortensen, D.A. The conscious control of fine levels of neuromuscular firing in spastic and normal subjects. Developmental Medical Child Neurology, 1971, 13, 762-771.

Houston, B. Kent. Control over stress, locus of control, and response to stress. Journal of Personality and Social Psychology, 1972, 21(2), 249-255.

Howarth, E., & Eysenck, H.J. Extraversion, arousal, paired-associate recall. Journal of Experimental Research and Personality, 1968, 3, 114-116.

Jacobs, A., & Felton, G.S. Visual feedback of myoelectric output to facilitate muscle relaxation in normal person and patients with neck injuries. Archives of Physical Medicine, 1969, 50, 34-39.

Jacobson, E. The two methods of tension control and certain basic techniques in anxiety tension control. Modern treatment of tense patients. Springfield, Ill.: Charles C. Thomas, Publisher, 1970, 39-58.

Jacobson, E. Biology of emotions. Springfield, Ill.: Charles C. Thomas, Publisher, 1967, 113.

Jacobson, E. Progressive relaxation. Chicago: University of Chicago Press, 1938.

James, W.H.; Woodruff, A.B.; & Werner, W. Effect of internal and external control upon changes in smoking. Journal of Consulting and Clinical Psychology, 1965, 29, 184-186.

Joe, Victor C. Review of the internal-external control construct as a personality variable. Psychological Reports, 1971, 28, 619-640.

Katkin, E.S., & Murray, E.N. Instrumental conditioning of autonomically mediated behavior: theoretical and methodological issues. Psychological Bulletin, 1968, 70(1), 52-68.

Kempe, J.E. An experimental investigation of the relationship between certain personality characteristics and physiological responses to stress in a normal population. Unpublished doctoral dissertation, Michigan State University, 1956.

Kirk, R.E. Experimental design procedures for the behavioral sciences. Belmont, Calif.: Brooke-Cole Publishing Co., 1969.

Lacey, U.I. Somatic response patterning and stress: some revisions of activation theory. In M.H. Appley & R. Trumbull (Eds.), Psychological Stress: Issues in research. New York: Appleton-Century-Crofts, 1967, 14-42.

Lader, M.H. & Matthews, A.M. Electromyographic studies of tension. Journal of Psychosomatic Research, 1971, 15, 479-486.

Libby, W.L., Jr.; Lacy, B.C., & Lacy, J.I. Pupillary and cardiac activity during visual attention. Psychophysiology, 1972, 10(3), 270-294.

Leibrecht, B.C.; Lloyd, A.J., & Pounder, S. Auditory feedback and conditioning of the single motor unit. Psychophysiology, 1973, 10(1), 1-7.

Lefcourt, H.M. The effects of cue explication upon persons maintaining external control expectancies. Journal of Personality and Social Psychology, 1967, 5, 392-398.

Levenson, H. Distinctions within the concept of internal-external control: development of a new scale. Proceedings of the American Psychological Association, 1972, 259-266.

Lippold, O.C.J. Electromyography. In P.H. Venables and I. Martin (Eds.) A manual of psychophysiological methods. New York: Wiley, 1967, 245-297.

Lisina, M.I. The role of orientation in the transformation of involuntary reactions into voluntary ones. In L.G. Voronin, A.N. Leontiev, A.R. Luria, E.N. Sokolov, & O.S. Vinogradova (Eds.) Orienting reflex and exploratory behavior. Washington: American Institute of Biological Sciences, 1965.

Malmo, R.B., & Shagrass, C. Physiologic studies of reaction to stress in anxiety and early schizaphrenia. Psychosomatic Medicine, 1949, 11, 9-24.

Malmo, R.B., & Smith, A.A. Forehead tension and motor irregularities in psychoneurotic patients under stress. Journal of Personality, 1955, 23, 391.

Martin, I. Levels of muscle activity in psychiatric patients. Acta Psychologica, 1956, 12, 326.

Matthews, A.M., & Gelder, M.G. Psycho-physiological investigations of brief relaxation training. Journal of Psychosomatic Research, 1969, 13, 1-12.

Matus, Orwin. Select personality variables and tension in two muscle groups. Psychophysiology, 1974, 2(1), p. 91.

Miller, N.E. Learning of glandular and visceral responses: postscript. In D. Singh & C.T. Morgan (Eds.), Current status of physiological psychology: Readings. Monterey, Calif.: Brooks/Cole, 1972, 245-250.

Miller, N.E., & DiCara, L.V. Instrumental learning of heart-rate changes in curarized rats: shaping and specificity to discriminative stimulus. Journal of Comparative Physiological Psychology, 1967, 63, 1279.

Miller, N.E., & Dworkin, B.R. Visceral learning: recent difficulties with curarized rats and significant problems for human research. In P.A. Obrist (Ed.), Contemporary trends in cardiovascular psychophysiology. Chicago: Aldine-Atherton, 1972.

Nidever, J.E. A factor analytic study of general muscular tension. Unpublished doctoral dissertation, University of California, Los Angeles, 1959.

Paul, G.L. Physiological effects of relaxation training and hypnotic suggestion. Journal of Abnormal Psychology, 1969, 74, 425-437.

Paul, Gordon L. Insight vs. Desensitization in psychotherapy. Stanford: Stanford University Press, 1966, 117-118.

Ray, W.J. The relationship of locus of control, self-report measures, and feedback to the voluntary control of heart rate. Dissertation Abstracts, 1971, B, 4226.

Ray, W.J., & Katahn, M. Relation of anxiety to locus of control. Psychological Reports, 1968, 23, 1196.

Rotter, J. Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 1966, 80(1, No. 609).

Rotter, J. Social learning and clinical psychology. New York: Prentice-Hall, 1954.

Rice, D.G. Operant conditioning and associated electromyogram responses. Journal of Experimental Psychology, 1966, 71, 908-912.

Sainsbury, P., & Gibson, J.G. Symptoms of anxiety and tension and the accompanying physiological changes in the muscular system. Journal of Neurology, Neurosurgery, and Psychiatry, 1954, 17, 216-224.

Seeman, M, & Evans, J.W. Alienation and learning in a hospital setting. American Sociological Review, 1962, 27, 772-783.

Sargent, J.D.; Green, E.E., & Walters, E.D. The use of autogenic feedback training in a pilot study of migraine and tension headaches. Headache, 1972, 12, 120-124.

Shipman, W.G.; Oken, D., & Heath, H.A. Muscle tension and effort at self control during anxiety. Archives of General Psychiatry, 1970, 359-368.

Shipman, W.G.; Oken, D., & Goldstein, I.D. Study in psychophysiology of muscle tension: II. Personality factors. Archives of General Psychiatry, 11, 1964, 330-345.

Silverman, A.J.; Cohen, S.I.; Shmavonian, B.M., & Greenberg, G. Psychophysical investigations in sensory deprivation: the body-field dimension. Psychosomatic Medicine, 1961, 23, 48-61.

Skinner, B.F. The behavior of organisms. New York: Appleton-Century-Crofts, 1938.

Smith, K. Conditioning as an artifact. Psychological Review, 1954, 61, 217-225.

Smith, Robert P. Frontalis tension and personality. Psychophysiology, 1973, 10(3), p. 311.

Straits, B.C., & Sechrest, L. Further support of some findings about characteristics of smokers and non-smokers. Journal of Consulting Psychology, 1963, 27, 282.

Sue, David. The role of relaxation in systematic desensitization. Journal of Behavior Research and Therapy, 1972, 10(2), 153-157.

Tolor, A., & Reznikoff, M. Relation between insight, repression-sensitization, internal-external control and death anxiety. Journal of Abnormal Psychology, 1967, 72, 426-430.

Voas, R.B. Generalization and consistency of muscle tension level. Unpublished doctoral dissertation, University of California, Los Angeles, 1952.

Wichramasekera, Ian. Electromyographic feedback training and tension headache: preliminary observations. American Journal of Clinical Hypnosis, 1972, 15(2), 83-85.

Williams, J.G.L., & Williams, B. The effect of meprobamate on the somatic responses of anxious patients and normal controls. Psychophysiology, 1967, 3, 403-405.

Wilson, A., & Wilson, A.S. Psychophysiological and learning correlates of anxiety and induced muscle relaxation. Psychophysiology, 1970, 6(6), 470-478.

Wing, L. Physiological effects of performing a difficult task in patients with anxiety states. Journal of Psychosomatic Research, 1964, 1, 283.

Witkin, Herman, A., & Oltman, Philip K. Cognitive style. International Journal of Neurology, 1967, 6(12), 119-135.

Wolpe, J. Psychotherapy by reciprocal inhibition. Stanford University Press, 1958.

Zuckerman, M. Field dependency as a predictor of response to sensory and social isolation. Perceptual and Motor Skills, 1968, 27, 757-758.

APPENDIX A

READ EACH ITEM AND CIRCLE THE ALTERNATIVE (A OR B) THAT MOST CLOSELY REPRESENTS YOUR OPINION ON THE STATEMENTS. IN SOME CASES IT MAY BE DIFFICULT TO CHOOSE, BUT PLEASE SELECT ONE.

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 opportunities.

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.

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 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.

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 they 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.

APPENDIX B

SELF-REPORT AFFECT QUESTIONNAIRE

NAME______________________________ DATE _______________

Please indicate the degree to which each word describes how you feel at this moment in the experiment by circling the appropriate number.

Slightly 1 Moderately 5 Strongly 9

1.	Interested	1	2	3	4	5	6	7	8	9
2.	Alert	1	2	3	4	5	6	7	8	9
3.	Engaged in thought	1	2	3	4	5	6	7	8	9
4.	Enthusiastic	1	2	3	4	5	6	7	8	9
5.	Anxious	1	2	3	4	5	6	7	8	9
6.	Discouraged	1	2	3	4	5	6	7	8	9
7.	Drowsy	1	2	3	4	5	6	7	8	9
8.	Bored	1	2	3	4	5	6	7	8	9
9.	Relaxed	1	2	3	4	5	6	7	8	9
10.	Tense	1	2	3	4	5	6	7	8	9
11.	Pleasant	1	2	3	4	5	6	7	8	9

APPENDIX C

POST EXPERIMENTAL QUESTIONNAIRE - SESSION I

NAME ______________________________ DATE ________________

Please indicate the percentage of time you engaged in each of the following during the task.

	None of the time				All of the time	
stared at an object in the room	0	20	40	60	80	100
visualized an event or object	0	20	40	60	80	100
thought about an event or object	0	20	40	60	80	100
thought about a feeling	0	20	40	60	80	100
thought about muscle activity	0	20	40	60	80	100

Please state what percentage of the time your muscle activity was lowered from normal resting.

% Time	0	20	40	60	80	100

Do you feel you had any influence over the frequency of the tone?

yes___________ no___________

APPENDIX D

INSTRUCTIONS FOR TREATMENT GROUPS

The procedure of electrode placement and recording was explained to all subjects as the electrodes were being positioned by the Experimenter. They were assured of the safety of the method, and their questions pertaining to safety were answered as completely as possible. They were told that they may choose not to continue at any point during the experiment. No one selected this option in Session I.

Biofeedback. This is a study in relaxation. At the sound of the short tone through the earphones, I would like for you to relax quietly for about five minutes. Then, after four minutes and thirty seconds another tone will be heard: this will signal you that the biofeedback training procedure will begin in thirty seconds. You will then be able to hear a continuous tone that will indicate to you how relaxed your frontalis muscle is. The lower the tone, the more relaxed your muscle is. If you become tense, likewise, the tone will increase in frequency and sound higher. This will continue for twenty minutes. Then, just remain relaxed for five minutes when I'll come back in. Do you understand? (questions answered concerning procedure) Just remember, relax for four minutes and thirty seconds when you will be signalled that the biofeedback tone will come on shortly. That will continue for twenty minutes, and then you are to relax for five minutes more.

Progressive Relaxation. This is a study in relaxation. At the sound of the short tone through the earphones, I would like for you to relax quietly for about five minutes. Then, after four minutes and thirty seconds another tone will be heard: this will signal you that the progressive relaxation procedure will begin in thirty seconds. You will then be able to hear a voice over the earphones that will instruct you in this relaxation training. Just follow the instructions which will continue for twenty minutes. Then, just remain relaxed for five minutes when I'll come back in. Do you understand? (questions answered concerning procedure) Just remember, relax for four minutes and thirty seconds when you will be signalled that the progressive relaxation instructions will begin shortly. They will continue for twenty minutes, and then you are to relax for five minutes more.

Control. This is a study in relaxation. At the sound of the short tone through the earphones, I would like for you to relax quietly for about five minutes. Then you will hear another tone, and you are to deeply relax for twenty minutes. A third tone will indicate to you that the twenty minutes are over, and you are to remain relaxed for five minutes when I'll come back in. Do you understand? (questions answered concerning procedure) Just remember, relax for five minutes, deeply relax for twenty minutes, and remain relaxed for five minutes more.