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Full Name of Author — Nom complet de l'auteur

Margaret WILKINSON

Date of Birth — Date de naissance	Country of Birth — Lieu de naissance
February 24, 1938	ENGLAND

Permanent Address — Résidence fixe

PO Box 3594 Stn. D, Edmonton, Alberta T5L 4J6

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THE UNIVERSITY OF ALBERTA

SOME PSYCHOPHYSIOLOGICAL EFFECTS OF EMG AND THERMAL FEEDBACK RELAXATION TRAINING

BY

© MARGARET WILKINSON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Some Psychophysiological Effects of EMG and Thermal Feedback Relaxation Training", submitted by Margaret Wilkinson in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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Supervisor

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External Examiner

Date.........April 18, 1980

ABSTRACT

The study was designed to examine the effects of successful EMG and thermal feedback relaxation training on frontal muscle tension, digital skin temperature, plantar skin conductance and scores on the A-Trait and A-State scales of the State-Trait Anxiety Inventory for Children (STAIC). A central purpose of the research was to explore the physical and psychological generalizability of EMG and thermal feedback relaxation training for children. Specific to that purpose, the inquiry contained an exploration of some of the psychophysiological effects of the use of EMG and thermal feedback relaxation techniques.

The 54 subjects for this study were drawn from the 89 grade six students attending an elementary school in a city of approximately 600,000 residents in northern Alberta. This grade six student body comprised 47 boys and 42 girls, from which 27 male and 27 female subjects were randomly selected and assigned to one of the following groups: experimental group 1, which received EMG feedback relaxation training, experimental group 2, which received thermal feedback relaxation training and group 3 (control group), which received no relaxation training, beyond the instruction to relax.

Each subject participated, individually, in one orientation session, one pretreatment session and five treatment sessions, each of approximately 40 minutes duration. These sessions were scheduled on consecutive weekdays, with one subject from each group entering the experiment on the same day, and the time of day during which subjects participated in the study was balanced for the three groups. All sessions comprised an initial phase of subject preparation, followed by a measuring and recording phase, of approximately 20 minutes, during which the physiological measurements were made. At the end of the pretreatment and final treatment sessions all subjects were required to complete the scales of the STAIC. During the treatment sessions, the EMG and thermal feedback subjects received visual feedback based on frontal EMG activity and digital skin temperature, respectively, while the controls relaxed without feedback. The scores obtained on the STAIC at the end of the final treatment session and the physiological measurements made during the final treatment session served as the basis for the main statistical analysis.

The results of this study revealed a significant difference in frontal EMG activity between the three groups during the final treatment session ($H = 14.07$, $p < .01$), with the EMG feedback group exhibiting a

lower level of EMG activity than either the thermal feedback group (U = 36, $p < .01$) or the control group (U = 99, $p < .05$), and with no significant difference demonstrated between the thermal feedback and control groups (U = 126, $p > .05$). However, there were no significant differences between the three groups with respect to skin temperature ($F = .33$, $p > .05$), skin conductance ($F = 3.09$, $p > .05$), trait anxiety ($F = 2.94$, $p > .05$) and state anxiety ($H = 5.70$, $p > .05$). These findings are discussed in terms of the research objectives and in relation to some of the theoretical and practical issues in the area of biofeedback training for children. In addition, some implications for further research and education are delineated.

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CHAPTER I

INTRODUCTION

Biofeedback Training

During the past decade, biofeedback training has become increasingly popular in the treatment of anxiety and stress-related disorders. As Miller (1974) indicates, biofeedback is "the use of...instrumentation to give a person better moment-to-moment information about a specific physiologic process that is under the control of the nervous system but not clearly or accurately perceived (p. 684)." Biofeedback can be comparatively simple, as when an individual is permitted to observe the output of a conventional monitoring device, or relatively complex, as when a person receives light displays or audio signals based on some physiological function. Biofeedback training generally entails instructions to alter the feedback signal in some specified way and is founded on the principle that the provision of exteroceptive feedback enables the subject to learn to control the function on which the external feedback is based (Gaarder, 1971).

Therapeutic Biofeedback Training

As previously noted, biofeedback training is being used with increasing frequency as a therapeutic technique. Biofeedback training has been applied, with apparent success, to anxiety reduction (Bernthal & Papsdorf, 1977;

Canter, Kondo, & Knott, 1975; Raskin, Johnson, & Rondestvedt, 1973) and to the treatment of a host of stress-related disorders, including essential hypertension (Datey, 1976; Elder, Ruiz, Deabler, & Dillenkoffer, 1973), migraine headaches (Friar & Beatty, 1976; Solbach & Sargent, 1977), Raynaud's syndrome (May & Weber, 1976; Surwit, 1973), tension headaches (Cox, Freundlich, & Meyer, 1975; Cram, 1978) and stuttering (Guitar, 1975; Lanyon, Barrington, & Newman, 1976).

Although biofeedback training has been used more extensively with adults, children have also benefited from biofeedback training during the course of treatment for a variety of disorders, including asthma (Davis, Saunders, Creer, & Chai, 1973; Kotses & Glaus, 1978), hyperkinesis (Braud, 1978; Jeffrey, 1978), migraine headaches (Peper & Grossman, 1974; Werder, 1978) and subvocalization (Aarons, 1971; Parsky & Papsdorf, 1976).

At this point, it should be observed that therapeutic biofeedback training techniques have been used in at least two basically different ways, with some applications being specific to a particular disorder and others being designed to bring the recipient general relief from anxiety and stress-related disorders. By means of illustration, the use of frontal electromyographic (EMG) feedback training in the treatment of tension headaches represents a specific application of biofeedback training, whereas the use of frontal EMG feedback as a general relaxation technique constitutes a general application of biofeedback training. This differentiation is significant in the present context, because the current study is primarily concerned with the use of biofeedback training techniques as types of general relaxation training.

Preventive Biofeedback Training

Some therapists believe that biofeedback training in the early years provides subsequent protection against emotional and psychosomatic disorders (Brown, 1974; Engelhardt, 1978; Luce & Peper, 1971; Volpe, 1975). On this basis, it has been recommended that children receive biofeedback training in school (Engelhardt, 1978; Volpe, 1975). Unfortunately, there is no empirical evidence directly pertaining to the prophylactic value of such early training. However, a number of public school children are currently participating in EMG (Engelhardt, 1978; Russell & Carter, 1979) and thermal feedback training programs (Engelhardt, 1978).

Biofeedback General Relaxation Training

In common with other types of general relaxation training, biofeedback general relaxation training techniques are designed to enable the individual to achieve, at will, a state of psychological and physiological calm, through the establishment of voluntary control over physiological functioning (Budzynski & Stoyva, 1972). Therefore, for the purpose of the present discussion, biofeedback general relaxation training will refer to biofeedback training techniques aimed at the reduction of psychological and physiological arousal.

Biofeedback General Relaxation Training Techniques

The most common types of biofeedback training to be used as general relaxation training techniques are electroencephalographic (EEG) feedback training (Benjamins, 1976; Hardt & Kamiya, 1978), EMG feedback training (Canter et al., 1975; Engelhardt, 1978; Raskin et al., 1973) and thermal feedback training (Bernthal & Papsdorf, 1977; Engelhardt, 1978). However, only EMG and thermal feedback training have received extensive use, in any capacity, with children. In common with more traditional types of general relaxation training techniques, such as Jacobson's (1938) progressive relaxation training and Schultz and Luthe's (1959) autogenic training, EMG and thermal feedback relaxation training entail instruction in the relaxation of striate muscle or peripheral vasodilation (Wilkinson, 1978).

EMG feedback relaxation training. EMG feedback involves the amplification of muscle action potentials (MAPs) and the feeding back of this information to the subject in the form of auditory or visual signals (Autogenic Systems Incorporated, 1976). During EMG feedback relaxation training, the subject is simply requested to alter the feedback in a manner indicative of a reduction in EMG activity. When used as a general relaxation training technique, EMG feedback training is typically restricted to the frontal region (Alexander, 1975). This common procedure is observed on the basis of the subjective reports of EMG feedback subjects (Budzynski & Stoyva, 1969, 1972). According to Budzynski and Stoyva (1969, 1972), frontal EMG feedback subjects report that deep relaxation of muscles in the frontal region is followed by a feeling of relaxation in the rest of the skeletal musculature. Underlying the use of EMG feedback relaxation training and other types of muscle relaxation training as general relaxation training techniques, is the assumption that relaxation of the skeletal musculature is incompatible with psychological and physiological arousal. At this point, it is sufficient to note that this assumption is generally supported in terms of research findings (Budzynski & Stoyva, 1972).

Thermal feedback relaxation training. When used as a general relaxation training technique, thermal feedback training entails the provision of audio or visual signals based on fluctuations in skin temperature (Autogenic Systems Incorporated, 1976).

The palmar surface of one of the fingertips customarily serves as the training site, and the subject is advised to alter the feedback in a manner indicative of an increase in skin temperature (Autogenic Systems Incorporated, 1976). The immediate goal of such training is peripheral vasodilation, which, in the absence of strenuous physical activity, fever, or high ambient temperatures, is associated with a calm psychological and physiological state (Ackner, 1956; Crawford, Friesen, & Tomlinson-Keasey, 1977; Russell, 1972).

Some Assumptions Underlying the Use of EMG and Thermal Feedback Training as General Relaxation Training Techniques

Anxiety and physiological state. A fundamental assumption of all general relaxation training techniques is that anxiety is associated with certain physiological responses and is incompatible with others (Benson, 1975; Budzynski, 1973). While there is an obvious lack of consensus regarding the nature, origin and resolution of anxiety, it is generally agreed that anxiety is accompanied by physiological responses that are in the direction of heightened physiological arousal or a shift toward dominance of the sympathetic division of the autonomic nervous system (Budzynski, 1973; Stoyva & Budzynski, 1974).

Conversely, it is commonly granted that those physiological responses indicative of a shift toward parasympathetic dominance are incongruous with anxiety (Benson, 1975; Wolpe, 1958). Grinker (1966), therefore, expresses a well accepted view when he observes that "anxiety is accompanied by a host of interrelated processes which are in the nature of activity preparatory to emergency action (p. 133)." On the basis of extensive research, Horvath and Fenz (1971) conclude that "there is abundant evidence that most autonomic measures...are responsive to heightened emotional states (p. 147)." Or more simply put, there is sound scientific evidence to indicate that there is a positive relationship between anxiety and physiological arousal.

However, to assume a relationship between anxiety and physiological state is not to suppose that the physiological state accompanying anxiety is precisely the same for every person. As Martin (1961) suggests, although the emergency reaction "may be largely innate...it is likely that as a result of learning or constitutional predisposition individuals tend to have variations in the manner in which the...reaction is expressed (p. 234)." In fact, numerous studies have indicated that people tend to demonstrate idiosyncratic patterns of physiological activity during stress reactions (Lacey, 1950; Lacey, Bateman, & Van Lehn, 1953; Lacey & Lacey, 1958; Lacey & Van Lehn, 1952). Therefore, it is reasonable to subscribe to Stoyva and Budzynski's (1974) conclusion that the assumption of a uniform emergency response represents an oversimplified interpretation of the concept.

Integration of voluntary and autonomic responding. Underlying the use of general relaxation training techniques that focus exclusively on the reduction of tension in the skeletal musculature is the assumption that the voluntary and autonomic nervous systems act in unison (Budzynski & Stoyva, 1972). EMG feedback relaxation training, for example, is used on the basis of the supposition that a relaxed skeletal musculature is sufficient to dampen the activity of the autonomic nervous system (Budzynski & Stoyva, 1972). However, while there is evidence in support of the proposition that the voluntary and autonomic nervous systems generally act in tandem (Gellhorn, 1964; Germana, 1969; Hess, 1954; Obrist, Webb, Sutterer, & Howard, 1970), Cameron (1944) and Le Boeuf (1974) have encountered subjects in whom the voluntary and autonomic nervous systems appear to be only loosely coupled. Perhaps as Budzynski and Stoyva (1972) suggest, these individuals are "the people for whom muscle relaxation does not diminish anxiety (p. 449)." Certainly this suggestion is consistent with Le Boeuf's (1974) finding that patients with predominantly autonomic symptoms did not show improvement in either specific symptoms or generalized anxiety as a result of training in muscle relaxation. Clearly, if muscle tension is not always a significant component of the stress response, then EMG feedback relaxation training may not be especially useful in the treatment of some individuals.

<u>Generalization of effects</u>. Unlike most other types of general relaxation training, EMG and thermal feedback relaxation training are typically limited to single sites and it is assumed that the effects of training generalize. As previously mentioned, EMG feedback relaxation training is usually restricted to the frontal region, on the basis of the supposition that the training effect generalizes to the rest of the skeletal musculature (Alexander, 1975). Similarly, thermal feedback relaxation training is generally limited to a single fingertip site and it is assumed that general peripheral vasodilation results (Engelhardt, 1978). However, the assumption of such generalization has dubious support in terms of empirical evidence.

Research concerned with the effect of frontal EMG feedback training on the rest of the skeletal musculature has not been substantial, but the findings that have emerged have proven disappointing. In apparent support of their earlier clinical observations regarding generalization, Stoyva and

Budzynski (1974) reported that "frontalis feedback subjects decreased on both frontalis and forearm EMG levels (p. 274)." However, while the frontal EMG feedback subjects reduced their forearm EMG level by 45%, the control subjects reduced theirs by 39%. Unfortunately, Stoyva and Budzynski (1974) failed to comment on the statistical significance of these percentages. Clearly, though, the reduction in forearm tension demonstrated by the control subjects had nothing to do with a generalization of relaxation from the frontal region, since only the frontal EMG feedback subjects showed a significant decline in frontal EMG activity. Therefore, a large proportion of the reduction in forearm tension experienced by the frontal EMG feedback subjects could be attributed to factors other than generalization of the frontal EMG feedback training effect. More recent studies conducted by Alexander (1975), Freedman (1976), Freedman, Glaros and Papsdorf (1977) and Freedman and Papsdorf (1976) do not lend credence to the assumption that frontal EMG feedback training is a sufficient condition for muscle tension reduction throughout the skeletal musculature. Alexander (1975), for example, discovered no evidence of a generalization of EMG reduction from the frontal region to untrained sites on the forearm and lower leg. In addition, Freedman (1976), Freedman et al. (1977) and Freedman and

Papsdorf (1976) reported findings indicating that the frontal EMG feedback training effect generalizes to the nearby masseter, but not to the forearm. However, as Freedman et al. (1977) caution, given the close proximity of the frontal region and masseter, it is likely that surface conductance of MAPs between the facial muscles was responsible for the apparent generalization of relaxation to the masseter.

Studies of changes in the peripheral vascular system resulting from thermal feedback relaxation training have also been limited. However, on the basis of the available evidence there appears to be considerable specificity of the training effect to the anatomical loci from which feedback is given (Slattery & Taub, 1976). Thus, while temperature changes are greatest at the training site (Slattery & Taub, 1976; Surwit, 1977; Wand, Slattery, Haskell, & Taub, 1978), there is only limited change at untrained sites on the hands (Slattery & Taub, 1976; Wand et al., 1978) and no evidence of concomitant changes in the surface temperature at other body sites (Elder, Frentz, McAfee, & Lewis, 1977).

Obviously, the lack of evidence for the generalization of EMG and thermal feedback relaxation training effects has serious implications for the use of these biofeedback techniques in general relaxation training. If the effects of EMG and thermal feedback relaxation training are as circumscribed as the research suggests, then it is difficult to understand how they can function as general relaxation training techniques.

The Problem

The use of EMG and thermal feedback training as general relaxation training techniques for both adults and children is increasing, despite the fact that the training effects of these biofeedback techniques appear to be far more limited than originally thought. Although there is a clear need for research concerning the general psychophysiological effects of EMG and thermal feedback training, there is a conspicuous lack of well controlled studies in the area. Therefore, the purpose of the present study was to respond to the need for the empirical examination of the general psychological and physiological effects of EMG and thermal feedback relaxation training. More specifically, the current study was designed to investigate the effects of these biofeedback techniques on anxiety and physiological arousal among children.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

Nature of Anxiety

While the concept of anxiety is attributed a significant role in most psychological theories, there is an apparent lack of consensus concerning the nature of anxiety (Fischer, 1970). It is generally agreed that anxiety is both psychological and physiological in nature, but the relative stress placed on each aspect varies with the orientation of the theorist. Freud (1936), for example, emphasizes the psychological nature of anxiety when he maintains that it "is in the first place something felt (p. 69)." Wolpe (1958), on the other hand, focuses on the physiological facet of anxiety by defining it as "the autonomic response pattern or patterns that are characteristically part of the organism's response to noxious stimulation (p. 34)."

When the specific nature of the components of anxiety is considered, additional differences in perspective are revealed. For instance, some investigators differentiate between anxiety and fear (Cattell, 1972; Lesse, 1970), whereas most make no such distinction (Spielberger, 1972; Wolpe, 1958). By means of further illustration, some writers recognize the concept of general or free-floating anxiety (Freud, 1964), while others believe that what appears to be undifferentiated anxiety is actually anxiety that is specific to numerous anxiety-evoking stimuli (Wolpe, 1958). Although this particular issue is not easily resolved by reference to empirical data, the success of systematic desensitization in the treatment of individuals apparently suffering from general anxiety, probably constitutes the strongest argument against the concept of free-floating anxiety (Wolpe, 1958, 1973, 1976). Theorists are also divided with respect to the emphasis placed on anxiety as a transitory state (A-State) and anxiety as a relatively stable personality trait (A-Trait). Wolpe (1958), for example, makes passing reference to individual differences in anxiety proneness, but is almost exclusively concerned with situational anxiety. Eysenck (1967), on the other hand, has demonstrated high interest in anxiety proneness, to the point of postulating inherited differences in the neurophysiological structure of the visceral brain to account for individual differences in this personality variable. Of course, not all investigators who are concerned with anxiety as a dimension of personality, agree with Eysenck (1967) that anxiety proneness is based mainly on inherited differences (Spielberger, 1966). Nevertheless, the differentiation between state and trait anxiety is relevant in the present context for a number of reasons. Firstly, when general relaxation training is used as the sole approach to anxiety reduction, the goal is a reduction in anxiety proneness, but when general relaxation training is used as part of the systematic desensitization process, the immediate aim is a reduction in situational anxiety (Stoyva & Budzynski, 1974). Secondly, the State-Trait Anxiety Inventory for Children (STAIC), which is designed to measure both A-State and A-Trait, was used as an anxiety inventory in the current study.

Different points of view are also evident with respect to the relationship between the psychological and physiological components of anxiety. Some writers subscribe to the James-Lange (1922) hypothesis, which proposes that the experience of preceding physiological arousal actually constitutes the emotional state. However, this view has been seriously undermined by Cannon's (1936) observation that organisms continue to manifest emotional behavior following separation of the viscera from the central nervous system.

Other investigators have adopted Cannon's (1936) approach to the relationship between emotion and physiological functioning, which entails the assumption that emotional experience and physiological arousal occur simultaneously. According to Cannon (1936), this process in mediated by the thalamus and hypothalamus and involves an upward discharge from the thalamus to the cortex and an orthosympathetic discharge from the hypothalamus, resulting in the secretion of epinephrine from the adrenal medullae. Consonant with Cannon's theory, but by no means unequivocal proof of it, is research showing increased secretion of epinephrine among anxious patients and healthy subjects under stress (Von Euler & Lundberg, 1954), and the induction of various psychological and physiological manifestations of anxiety through the administration of epinephrine (Rickles, 1965).

Although the approaches of James-Lange (1922) and Cannon (1936) differ regarding the timing of emotional and physiological events, this is not the only point on which they diverge. These positions are also at odds with respect to the type of correspondence between the psychological and physiological concomitants of anxiety. While the James-Lange hypothesis requires that there is a unique pattern of physiological arousal for the emotion of anxiety, Cannon's theory entails no such assumption. In fact, one of the criticisms that Cannon (1936) leveled against the James-Lange hypothesis was that visceral changes do not seem to vary from emotion to emotion. However, it should be understood that the emotions Cannon had in mind when he made this observation were those of the "fight-or-flight" reaction, such as anger and anxiety. This clarification is necessary, because some theorists have gone a step further than Cannon by maintaining that the physiological concomitants of all emotions are the same (Duffy, 1962; Mandler, 1962). Duffy (1962), for instance, proposes that any emotional condition comprises a state, which is physiological and nonspecific, and a direction, which is psychological or cognitive. According to this perspective, there should be no difference between the physiological manifestations of such disparate emotions as anxiety and euphoria, with the subjective experience of such states being determined by cognitions arising from the immediate situation. Consonant with this view is research indicating that such dissimilar emotions as joy and anger can be experimentally induced in subjects infused with epinephrine, without any explanation of its physiological effects (Schachter & Singer, 1962). On the other hand, numerous investigators have provided evidence of differential physiological responses in emotions (Ax, 1953; Engel, 1959; Funkenstein, King, & Drolette, 1957; Lewinsohm, 1956; Schachter, 1957). It is interesting to note that the majority of these investigators have been concerned with precisely the same emotions as

Cannon (1936), that is, anger and anxiety. Nevertheless, as Spielberger (1966) aptly observes, the diversity of emotional states is not paralleled by an equal number of visceral and endocrinological patterns, or, if this is the case, these patterns have neither been isolated nor identified. Perhaps, as Martin (1961) suggests, arousal states can be differentiated from a more general state of activation only when arousal reaches a minimal level of intensity.

Origins of Anxiety

Most theorists are not concerned with the origin of anxiety, per se, but with the etiology of neurotic anxiety, that is, anxiety that is disproportionate or inappropriate to the situation. Different theorists tend to subscribe to different causes of neurotic anxiety, including classical conditioning and stimulus generalization (Wolpe, 1958), operant conditioning and modeling (Bandura & Walters, 1963), prolonged stress (Selye, 1974), unresolved intrapsychic conflict (Freud, 1936), acquired behavioral dispositions (Spielberger, 1966) and deficiencies in the nervous system (Eysenck, 1967; Malmo, 1970). This variety of postulated causes reflects divisions on a number of basic issues. Firstly, although it is generally agreed that neurotic anxiety is both genetically and environmentally determined, and despite evidence that both heredity (Braconi, 1966; Jost & Sontag, 1944; Shields & Slater, 1960) and environment (Bandura & Rosenthal, 1966; Selye, 1974; Watson & Rayner, 1920) are implicated, the relative stress placed on each of these factors varies among theorists. Secondly, while some theorists consider reinforcement to be a significant factor in the etiology of neurotic anxiety (Bandura & Walters, 1963), others do not focus on the part played by this variable (Malmo, 1970; Selye, 1974). Thirdly, some investigators are concerned with unconscious causes of neurotic anxiety (Freud, 1936), while others make no reference to unconscious determinants (Bandura & Walters, 1963; Selye, 1974). In addition, the part played by cognition is recognized by some (Bandura & Walters, 1963; Spielberger, 1966), but not by others (Wolpe, 1958). Finally, the importance of vicarious learning is stressed by some theorists (Bandura & Walters, 1963) and ignored by other investigators (Malmo, 1970; Selye, 1974).

Since Spielberger's (1973) STAIC was used as an anxiety inventory in the present study, Spielberger's views on the origin of neurotic anxiety are of particular interest. According to Spielberger (1966), "A-trait is assumed to reflect residues of past experience that in some way determine individual differences in anxiety proneness, i.e., in the disposition to see certain types of situations as dangerous and to respond to them with A-states (p. 18)." More specifically, Spielberger (1972) suggests that "high A-Trait persons...received excessive criticism and negative appraisals from their parents which undermined their self-confidence and adversely influenced their self-concept (p. 45)." It is clear, therefore, that Spielberger (1966, 1972) emphasizes environmental, rather than genetic, factors in the origin and etiology of neurotic anxiety.

Anxiety Resolution

Just as opinions vary regarding the origin of dysfunctional anxiety, so they differ with respect to its resolution. Among the numerous strategies used in the cause of anxiety reduction are counterconditioning (Wolpe, 1958, 1973, 1976), the rearrangement of reinforcement contingencies (Skinner, 1953), the provision of appropriate models (Bandura & Walters, 1963), insight-oriented therapy (Freud, 1936; Ellis & Harper, 1961; Perls, Hefferline, & Goodman, 1951; Rogers, 1951) and general relaxation training (Haugen, Dixon, & Dickel, 1958; Jacobson, 1970; Payne, 1970; Schultz & Luthe, 1959).

As previously indicated, the application of general relaxation training in psychotherapy customarily takes one of two forms. Firstly, some therapists, most notably Wolpe (1958, 1973, 1976), use general relaxation training as a temporary anxiety inhibitor during counterconditioning. Therapists operating from this perspective do not attempt to bring about some general change in the individual, but aim at desensitizing the person to specific anxiety-evoking stimuli or situations. Other therapists, including Haugen et al. (1958), Jacobson (1967), and Schultz and Luthe (1959), use general relaxation training as a means of developing the individual's general self-regulation ability (Lowenstein, 1977). However, while the value of general relaxation training as a temporary anxiety inhibitor is well documented (Paul, 1969), the value of general relaxation training as an antistress response is more of a working hypothesis than a scientific fact (Stoyva & Budzynski, 1974).

Measurement of Anxiety

As Martin (1961) observes, "one's theoretical approach to anxiety affects how one goes about measuring it (p. 234)." It is not surprising, therefore, that anxiety research has employed a host of physiological, behavioral and self-report measures of anxiety. Both scales of the STAIC, for example, constitute self-report measures of anxiety. However, in apparent recognition of the difficulties associated with self-report measures, Spielberger (1972) concludes that "the presence of anxiety states in humans can be most meaningfully...defined in terms of some combination of introspective verbal reports and physiological-behavioral signs (p. 29)." A number of investigators appear to share Spielberger's (1972) view, because it is not an uncommon practice for experimenters to simultaneously employ self-report and physiological indicators of anxiety (Engelhardt, 1978; Payne, 1970; Reinking & Kohl, 1975). Among the common physiological measures of anxiety are muscle tension, skin temperature and electrodermal activity (Fee & Girdano, 1978), which were used in the present study to explore the physiological effects of EMG and thermal feedback relaxation training.

Nature of Physiological Arousal

As previously indicated, heightened physiological arousal entails a shift toward dominance of the sympathetic division of the autonomic nervous system. While the parasympathetic system is primarily an energy-conserving system, the sympathetic system tends to promote energy expenditure by mobilizing the body to meet emergencies. Thus, increases in physiological arousal are characterized by increases in blood sugar level, blood pressure, heart rate, respiratory rate, EMG activity, blood flow to the skeletal muscles and sweat gland activity, and by decreases in digestive activity and skin temperature (Benson, 1975).

Measurement of Physiological State

Numerous different measures have been used as indicators of physiological state, including blood sugar level, blood pressure, brain-wave activity, cardiac output, electrodermal activity, endocrinal activity, heart rate, muscle tension, pulse rate, respiration rate, salivary output and skin temperature (Martin, 1961). As noted earlier, muscle tension, skin temperature and electrodermal activity were used in the present study as measures of physiological state. The choice of muscle tension and skin temperature was partly governed by the consideration that measurement of these variables was necessary in order to determine mastery of the EMG and thermal feedback training, although both measures are generally accepted and commonly used indicators of physiological state (Martin, 1961). The selection of electrodermal activity as a measure of physiological state was based on experimental evidence indicating that this variable is a particularly sensitive indicator of change in level of physiological arousal (Martin, 1961).

Measurement of muscle tension. In research, and to an increasing extent in clinical settings, electromyography has replaced the estimation of muscle tension, or muscular contraction, by subjective report, visual inspection or palpation. Electromyography entails the detection, amplification and recording of the MAPs that are produced when motor units fire (Goldstein, 1972). Of course, the electromyograph does not provide a direct measure of muscle tension, since the MAPs occur prior to the contraction of the muscle. Nevertheless, in studies relating variations in muscular contraction to changes in EMG amplitude the resulting correlations have been high. Wilcott and Beenken (1957), for example, reported correlations in the .80s and .90s between muscle tension and EMG amplitude. With respect to the sensitivity of electromyography, which constitutes one of its main advantages, Green, Green and Walters (1970) indicate that "an electromyographic (EMG) electrode...will usually detect a continuous firing of motor fibres, even though visible signs of tension may not exist and muscular feelings of tension may not exist (p. 7)." While electromyography may be applied to any accessible muscle, the frontal region is a common site, because it appears to be an especially sensitive indicator of muscle tension (Luce & Peper, 1971).

Measurement of skin temperature. The familiar mercury-in-glass thermometer is unsuitable for most research applications, because it unduly restricts the activity of the subject and does not provide a remotely recordable signal. Therefore, thermometers used for research purposes usually have thermocouples or thermistors as sensing elements. The thermocouple is a simple device formed by the junction of two wires made from dissimilar metals, usually copper and constantan, which generates a small potential when heated (Brown, 1972). Among the disadvantages of the thermocouple are its low output, and consequent need for high amplification, and the necessity for using special alloys in the connecting cables to eliminate temperature artifacts. The thermistor, on the other hand, is a semiconductor that changes resistance with changes in temperature. Modern thermistors are manufactured from oxides of nickel, manganese, iron, cobalt, copper, magnesium and other metals (Brown, 1972). In the past, the thermocouple was favored over the thermistor for temperature detection, because of its greater linearity of output versus temperature change. However, this difficulty has been largely overcome by the newer thermistor elements, such as that used in the present study, which exhibit rapid and large changes in resistance for relatively small changes in temperature (Brown, 1972). Regardless of the type of sensing element used, skin temperature is usually monitored at a site on the hands or feet. These locations are popular because the skin of the hands and feet generally undergoes the most pronounced cooling during physiological arousal (Duffy, 1962, 1972).

Measurement of electrodermal activity. Since the discovery of the galvanic skin reflex by Vigouroux (1879), the electrical properties of the skin have been studied extensively as indices of human psychophysiological processes. There are three basic indicators of electrodermal activity in common use, namely, skin conductance, skin resistance and skin potential (Venables & Christie, [illegible]). Skin conductance, which was the indicator [illegible] in the present study, is measured by applying [illegible] constant voltage across the skin between two electrodes and determining the amount of current transmitted by the skin (Autogenic Systems Incorporated, 1976). Since an externally applied voltage is employed in this determination, skin conductance is an exosomatic electrodermal measure (Edelberg, 1972). Skin resistance, which is also an exosomatic indicator, is measured by driving a small constant current across the skin between two electrodes and noting the voltage that develops across the electrodes in order to calculate the resistance of the skin (Edelberg, 1972). Although skin resistance is used as the electrodermal measure in several inexpensive electrodermal feedback devices, skin conductance is generally preferred over skin resistance, because the application of a constant current across the skin can cause skin irritation and produce artifacts (Autogenic Systems Incorporated, 1976). Unlike skin conductance and skin resistance, skin potential is an endosomatic measure, since its detection does not require the application of an external current source (Edelberg, 1972). Skin potential is measured by placing two electrodes on the surface of the skin and noting the electrical potential difference between them (Edelberg, 1972). Of course, in order to observe activity, two sites of dissimilar activity are required. Unfortunately, however, if a positive wave is recorded, it is impossible to determine whether it indicates a positive response in the first site or a negative one in the other (Edelberg, 1972). This difficulty is usually approached by employing an inactive site, such as the inner aspect of the ear lobe, for one of the electrodes, or by attempting to inactivate one of the sites by perforation (Wilcott, 1959) or skin drilling (Shackel, 1959). While skin potential appears to be a relatively popular electrodermal measure, the practical difficulties associated with its detection are somewhat formidable. Irrespective of the type of indicator used, the palmar and plantar surfaces are generally recognized as the best sites for the measurement of electrodermal activity (Edelberg, 1967). The palmar and plantar surfaces are not only highly active in displaying electrodermal responses, but are also convenient in terms of electrode placements (Edelberg, 1967). In addition, in the absence of high ambient temperatures, the eccrine sweat glands of the palms and soles produce arousal, rather than heat-loss, sweating (Wilcott, 1967).

Psychophysiological Effects of EMG Feedback Relaxation Training

Certain common deficiencies in biofeedback research make it imperative to exercise caution in evaluating studies of the psychophysiological effects of EMG feedback relaxation training. For example, numerous investigations fail to include any type of control group (Bowles & Smith, 1978; Canter et al., 1975; Staples & Coursey, 1975). In addition, many studies are based on a totally inadequate number of subjects (Breeden, Bean, Scandrett, & Kondo, 1975; Kappes & Michaud, 1978; Miller, Murphy, Miller, & Smouse, 1976) and it is not unusual for EMG feedback relaxation training to be supplemented by home practice in progressive relaxation (Le Boeuf, 1974; Montgomery & Besner, 1975; Townsend, House, & Addario, 1975).

Since such procedures do not permit evaluation of the effects of EMG feedback relaxation training, studies without control groups, investigations with less than ten subjects per group and experiments in which mixed training is used will be excluded from discussion.

Studies of the psychophysiological effects of EMG feedback relaxation training, that meet the previously mentioned criteria, seriously question the effectiveness of this biofeedback technique as a type of general relaxation training. With respect to anxiety reduction, such studies appear to produce the consistent finding that EMG feedback relaxation training is generally no more effective than control procedures (Alexander, 1975; Coursey, 1975; Coursey & Frankel, 1974; Haynes, Moseley, & McGowan, 1975; Mehearg & Eschette, 1975; Ohno, Tanaka, Takeya, Matsubara, Kuriya, & Komemushi, 1978). This finding applies to both state and trait anxiety, although it should be noted that all the studies cited were conducted with normal adults.

In relation to the physiological effects of EMG feedback relaxation training, the vast majority of studies indicate that this biofeedback technique does reduce muscle tension in the region of the training site (Carlson, 1977; Coursey & Frankel, 1974; Fee & Girdano, 1978; Ohno et al., 1978; Reinking &

Kohl, 1975), but that this seems to be the extent of its physiological effects. As previously indicated, investigations concerned with the generalization of muscle relaxation from the frontal area to the rest of the skeletal musculature have generally failed to provide evidence in support of such an effect (Alexander, 1975). Since this generalization effect was originally postulated on the basis of the subjective reports of frontal EMG feedback subjects (Budzynski & Stoyva, 1969), it is noteworthy that when frontal EMG feedback subjects report a subjective generalization effect, it is usual for control subjects to indicate a similar experience (Alexander, 1975; Reinking & Kohl, 1975).

The limited number of studies that have examined the effects of EMG feedback relaxation training on autonomic variables, have produced equally disappointing results (Carlson, 1977; Fee & Girdano, 1978; Ohno et al., 1978). Carlson (1977), for example, found that frontal EMG feedback training was associated with a decrease, rather than an increase, in finger temperature. Thus, the direction of temperature change in the frontal EMG feedback group was opposite to that expected if the training had induced general relaxation. In addition, Fee and Girdano (1978) reported that frontal EMG feedback training did not significantly reduce autonomic nervous system activity as measured by electrodermal response, heart rate, respiration rate and skin temperature. Furthermore, Ohno et al. (1978) found that frontal EMG feedback training was no more effective than control measures in reducing heart rate. It should be observed, however, that these studies were also restricted to normal adults.

Few studies have been concerned with the psychophysiological effects of EMG feedback relaxation training among children. Nevertheless, it does appear that with children, as with adults, this biofeedback technique reduces muscle tension at the training site. This specific effect of EMG feedback relaxation training has been demonstrated with normal children (Wilkinson, 1976) and with children suffering from asthma (Kotses & Glaus, 1978; Kotses, Glaus, Crawford, Edwards, & Scherr, 1976) and hyperkinesis (Jeffrey, 1978). However, it is interesting to note Jeffrey's (1978) observation that motor activity in other parts of the body is not incompatible with relaxation at the training site. According to Jeffrey (1978), many of his hyperkinetic subjects were able to produce significant reductions in frontal muscle tension while moving a foot or hand in a repetitive manner, which suggests a lack of generalization of training effect. Although there is no compelling reason to expect the psychophysiological effects of

EMG feedback relaxation training among children to be markedly different from those among adults, there is an obvious need for investigations conducted with children.

Psychophysiological Effects of Thermal Feedback Relaxation Training

Relatively few studies have been concerned with the psychophysiological effects of thermal feedback relaxation training, and those that have been conducted are not immune to the common deficiencies of biofeedback research. Unfortunately, investigations of the psychophysiological effects of thermal feedback relaxation training frequently lack control groups (Bernthal & Papsdorf, 1977; Freedman, Lynn, & Ianni, 1978; Mathew, Largen, Claghorn, Dobbins, & Meyer, 1978), are often based on extremely limited samples (Lynch, Hama, Kohn, & Miller, 1976; Peper & Grossman, 1974; Thompson & Russell, 1976) and commonly involve the simultaneous application of thermal feedback relaxation training and other types of training (Engelhardt, 1978; Surwit, Pilon, & Fenton, 1978; Werbach & Sandweiss, 1978). If studies of the psychophysiological effects of thermal feedback relaxation training had to meet all the criteria specified in the previous section, hardly any would remain for consideration. Therefore, some of the studies to be examined in the proceeding discussion will be based on limited samples, although those without control groups and those entailing mixed training will be omitted from consideration.

The small number of studies that do qualify for inclusion, are based entirely on adult samples (Elder et al., 1977; Stoffer, Jensen & Nesset, 1977; Thompson & Russell, 1976). Furthermore, none of these investigations have included subjective measures of anxiety. Therefore, despite the fact that thermal feedback relaxation training is being used as an approach to anxiety resolution (Bernthal & Papsdorf, 1977; Engelhardt, 1978), there is an absence of sound experimental evidence supporting its use in this capacity. With respect to the physiological effects of thermal feedback relaxation training, the limited number of studies in the area have produced findings which suggest that this biofeedback technique exerts a specific, rather than a general, influence on physiological functioning. It does appear that thermal feedback relaxation training increases skin temperature in the region of the training site (Elder et al., 1977; Stoffer et al., 1977; Thompson & Russell, 1976), with a concomitant change in the untrained hand (Elder et al., 1977). However, Elder et al. (1977) found no evidence of a generalization of training effect from a training site on the right hand to untrained sites on the ankles, the forehead, the thorax and under the right arm. At the same time, Elder et al. (1977) observed no changes in heart rate or respiration rate. In addition, Stoffer et al. (1977) reported that successful thermal feedback relaxation training did not affect immersion time, pain ratings or blood pressure during a cold pressor posttest. Therefore, the potential of thermal feedback training as a general relaxation training technique, for adults and children, remains in question.

Hypotheses

A number of hypotheses, including those delineated for empirical investigation in the present study, are suggested by the preceding discussion. The basic proposition to be tested, which subsumes the following specific hypotheses, is that EMG feedback relaxation training (group 1) and thermal feedback relaxation training (group 2) exhibit specificity of training effect and are ineffective as general relaxation training techniques for children:

1. The EMG feedback group, in contrast with the thermal feedback group and the control group (group 3), will demonstrate a lower level of muscle tension in the frontal region.
2. There will be no difference in level of muscle tension in the frontal region between the thermal

feedback group and the control group.

3. The thermal feedback group, compared with the EMG feedback group and the control group, will show a higher level of skin temperature.

4. There will be no difference in skin temperature between the EMG feedback group and the control group.

5. There will be no difference in skin conductance level between the three groups.

6. There will be no difference in level of trait anxiety between the three groups.

7. There will be no difference in level of state anxiety between the three groups.

CHAPTER III

DESIGN AND PROCEDURE

Sample

Subjects for this study were drawn from the 89 grade six students attending an elementary school in a city of approximately 600,000 residents in northern Alberta. This grade six student body comprised 47 boys and 42 girls, from which 27 male and 27 female subjects were randomly selected and assigned to one of the following groups: experimental group 1, which received EMG feedback relaxation training, experimental group 2, which received thermal feedback relaxation training and group 3 (control group), which received no relaxation training. Parental permission for participation in the study, which was presented as an extracurricular relaxation training course, was obtained for all subjects.

Procedure

The 54 subjects participated, individually, in one orientation session, one pretreatment session and five treatment sessions, each of approximately 40 minutes duration. These sessions were scheduled on consecutive weekdays, with one subject from each group entering the experiment on the same day. Adherence to this schedule ensured that the pretreatment session and the final treatment session for any particular subject occured on the same day of the week, and that the day of the week on which subjects entered the experiment was balanced for the three groups. In addition, the time of day during which the subjects participated in the study was balanced for the three groups, in order to control for the possible effects of diurnal biological rhythms and fluctuations in environmental conditions. All sessions were conducted in a quiet, well lit room, which was maintained at a constant temperature of 70'F (Autogenic Systems Incorporated, 1976).

All sessions comprised an initial phase of subject preparation, followed by a measuring and recording phase of approximately 20 minutes duration. During the subject preparation phase, the subject reclined on a black, Kroken lounging-chair (Ikea, 1979) and was connected to a thermometer (Autogen 2000), a skin conductance dermograph (Autogen 3000) and an electromyograph (Autogen 1500). The two active dermograph electrodes were attached to the ball of the foot (same side of the body as the dominant hand), with the reference electrode attached to the dorsal surface of the foot (Edelberg, 1967). Prior to the attachment of the active dermograph electrodes, the ball of the foot was cleansed with Sterling's Wet Ones, and dried with

Kleenex tissues, to ensure firm electrode attachments. The temperature probe was attached to the palmar surface of the distal phalanx of the middle finger of the dominant hand (Autogenic Systems Incorporated, 1976). The two active EMG electrodes were attached 1 inch above the eyebrows, with a reference electrode between them in the center of the forehead (Davis, 1959).

During the measuring and recording phase of each session, average EMG activity, average skin temperature and average skin conductance level, from the previously indicated sites, were measured and recorded in alternating sequence. The order in which the three physiological variables were measured and recorded was rotated and balanced for each group. Average EMG activity, average skin temperature and average skin conductance level were monitored and recorded five times during each measuring and recording phase. Each measurement period was of 60 seconds duration and was followed by a 15 second recording period, during which the experimenter recorded the data for the preceding measurement period and adjusted the equipment to monitor the next physiological variable. The data recorded during the pretreatment sessions was used to calculate the pretreatment baselines, while the data recorded during the final treatment sessions was used to calculate the final treatment baselines.

Measurement and recording during the orientation session and the first four treatment sessions was performed in an attempt to standardize procedures across all sessions. During the measuring and recording phases, the subjects were positioned in such a way that they were unable to observe either the measuring equipment or the experimenter recording the data.

Orientation session. At the beginning of the orientation session, which was designed to adjust the subjects to the experimental situation, the experimenter instructed each subject as follows: "Hello, X. We will be working together for about 40 minutes today, so if you need to use the washroom, please do so now. All I want you to do is to take off your shoes and socks and sit on this chair, while I measure how well you are relaxing. Which hand do you usually write with? I am going to attach this sensor to your finger. It won't hurt you at all. It is just used to tell how well you are relaxing." (Temperature probe attached.) "Please do not touch the sensor on your finger or allow it to come into contact with anything. Next, I am going to attach some sensors to your foot, after I have wiped your foot to make sure that the sensors stick on properly." (Dermograph electrodes attached.) "Now, I am going to attach the last set of sensors to your forehead."

(EMG [illegible]des attached.) "Your task for the next 20 mi[illegible] to relax as completely as you can, but [illegible]o not [illegible] sleep or close your eyes. Any questions? [illegible]e yo[illegible]mfortable? Now, just sit quietly and wait u[illegible]til [illegible] tell you that we have finished."

[illegible]etreatment session. The experimenter prepared ea[illegible]ubject for the measuring and recording phase of the [illegible]retreatment session as follows: "Hello, X. Do you [illegible]eed to use the washroom before we start? All I wa[illegible] you to do is to take off your shoes and socks and s[illegible] on this chair, while I measure how well you are relaxing." (Probe and electrodes attached.) "Your t[illegible]sk for the next 20 minutes is to relax as comple[illegible] as you can, but do not go to sleep or close your eyes. Any questions? Are you comfortable? Now, just sit quietly and wait until I tell you that we have finished."

Following the measuring and recording phase of the pretreatment session, and the removal of the probe and electrodes, each subject was directed to complete the scales of the STAIC as follows: "Before you leave, X, I want you to complete these two questionnaires. I will read the directions aloud for the first one, while you read them silently." (Standardized directions for the A-Trait scale of the STAIC read aloud by experimenter.) "Now, go ahead and let me know when you have finished the first questionnaire." (Subject completes scale.) "I will now read the directions aloud for the second questionnaire, while you read them silently." (Standardized directions for the A-State scale of the STAIC read aloud by experimenter.) "Now, go ahead and let me know when you have finished the second questionnaire." (Subject completes scale.) The scores obtained on the STAIC, at this time, served as indicators of pretreatment trait and state anxiety levels.

Treatment sessions. During the subject preparation phases of the treatment sessions, subjects received standardized instructions according to group membership. Subjects in group 1 received instruction in EMG feedback relaxation training. (For transcript of EMG feedback training instructions, see Appendix A.) Subjects in group 2 received instruction in thermal feedback relaxation training. (For transcript of thermal feedback training instructions, see Appendix B.) Subjects in group 3 received no relaxation training instructions. (For transcript of no relaxation training instructions, see Appendix C.) Following the subject preparation phase of each treatment session, subjects in group 1 received EMG feedback, subjects in group 2 received thermal feedback and subjects in group 3 attempted to relax without any type of feedback.

Upon completion of the measuring and recording phase of the last treatment session, and the removal of the probe and electrodes, each subject was directed to complete the scales of the STAIC as follows: "Before you leave, X, I want you to complete these two questionnaires. I will read the directions aloud for the first one, while you read them silently." (Standardized directions for the A-Trait scale of the STAIC read aloud by experimenter.) "Now, go ahead and let me know when you have finished the first questionnaire." (Subject completes scale.) "I will now read the directions aloud for the second questionnaire, while you read them silently." (Standardized directions for the A-State scale of the STAIC read aloud by the experimenter.) "Now, go ahead and let me know when you have finished the second questionnaire." (Subject completes scale.) The scores obtained on the STAIC, at this time, served as indicators of final treatment trait and state anxiety levels.

Instrumentation

STAIC, A-State scale. The A-State (form C-1) scale of the STAIC, which is designed for use with nine to twelve year old children, was used as a measure of state anxiety in the present study. The STAIC, A-State scale comprises 20 items pertaining to the respondent's feelings at the time of testing. The 20 items of the A-State scale were selected from 33 items derived from an examination of the State-Trait

Anxiety Inventory (STAI) for adults and other inventories designed to measure anxiety in children. Selection of the final set of items for the STAIC, A-State scale was made according to the joint considerations of internal consistency and construct validity (Spielberger, 1973). Respondents to the STAIC, A-State scale are required to select one of three alternative choices for each item, by placing an X in the box in front of the word or phrase that best describes them at the time. Each choice for which agreement is indicated receives the appropriate scale value. High scores on the STAIC, A-State scale are indicative of elevations in anxiety at the time of testing (Spielberger, 1973).

Spielberger (1973) has provided evidence bearing on the construct validity of the STAIC, A-State scale for a sample of 913 fourth, fifth and sixth grade students, who were administered the STAIC, A-State scale with the standard instructions (NORM condition) and then asked to respond to the STAIC, A-State scale according to how they believed they would feel just before the final examination in an important subject (TEST condition.) As anticipated, Spielberger (1973) found that the "mean scores for the A-State scale were considerably higher in the TEST condition...than in the NORM condition (p. 9)." Furthermore, each individual item significantly discriminated between the

NORM and TEST conditions for both the males and females (Spielberger, 1973). Reliability data for the STAIC, A-State scale is available in the form of stability and alpha coefficients. Based on the STAIC, A-State scores of 246 fourth, fifth and sixth grade students, test-retest correlations for the STAIC, A-State scale were .31 for males and .47 for females (Spielberger, 1973). These stability coefficients are quite low, as could be expected for a measure designed to be sensitive to the influence of situational factors. However, alpha coefficients for the STAIC, A-State scale, based on the STAIC, A-State scale scores of the same 246 students, were .82 for males and .87 for females (Spielberger, 1973). As Spielberger (1973) indicates, given the transitory nature of state anxiety, this measure of internal consistency would appear to provide a more meaningful index of reliability than test-retest correlations.

STAIC, A-Trait scale. The A-Trait (form C-2) scale of the STAIC, which was also constructed for use with upper elementary children, was used as a measure of trait anxiety in the present study. The 20 items of the STAIC, A-Trait scale relate to the way the respondent generally feels. The majority of these items were selected from 40 preliminary A-Trait items developed on the basis of an examination of the STAI and other inventories designed to measure anxiety among children. The final selection of items for the STAIC, A-Trait scale was based on the combined criteria of internal consistency and concurrent validity (Spielberger, 1973). The STAIC, A-Trait scale requires the child to respond to each item by indicating the frequency of occurrence of the behavior described by that item. In responding to the STAIC, A-Trait scale, the child is instructed to select one of three alternative choices by placing an X in the box in front of the word that best describes the frequency of the behavior under consideration. Each choice for which agreement is indicated receives the appropriate scale value. High scores on the STAIC, A-Trait scale are indicative of a high degree of anxiety proneness (Spielberger, 1973).

Evidence of the concurrent validity of the STAIC, A-Trait scale is shown by its correlations with the Children's Manifest Anxiety Scale (Castaneda, McCandless, & Palermo, 1956) and the General Anxiety Scale for Children (Sarason, Davidson, Lighthall, Waite, & Ruebush, 1960). In a sample of 75 fourth, fifth and sixth grade children, the STAIC, A-Trait scale correlated .75 with the Children's Manifest Anxiety Scale and .63 with the General Anxiety Scale for Children (Platzek, 1970). Further validity data has been presented by Spielberger (1973), who reported correlations between the STAIC, A-Trait scale and the California Achievement Test, for groups of 80 to

140 fourth, fifth and sixth grade children; as might be expected, all the correlations were negative, ranging from - .13 to - .37. Spielberger (1973) has also furnished reliability data for the STAIC, A-Trait scale, in the form of stability and alpha coefficients. Based on the STAIC, A-Trait scale scores of 246 fourth, fifth and sixth grade students, the test-retest correlations were .65 for males and .71 for females, and the alpha coefficients were .78 for males and .81 for females (Spielberger, 1973).

Electromyograph. An Autogen 1500 feedback myograph, capable of accurately registering EMG activity changes of .10 microvolts (μV), was used to monitor EMG activity in the frontal region. The main component of the electromyograph was a differential amplifier with low internal noise levels (.10 μV noise). Incorporated into the electromyograph was a band pass filter for the rejection of EEG and electrocardiographic (ECG) artifacts. The electromyograph had high common mode and 60 hertz (Hz) rejection characteristics and was equipped with shielded electrode cables to reduce external electrical interference (Autogenic Systems Incorporated, 1976). Silver/silver chloride electrodes, embedded in plastic insulator discs, were used to detect the MAPs. Biogel biopotential contact medium was used in the cups of the electrodes, which were attached to the skin with donut-shaped adhesive discs.

Thermometer. An Autogen 2000 feedback thermometer, capable of accurately registering temperature changes of .02°F, was used to monitor digital skin temperature. Incorporated into the thermometer was a summing amplifier, which converted the transduced electrical resistances into DC voltages and boosted them proportional to absolute temperature. The thermometer also contained filters, which attenuated all signal information greater than 1 Hz, for the rejection of static electricity and other forms of higher frequency electrical interference. A Yellow Springs Instrument temperature probe was used with the thermometer. At the tip of the temperature probe was an epoxy-coated precision linear thermistor, which served as the temperature sensor (Autogenic Systems Incorporated, 1976). Micropore tape was used to attach the temperature probe to the finger.

Dermograph. An Autogen 3000 skin conductance feedback dermograph, capable of registering conductance changes of .01 micromhos (μmho), was used to monitor plantar skin conductance level. This instrument applied an AC current, in the form of a 10 Hz sine wave, which had no high frequency subdominant components that could be picked up through the electromyograph. Incorporated into the dermograph was an external control system, which balanced the amount of current entering the skin through the first active electrode with that taken out by the second active electrode. In addition, the dermograph had high common mode and 60 Hz rejection characteristics (Autogenic Systems Incorporated, 1976). Silver/silver chloride electrodes, embedded in plastic insulator discs, were used with the dermograph. These electrodes were used with Biogel contact medium and attached to the skin by means of donut-shaped adhesive discs.

Digital integrator. An Autogen 5100 digital integrator was used to compute average EMG activity in microvolts, average skin temperature in degrees Fahrenheit and average skin conductance level in micromhos, over the selected time intervals. Functions 2, 3, and 4 of the integrator were used for the inputs of the electromyograph, the thermometer and the dermograph, respectively. Standard RCA phono male cables were used to connect the electromyograph, the thermometer and the dermograph to the integrator. The integrator presented average EMG activity, average skin temperature and average skin conductance level on a digital readout.

Visual feedback system. An Autogen 7000 light feedback display was used in conjunction with the Autogen 1500 feedback myograph and the Autogen 2000 feedback thermometer to provide diamond light feedback to the EMG feedback subjects (group 1) and the thermal feedback subjects (group 2), respectively. Standard RCA phono cables were used to connect the electromyograph and thermometer to inputs 1 and 2 of the Autogen 7000, respectively (Autogenic Systems Incorporated, 1979).

CHAPTER IV

ANALYSIS, FINDINGS AND CONCLUSIONS

Basically, Chapter IV comprises a restatement of the hypotheses delineated in Chapter II, together with a presentation of the related findings and conclusions. In order to test the hypothesized effects of the different types of relaxation training, one way analyses of variance (Ferguson, 1971, p. 261) and, where indicated, Bartlett's test for homogeneity of variance (Winer, 1971, p. 208) were applied to the data of the final treatment sessions. In cases where the Bartlett test revealed inequality of variance between the groups, an appropriate transformation of the data was made (Ferguson, 1971, p. 202). Where the transformations did not result in homogeneity of variance between the groups, the Kruskal-Wallis one way analysis of variance by ranks (Ferguson, 1971, p. 331) and, where applicable, the Mann-Whitney U test (Seigel, 1956, p. 116) were used to analyze the data of the final treatment sessions. However, prior to testing the specific hypotheses, one way analyses of variance were used to examine the pretreatment data.

Table 1 shows the means and standard deviations of the pretreatment scores for the three groups.

With reference to Table 2, one way analyses of variance indicated that there was no significant

TABLE 1

SUMMARY OF PRETREATMENT DATA

	EMG ACTIVITY (μV) GROUP	MEAN	S D	N
1	EMG FEEDBACK	3.17	1.23	18
2	THERMAL FEEDBACK	3.34	1.36	18
3	CONTROL	3.14	1.38	18
	SKIN TEMPERATURE ('F) GROUP	MEAN	S D	N
1	EMG FEEDBACK	91.61	4.81	18
2	THERMAL FEEDBACK	92.06	3.54	18
3	CONTROL	91.58	6.25	18
	SKIN CONDUCTANCE (μmho) GROUP	MEAN	S D	N
1	EMG FEEDBACK	28.83	13.79	18
2	THERMAL FEEDBACK	22.67	9.60	18
3	CONTROL	22.35	12.20	18
	TRAIT ANXIETY GROUP	MEAN	S D	N
1	EMG FEEDBACK	33.17	5.29	18
2	THERMAL FEEDBACK	35.33	3.88	18
3	CONTROL	35.67	6.22	18
	STATE ANXIETY GROUP	MEAN	S D	N
1	EMG FEEDBACK	27.17	5.23	18
2	THERMAL FEEDBACK	30.17	3.91	18
3	CONTROL	27.50	5.27	18

TABLE 2

SUMMARY OF PRETREATMENT ANALYSES OF VARIANCE

	SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	VARIANCE ESTIMATE	F	PROBABILITY
EMG ACTIVITY (μV)	BETWEEN	.40	2	.20		
	WITHIN	89.59	51	1.76	.11	$p > .05$
SKIN TEMPERATURE (°F)	BETWEEN	3.13	2	1.56		
	WITHIN	1270.38	51	24.91	.06	$p > .05$
SKIN CONDUCTANCE (μmho)	BETWEEN	479.69	2	239.85		
	WITHIN	7330.70	51	143.74	1.67	$p > .05$
TRAIT ANXIETY	BETWEEN	66.34	2	33.17		
	WITHIN	1390.50	51	27.26	1.22	$p > .05$
STATE ANXIETY	BETWEEN	97.34	2	48.67		
	WITHIN	1197.50	51	23.48	2.07	$p > .05$

difference between the pretreatment means of the three groups on any of the five dependent variables.

HYPOTHESIS 1

The EMG feedback group, in contrast with the thermal feedback group and the control group, will demonstrate a lower level of muscle tension in the frontal region.

Findings

Table 3 shows the means and standard deviations of the final treatment EMG activity scores for the three groups.

TABLE 3

SUMMARY OF FINAL TREATMENT EMG ACTIVITY (μV)

	GROUP	MEAN	S D	N
1	EMG FEEDBACK	2.08	.76	18
2	THERMAL FEEDBACK	3.66	1.14	18
3	CONTROL	3.15	1.48	18

A one way analysis of variance showed that there was a significant difference between the final treatment EMG activity means of the three groups ($F = 8.64$, $p < .01$). However, the Bartlett test revealed that homogeneity of variance did not exist between the three groups ($\chi^2 = 6.94$, $p < .05$). Since a reciprocal transformation of the data

(Ferguson, 1971, p. 220) did not result in equality of variance between the three groups, as indicated by the Bartlett test ($\chi^2 = 7.58$, $p < .05$), the Kruskal-Wallis one way analysis by ranks was applied to the final treatment EMG activity data. Referring to Table 4, the Kruskal-Wallis one way analysis by ranks indicated an overall significant difference between the three groups with respect to averages ($H = 14.07$, $p < .01$).

TABLE 4

KRUSKAL-WALLIS ANALYSIS OF VARIANCE FOR FINAL TREATMENT EMG ACTIVITY (µV)

SUMS OF RANKS	DEGREES OF FREEDOM	H	CORRECTED H	PROBABILITY
$R_1 = 306.00$				
$R_2 = 657.00$				
$R_3 = 522.00$	2	14.07	14.07	$p < .01$

With reference to Table 5, paired comparisons between the three groups, using the Mann-Whitney U test, indicated significant differences, in the predicted direction, between the EMG and thermal feedback groups ($U = 36$, $p < .01$) and between the EMG feedback and control groups ($U = 99$, $p < .05$)

Conclusion

Statistical analysis of the data confirmed that the EMG feedback group, in contrast with the thermal feedback group and the control group, demonstrated a lower level of muscle tension in the frontal region

TABLE 5

SUMMARY OF MANN-WHITNEY U TESTS FOR FINAL TREATMENT EMG ACTIVITY (μV)

COMPARISON GROUPS	FINAL TREATMENT U	PROBABILITY
1 : 2	36	$p < .01$
1 : 3	99	$p < .05$
2 : 3	126	$p > .05$

HYPOTHESIS 2

There will be no difference in level of muscle tension in the frontal region between the thermal feedback group and the control group.

Findings

As Table 5 shows, the Mann-Whitney U test indicated that there was no significant difference between the thermal feedback and control groups ($U = 126$, $p > .05$).

Conclusion

On the basis of this result, it was possible [illegible]rm the hypothesis that there would be no [illegible] in level of muscle tension in the [illegible]on between the thermal feedback group and the control group.

HYPOTHESIS 3

The thermal feedback group, compared with the EMG feedback group and the control group, will show a higher level of skin temperature.

Findings

Table 6 shows the means and standard deviations of the final treatment skin temperature scores for the three groups.

TABLE 6

SUMMARY OF FINAL TREATMENT SKIN TEMPERATURE DATA ('F)

GROUP	MEAN	S D	N
1 EMG FEEDBACK	91.47	3.64	18
2 THERMAL FEEDBACK	92.53	3.94	18
3 CONTROL	91.89	4.31	18

As Table 7 indicates, a one way analysis of variance showed that there was no significant difference between the final treatment skin temperature means of the three groups ($F = .33$, $p > .05$).

Conclusion

On the basis of this analysis, Hypothesis 3 was rejected.

HYPOTHESIS 4

There will be no difference in skin temperature between the EMG feedback group and the control group.

Findings

As Table 7 indicates, a one way analysis of variance showed that there was no significant difference between the final treatment skin temperature means ($F = .33$, $p > .05$).

TABLE 7

ANALYSIS OF VARIANCE FOR FINAL TREATMENT SKIN TEMPERATURE (°F)

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	VARIANCE ESTIMATE	F	PROBABILITY
BETWEEN	10.44	2	5.22		
WITHIN	805.25	51	15.79	.33	$p > .05$

Conclusion

The conclusion warranted on the basis of this analysis is that there was, indeed, no difference in skin temperature between the EMG feedback group and the control group

HYPOTHESIS 5

There will be no difference in skin conductance level between the three groups.

Findings

Table 8 shows the means and standard deviations the three groups.

TABLE 8

SUMMARY OF FINAL TREATMENT SKIN CONDUCTANCE DATA (μmho)

	GROUP	MEAN	S D	N
1	EMG FEEDBACK	27.55	11.72	18
2	THERMAL FEEDBACK	27.55	14.08	18
3	CONTROL	19.75	4.34	18

Referring to Table 9, a one way analysis of variance showed that there was no significant difference between the final treatment skin conductance means of the three groups ($F = 3.09$, $p > .05$)

TABLE 9

ANALYSIS OF VARIANCE FOR FINAL TREATMENT SKIN CONDUCTANCE (μmho)

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	VARIANCE ESTIMATE	F	PROBABILITY
BETWEEN	730.08	2	365.04		
WITHIN	6026.68	51	118.17	3.09	$p > .05$

Conclusion

Statistical analysis of the data confirmed that there was no difference in skin conductance level between the three groups.

There will be no difference in level of trait anxiety between the three groups.

Findings

Table 10 shows the means and standard deviations of the final treatment trait anxiety scores for the three groups.

TABLE 10

SUMMARY OF FINAL TREATMENT TRAIT ANXIETY DATA

	GROUP	MEAN	S D	N
1	EMG FEEDBACK	29.00	6.06	18
2	THERMAL FEEDBACK	32.50	5.07	18
3	CONTROL	33.33	5.90	18

As table 11 shows, a one way analysis of variance indicated that there was no significant difference between the final treatment trait anxiety means of the three groups ($F = 2.94$, $p > .05$).

TABLE 11

ANALYSIS OF VARIANCE FOR FINAL TREATMENT TRAIT ANXIETY

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	VARIANCE ESTIMATE	F	PROBABILITY
BETWEEN	190.34	2	95.17		
WITHIN	1652.50	51	32.40	2.94	$p > .05$

Conclusion

Statistical analysis of the data confirmed that there was no difference in level of trait anxiety between the three groups.

HYPOTHESIS 7

There will be no difference in level of state anxiety between the three groups.

Findings

Table 12 shows the means and standard deviations of the final treatment state anxiety scores for the three groups.

TABLE 12

SUMMARY OF FINAL TREATMENT STATE ANXIETY DATA

	GROUP	MEAN	S D	N
1	EMG FEEDBACK	26.83	4.54	18
2	THERMAL FEEDBACK	30.67	3.01	18
3	CONTROL	26.72	5.61	18

A one way analysis of variance showed that there was a significant difference between the final treatment state anxiety means of the three groups ($F = 4.45$, $p < .05$). However, the Bartlett test revealed that homogeneity of variance did not exist between the three groups ($\chi^2 = 6.06$, $p < .05$). Since a reciprocal transformation of the data did not result in equality of variance between the three groups, as indicated by the Bartlett test ($\chi^2 = 16.16$, $p < .01$), the Kruskal-Wallis one way analysis of variance by ranks was applied to the final treatment state anxiety data. As Table 13 shows, the Kruskal-Wallis one way analysis of variance by ranks indicated that there was no significant difference between the three groups with respect to averages ($H = 5.70$, $p > .05$).

TABLE 13

KRUSKAL-WALLIS ANALYSIS OF VARIANCE FOR FINAL TREATMENT STATE ANXIETY

SUMS OF RANKS	DEGREES OF FREEDOM	H	CORRECTED H	PROBABILITY
$R_1 = 428.50$				
$R_2 = 624.50$				
$R_3 = 432.00$	2	5.65	5.70	$p > .05$

Conclusion

On the basis of this analysis, it was confirmed that there was no difference in level of state anxiety between the three groups.

CONCLUSIONS

In summary, the above findings suggest the following conclusions:

1. As predicted, the EMG feedback training was successful as a specific technique, as shown by the finding that

the EMG feedback group, in contrast with the thermal feedback and control groups, demonstrated a lower level of muscle tension in the frontal region, as a consequence of training. In other words, the EMG feedback group mastered the EMG feedback training.

2. As anticipated, the EMG feedback training was not effective as a general relaxation training technique, as evidenced by the finding that the EMG feedback group, in comparison with the control group, did not exhibit a higher level of skin temperature or lower levels of skin conductance, trait anxiety and state anxiety, as a result of training.

3. Therefore, as predicted, the EMG feedback training exhibited specificity of training effect.

4. Contrary to expectation, the thermal feedback training was not mastered by the thermal feedback group, as demonstrated by the finding that the thermal feedback group, compared with the EMG feedback and control groups, did not show a higher level of skin temperature, as a consequence of training. Therefore, in this instance, the thermal feedback training was not effective as a specific technique.

5. Since the thermal feedback group did not master the thermal feedback training, no conclusion could

be drawn regarding the effectiveness of thermal feedback training as a general relaxation training technique.

CHAPTER V

DISCUSSION AND IMPLICATIONS

The main purpose of this research was to investigate the effectiveness of EMG and thermal feedback training as general relaxation training techniques for children. In general terms, the study involved an examination of the effects of EMG and thermal feedback training on measures of physiological and psychological arousal. More specifically, of concern was the effect of successful EMG feedback training on skin temperature, skin conductance, trait anxiety and state anxiety, and with the effect of successful thermal feedback training on EMG activity, skin conductance, trait anxiety and state anxiety. In Chapter V, the results of this study are discussed, both in terms of the research objectives and in relation to some of the theoretical and practical issues in the area of biofeedback training for children. Following the discussion, some implications for further research and education are outlined.

DISCUSSION

EMG Feedback Relaxation Training as a General Relaxation Training Technique for Children

As noted in Chapter I, it is frequently assumed that frontal EMG feedback relaxation training is effective as a general relaxation training technique. Expressed differently, it is commonly supposed that successful frontal EMG feedback relaxation training is associated with a reduction in physiological and psychological arousal. On the basis of this notion, it has been recommended that children receive frontal EMG feedback relaxation training in the schools, as a form of protection against the subsequent development of emotional and psychosomatic disorders (Engelhardt, 1978; Volpe, 1975). However, studies conducted with normal adults strongly suggest that the effects of frontal EMG feedback relaxation training are quite limited, even within the skeletal musculature (Alexander, 1975; Freedman et al., 1977), that frontal EMG feedback relaxation training is generally no more effective than control procedures in reducing anxiety (Mehearg & Eschette, 1975; Ohno et al., 1978), and that frontal EMG feedback relaxation training does not significantly influence autonomic variables (Fee & Girdano, 1978; Ohno et al., 1978). Since there is no compelling reason to expect the psychophysiological effects of frontal EMG feedback relaxation training among children to be markedly different from those among adults, it is difficult to understand how frontal EMG feedback relaxation training can function as an effective general relaxation training technique for children. In the present study, therefore, it was hypothesized that frontal EMG feedback relaxation training would reduce muscle tension in the frontal region, but would not significantly influence skin temperature, skin conductance, trait anxiety and state anxiety. As predicted, the findings of the current study indicated that frontal EMG feedback relaxation training did reduce muscle tension in the frontal region, but did not significantly affect either the autonomic variables or the anxiety measures, thereby lending support to the idea that frontal EMG feedback relaxation training, alone, is ineffective as a general relaxation training technique for children.

<u>Thermal Feedback Relaxation Training as a General Relaxation Training Technique for Children</u>

As previously noted, it is also commonly assumed that successful thermal feedback relaxation training is effective as a general relaxation training technique. In view of the possible benefits to be derived from early training in general relaxation, it has been proposed that children receive thermal feedback relaxation training in the schools (Engelhardt, 1978). However, the limited number of controlled studies that have investigated the effects of thermal feedback relaxation training among normal adults suggest that this technique has circumscribed effects even within the vascular system (Elder et al., 1977) and that thermal feedback relaxation training exerts no significant influence on other bodily systems (Elder et al., 1977; Stoffer et al., 1977). In the current study, therefore, it was hypothesized that thermal feedback relaxation training would increase skin temperature at the training site, but would have no appreciable effect on EMG activity, skin conductance, trait anxiety and state anxiety. Contrary to prediction, the thermal feedback relaxation training was not successful, that is, there was no significant difference in skin temperature, at the training site, between the thermal feedback relaxation training group and the control group. Therefore, the hypothesis that successful thermal feedback relaxation training is ineffective as a general relaxation training technique could not be tested.

The finding that thermal feedback relaxation training was not mastered by the subjects in the present study was somewhat surprising, in view of the claim that normal children rapidly achieve self-regulation of peripheral skin temperature through thermal feedback training (Hunter, Russell, Russell, & Zimmerman, 1976; Loughry-Machado & Suter, 1979; Lynch et al., 1976). However, as Kaplan and Crawford (1978) indicate, the determination of the attainment of self-regulation of peripheral skin temperature can be difficult, since skin temperature is affected by such a variety of internal and external factors. With this caution in mind, it is important to note that none of the published studies of thermal feedback training among normal children have included a no-feedback control group (Hunter et al., 1976; Loughry-Machado & Suter, 1979; Lynch & Schuri, 1978; Lynch et al., 1976). Therefore, any skin temperature changes observed in these studies cannot, with any degree of certainty, be attributed to thermal feedback training. This may well explain why Lynch and Schuri (1978), in an extension of an earlier study (Lynch et al., 1976), were unable to replicate their previous positive findings. In any case, the ease with which normal children master thermal feedback training appears questionable, particularly in terms of the findings of the current study.

Turning, briefly, to a consideration of thermal feedback studies conducted with normal adults, it seems that self-regulation of skin temperature has been adequately demonstrated. Elder et al. (1977), Stoffer et al. (1977) and Thompson and Russell (1976), for example, have reported significant skin temperature differences between thermal feedback subjects and no-feedback controls. Nevertheless, as Taub (1977) has indicated, experimenters have reported varying degrees of success with respect to the mastery of thermal feedback training.

A number of factors appear to influence the mastery of thermal feedback training among normal adults, some of which have possible relevance to the findings of the present study. Among these factors is the method of control used by the subject. Thompson and Russell (1976), for instance, found that a group of normal adults reported visual imagery of scenes associated with physical heat as the most productive method of control. Unfortunately, it was not a predetermined objective of the present study to investigate the strategies of control adopted by the thermal feedback subjects. Nevertheless, upon completion of the study, the thermal feedback subjects were asked what they thought or did to try to make the feedback light move in the correct direction. The responses to this line of questioning fell into four categories. Approximately 56% of the subjects said they didn't know what control strategy they had used, about 22% reported that they had focused attention on their dominant hand and willed it to get warmer, roughly 11% intimated that they had willed the light to move in the prescribed direction and the remaining 11% indicated that they had tried to ignore their dominant hand. There was, however, no mention of the use of the type of visual imagery described by Thompson and Russell (1976).

At this juncture, it should also be observed that a number of the thermal feedback subjects, in an apparent attempt to achieve self-regulation of skin temperature, altered the position of their dominant hand during training. Of course, due to the time lapse between the thermal feedback training and the questioning regarding control strategies, the responses cannot be viewed as highly valid indicators of the methods of control actually used by the subjects. Nevertheless, further investigation of the control strategies used by normal children during thermal feedback training appears warranted.

Another factor that seems to influence self-regulation of skin temperature, and which appears relevant to the current discussion, is attitude toward the task. Kaplan and Crawford (1979), Roberts and Schuler (1974) and Taub (1977) have all noted the detrimental effect of skepticism on the mastery of thermal feedback training among adults. While no systematic attempt was made to measure attitude toward the task in the present study, it was observed that a number of the thermal feedback subjects exhibited a skeptical attitude, either verbally or by means of facial expression, toward self-regulation of skin temperature. Interestingly, such skepticism was not observed among the EMG feedback subjects in relation to their task. Possibly, the attitude of some of the thermal feedback subjects was a reflection of the traditional view that autonomic responses are not susceptible to voluntary control. In any case, it would be valuable to make a systematic study of the relationship between attitude toward the task and mastery of thermal feedback training among normal children.

IMPLICATIONS

Research Implications

A number of implications for further research are suggested by the preceding discussion. These research implications may be delineated as follows:

1. There is a need for more well-controlled studies of the psychophysiological effects of frontal EMG feedback relaxation training among normal children.
2. Investigations designed to determine the factors influencing the mastery of thermal feedback relaxation training, among normal children, are needed.
3. Research concerning the psychophysiological effects of successful thermal feedback relaxation training, among normal children, is also indicated.

Practical Implications

For the educator, the results of the present study entail the following practical implications:

1. Frontal EMG feedback relaxation training, alone, would appear to be ineffective as a general relaxation training technique for school children.
2. Thermal feedback relaxation training should not be construed to be a general relaxation training technique for use in schools, until such capacity has been demonstrated.

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A. <u>Transcript of EMG Feedback Training Instructions</u>

"Hello, X. Do you need to use the washroom before we start? I want you to take off your shoes and socks and sit on this chair, while I measure how well you are relaxing." (Probe and electrodes attached.) "Today, I want you to watch this diamond light display, which shows the tension in your forehead." (Autogen 7000 light display indicated.) "When your forehead is relaxing, the light will travel around the diamond in this direction." (Direction indicated.) "But, when your forehead is getting tense, the light will change direction and travel around the diamond this way." (Direction indicated.) "Your task is to keep the light moving in this direction, without letting it slip back, because this means that your forehead is getting less tense and that you are relaxing. Any questions? Are you comfortable? Then we'll begin."

B. <u>Transcript of Thermal Feedback Training Instructions</u>

"Hello, X. Do you need to use the washroom before we start? I want you to take off your shoes and socks and sit on this chair, while I measure how well you are relaxing." (Probe and electrodes attached.) "Today, I want you to watch this diamond light display, which shows the temperature of your hand." (Autogen 7000 light display indicated.) "When your hand is getting warmer, the light will travel around the diamond in this direction." (Direction indicated.) "But, when your hand is getting cooler, the light will change direction and travel around the diamond this way." (Direction indicated.) "Your task is to keep the light moving in this direction, without letting it slip back, because this means that your hand is getting warmer and that you are relaxing. Any questions? Are you comfortable? Then we'll begin."

C. <u>Transcript of No Relaxation Training Instructions</u>

"Hello, X. Do you need to use the washroom before we start? I want you to take off your shoes and socks and sit on this chair, while I measure how well you are relaxing." (Probe and electrodes attached.) "Today, I want you to relax as completely as you can, but do not go to sleep or close your eyes. Any questions? Are you comfortable? Then we'll begin."