THE EFFECTIVENESS OF A PHYSICAL RELAXATION TECHNIQUE IN REDUCING ANXIETY

by

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The Effectiveness of a Physical Relaxation Technique in Reducing Anxiety

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ABSTRACT

The general aim of this study was to investigate the effectiveness of a physical relaxation technique in decreasing anxiety in a non-clinacal setting. The independent variable was the relaxation technique designed to be taught to the subjects. The dependent variables were the measures of both physiological and psychological parameters of anxiety.

130 undergraduates in a Kinesiology course were administered the Spielberger State-Trait Anxiety Inventory (STAI). The twenty subjects with the highest anxiety-state scores participated in the study and were randomly divided into two groups of equal size, a treatment group and a control group. The treatment group was taught to use the relaxation program designed by Mitchell (1977), Physiological Relaxation. The control group was instructed to sit quietly and attempt to relax.

Each subject met with the experimenter on three occasions for two hours. During each of these sessions the treatment group underwent two training periods for Physiological Relaxation while the control group used the same periods of time to relax on their own.

During these daily sessions pre- and post training measures of forehead and trapezius EMG, heart rate, blood pressure, galvanic skin response, and respiration rate were recorded from all subjects. In addition, Spielberger's State-Trait Anxiety Inventory was administered to all subjects prior to their first meeting with the experimenter and again immediately following their final meeting.

Significant changes across training periods were demonstrated in all dependent variables with the exception of treatment group EMG measures. The treatment group displayed significantly lower EMG measures than did the control group after the training periods. Although state and trait anxiety, galvanic skin response, respiration rate, systolic blood pressure, and heart rate values were also reduced after the training periods, there were no significant differences evident between the treatment and control groups.

The physiological changes support Benson's (1974) hypothesis that the practice of a relaxation technique will elicit a "relaxation response". These changes also correlate well with reductions on State and Trait anxiety scores as measured by Spielberger's State-Trait Anxiety Inventory.

Although the practice of Physiological Relaxation demonstrated a more consistent and more substantial effect on the autonomic nervous system, it failed to establish itself as significantly superior in all respects to simply sitting quietly in a reclining chair and attempting to relax.

We dance 'round in a ring and suppose,
But the secret sits in the middle and knows.

— Robert Frost

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Introduction

Jacobson has described anxiety as excitation of the somatomotor as well as the autonomic nervous system when a threat, either real or imaginary, is perceived and an attempt is made to confront or avoid this threat. Both smooth and striated muscle patterns show heightened action potential levels which are an indication of the emotional reaction in which virtually the whole organism participates. (Jacobson, 1964, preface).

The discomfort of anxiety has troubled people throughout the history of mankind. The present era has been described as "The Age of Anxiety" (Marmor, 1972, p. 212) and our literature, art and music offer testimony to the pervasiveness of this phenomenon. Marmor states that a certain degree of anxiety is useful, and indeed essential, to alert the individual so that adaptive responses are mobilized to meet actual or potential threats. Excessive anxiety however is debilitating because considerable amounts of energy are dissipated and the life forces of the individual can be diminished and disorganized, (Marmor, 1972).

The elements that typically constitute an anxiety response are largely those associated with a widespread discharge of the autonomic nervous system; predominantly its sympathetic division. These elements vary with the duration and intensity of the stress and according to each organism's individual patterns of responses (Benson, 1974, p. 37).

Physiological manifestations of anxiety can include increases in muscle tension, pulse rate, blood pressure, sweating (particularly palmar), frequency of micturition and defacation, and gastric secretions along with hyperventilation, pupil dilatation, dry mouth and flushing or paling (Turner, 1963, Buss, 1966, Pitto, 1969). This is not to imply that all anxious individuals will show equally incremental rises in all the above mentioned responses or that an increase in any of these responses is an absolute indication of an anxiety reaction in a particular individual. Rather the statement indicates that the aforementioned responses are a part of a package which is regulated, in degree and form, by an individual's reaction to an anxiety provoking stimulus (Lacy, 1953).

Other physiological manifestations, which also reflect autonomic activation, are increased levels of serum and urinary corticosteriods and cathecholamines, increased urinary excretion of potassium and decreased secretion of sodium, increased erythrocyte sedimentation rate, and an increase in plasma lipids (Froberg et al., 1971). Electroencephalogram studies show less alpha activity in persons suffering anxiety states as compared to normal subjects, (Brockway et al., 1954).

Secondary conditioning of anxiety responses to any of the symptoms of anxiety may then occur creating a "vicious circle". This circle involves some noxious stimulation which causes an anxiety response to develop in that organism. The developed anxiety response can then manifest certain symptoms which in turn will add to the noxious stimulation to cause an increase in anxiety. Allowing the "vicious circle" to remain unbroken can promote the affected individual's susceptibility to a large family of psychosomatic disorders ranging from stomach ulcers to obesity. The individual's susceptibility to many emotional ills is also increased (Jacobson, 1964, p. 214).

Throughout the early history of mankind the aforementioned anxiety response had a definite survival value and thus, probably became strongly established in man's genetic make-up. In this prehistoric setting Cannon referred to the response as "the fight or flight instinct" or "the defence alarm reaction[1]". In early times individuals required such a set of physiological conditions. The majority of the environmental stimuli required some form of physical response. However, in our more modern environment, the defense alarm reaction is no longer always appropriate; it is an anachronism. Although the reaction continues to become aroused in all its visceral and muscular aspects, in any situation where an individual becomes threatened, we are less often confronted by threatening situations requiring a physical response. In other words, in place of real tigers, in our contemporary environment we face paper tigers. Most modern societal standards have deemed it inappropriate behavior to fight these paper tigers or to run from them. Thus, the challenged individual is left with a body prepared for physical action and most often no physical outlet for expression which results in an unresolved conflict.

Our rapidly changing environment with its incessant stimulations of the sympathetic nervous system, is largely responsible

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[1]Harvard physiologist W.B. Cannon described this involuntary response which mobilized the human body in preparation for a danger situation. A set of physiological responses including increased blood pressure, heart rate, and oxygen consumption alerted and prepared the body for "fight or flight". For further information see: (Cannon, 1914).

for the high incidence of anxiety which is in turn a precursor to hypertension and similar maladies prevalent in our society. The model shown in figure 1 is an adaptation of a model for psychosocially mediated disease developed by Levi (Levi, 1972).

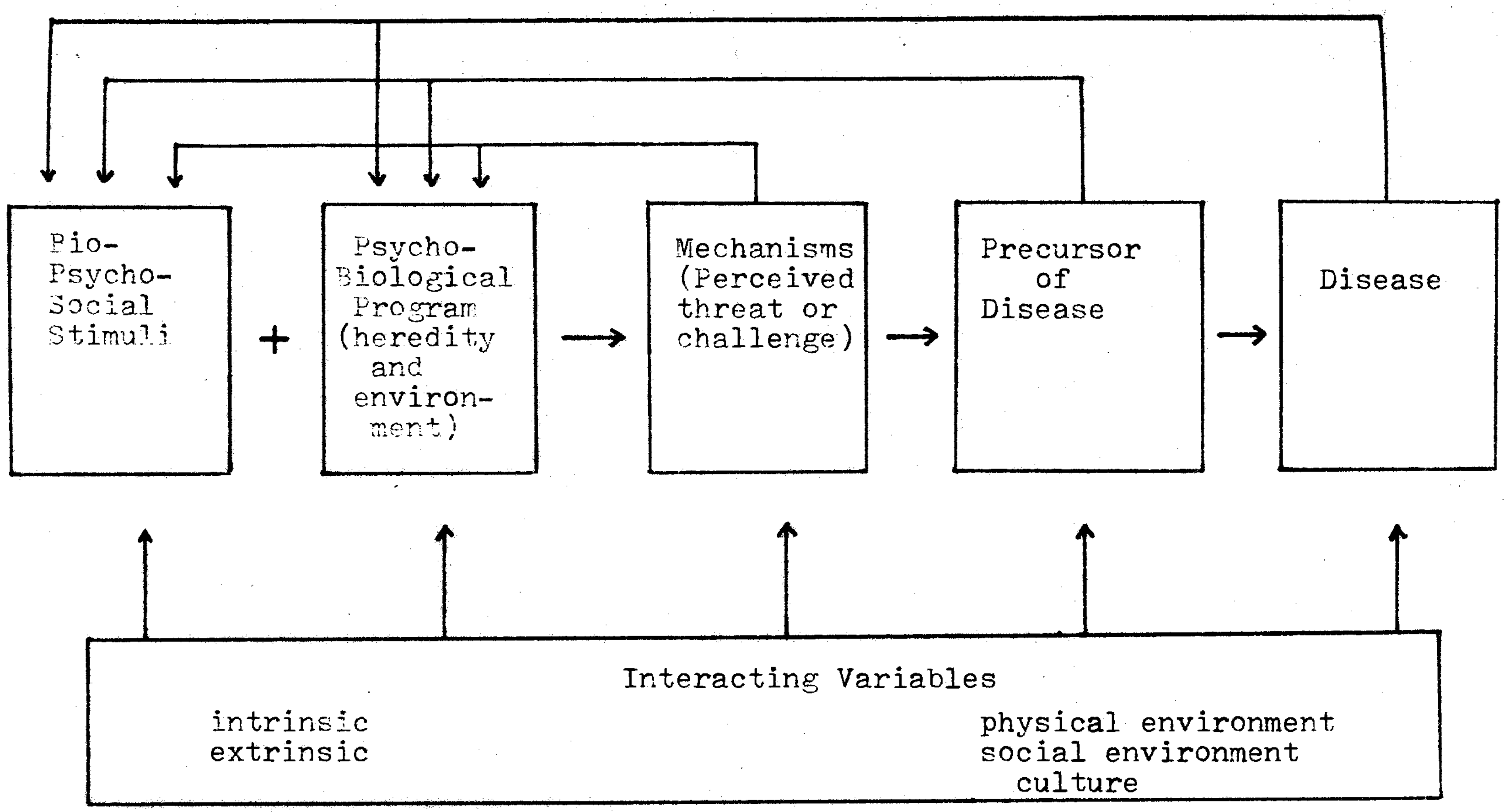

Figure 1. A Model for Anxiety (Adapted from Levi's (1972) model for Psychosocially Mediated Disease).

Levi, in studying biopsychosocial stimuli, postulates that an unresolved challenge to a predisposed organism leads from the initial tension (stress reaction ⟶ physiological changes) to precursor of disease and finally to actual disease. The biopsychosocial stimuli may arise from the inner or outer environment of the individual and include electrolyte imbalance, pain, sensory deprivation or overload, emotionally charged experiences, inner conflict, etc. Any of those stimuli may become a "stressor" in Selye's terminology (Selye, 1956). In fact, any biopsychosocial change can act as a stressor insofar as it challenges the individual to adapt and is thus a potential threat to homeostasis.

The combined effect of the biopsychosocial stimuli and the psychobiological program determines the psychological and physiological reactions (mechanisms: e.g., stress) of each individual. These may, under certain circumstances, lead to precursors of disease and then to disease itself. Interacting variables are intrinsic and extrinsic factors which influence (i.e., alter the action of) all other parts of the model. These variables tend to promote, diminish, or prevent anxiety. Variables such as heat, noise, health care and recreation qualify as extrinsic factors whereas age, sex, diet, and the absence or presence of disease would be examples of intrinsic factors.

From an examination of the model a definition of anxiety can now be proposed.[2]

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[2] An examination of this working definition of anxiety from Levi's model (see page 5) reveals that anxiety and stress can be used synonomously in this paper.

> Anxiety is a total organismic response to perceived threat or challenge arising from biopsychosocial stimuli impinging upon the psychobiological program of the individual and influenced by intrinsic interacting variables. The response is characterized by cortical and autonomic activation and subjective feelings of physical and psychological tension. Anxiety is adaptive in alerting the individual to the presence of a problem. However, anxiety which remains unresolved, or inadequately resolved, is physiologically and psychologically disorganizing and thus maladaptive (Miller, 1975, p. 26).

Hans Selye presents a slightly different perspective on the subject of anxiety, which he refers to as stress. He begins by defining stress in the following manner: "... stress is essentially the rate of wear and tear in the body." (Selye, 1956 Preface). Feelings of hunger, tiredness, apprehension, and anger are all subjective sensations of stress. Stress however does not necessarily imply a catastrophic state, for any emotion, any activity causes stress.

> Life is largely a process of adaptation to the circumstances in which we exist.... The secret of health and happiness lies in successful adjustment to the ever changing conditions on this globe; the penalties for failure in this great process of adaptation are disease and unhappiness (Selye, 1956 Preface).

Selye points out that many common diseases are a product of adaptive errors in the afflicted individual's response to stress as opposed to direct damage due to germs, poisons, or other external agents. The common diseases referred to here are: many nervous and emotional disturbances, high blood pressure, gastric and duodenal ulcers, certain types of rheumatic, allergic, cardiovascular and renal diseases. Selye classifies these as "diseases of adaptation".

The general adaptation syndrome (GAS) or the stress syndrome as it is now called, refers to the entire non-specific response of an organism to its external and internal environments. Selye explains how he decided on the title, general adaptation syndrome:

> I call this syndrome "general" because it is produced only by agents which have a general effect upon large portions of the body. I call it "adaptive" because it stimulates defense and thereby helps the acquisition and maintenance of a stage of inurement. I call it a "syndrome" because its individual manifestations are coordinated and even partly dependent upon each other (Selye, 1956, p.32).

The physiological elements Selye alludes to in his discussion of the general adaptation syndrome are discussed in the beginning of the paper. The human organism responds to a stressor with a widespread discharge of the autonomic nervous system, predominately its sympathetic division. These physiological actions prepare the organism to cope with the omnipresent stress situations by which it is continually confronted.

The stress syndrome progresses through three stages. The first stage is the alarm reaction. The organism mobilizes to confront the challenge of a stimulus. The second phase is called the stage of resistance wherein the organism adapts to the challenge of the stimulus. No living organism can be maintained continuously in a state of alarm. Either the organism adapts to the challenging agent or it is eventually destroyed by it. The third phase of the syndrome is the stage of exhaustion. Prolonged exposure to a noxious agent will result in the failure of the adaptation process. Only the most severe stress will lead to the stage of exhaustion and death. Under all but the most severe circumstances an individual will proceed only through the first two stages of the stress syndrome. Most stressors are short lived, not pushing the individual past the stage of adaptation.

Drug Therapy

The most common therapy for the treatment of both psychological and physiological stress has been the administration of a variety of aniolytic drugs ranging from the barbiturates to antianxiety agents. Practical experience has shown that these drugs are not always effective in controlling an individual's reaction to either the causes or the symptoms of both psychological and physiological stress. In fact, the drug therapies discussed here are considered, at best, to be palliative, and not curative. That is to say that adequate doses of these compounds, properly administered, will provide varying degrees of symptomatic relief for individuals suffering from anxiety. There are a number of reasons why other forms of therapy are beginning to supplement or replace drug administration as a means of treating anxiety.

Barbiturates such as pentobarbital (nembutal), secobarbital (seconal), and amobarbital (amytal) have been used extensively not because they were highly effective but because there were no other treatments available for the symptoms of anxiety seen so often by the medical profession. They are central nervous depressants. With even small doses psychomotor coordination is adversely affected. The barbiturates have a serious addictive potential with ever increasing doses required to produce the desired psychological or behavioral effects. As usage becomes habitual, the effective dose may approach lethal levels (Honigfeld and Howard, 1978, p. 45).

When antianxiety agents were introduced to the clinical setting it became readily apparent that the magnitude of their therapeutic effect on anxiety was far greater than that of barbiturates (Wheatley, 1973). The antianxiety agents could also be described as minor tranquilizers. Examples of the minor tranquilizers would be meprobamate (Miltown, Equanil), chordiazepoxide (Librium), and diazepam (Valium).

Their usage, however, is not without its drawbacks. Antianxiety drugs can also create a dependence upon or an addiction to their use with a resultant loss of self-confidence and emotional security (Wheatley, 1973). Individuals using these drugs are also subject to severe withdrawal symptoms. Potentially toxic reactions include skin rash, nausea, headache, impairment of sexual function, vertigo, light headedness, and menstrual irregularities (Goodman and Gilman, 1975, p. 191). Undesirable cognitive effects may appear for varying periods of time and include an incapacity to perceive stimuli clearly along with poor organizational ability (Honigfeld and Howard, 1973, p. 46).

Many researchers have proposed an alternative program to deal with excessive anxiety and muscle tension which would replace or be used concomitantly with drug therapy. This alternative program involves psychophysiologic relaxation techniques. These techniques put the individual in control, to decide which level of arousal is appropriate for a given stimulus. Psychophysiologic relaxation techniques are claimed to leave the mind alert and there are no addictive or withdrawal symptoms.

> Regulation, the avoidance of excessive tension, can be mediated through the striated (voluntary) musculature. When this musculature acts, as in effort patterns, the function can be measured electrically; when this musculature relaxes toward zero levels, anxiety decreases during this diminution. In this sense, anxiety tension is a dependent variable. Thus there is no speculation, no mystery, no hypnotic suggestion... (Jacobson, 1964, p. 1).

Psychophysiologic Relaxation Techniques.

Psychophysiologic methods to control anxiety and to promote relaxation and composure have been used in both Eastern and Western cultures for centuries. Eastern disciplines such as Yoga and Zen teach methods of breath control, physical exercises, and mental concentration leading to meditation and contemplation. These practices induce serenity, a state diametrically opposed to the alerted, aroused state of anxiety.

Western practices of psychophysiologic techniques which lead to composure and serenity have occurred within the framework of religious beliefs and more recently in medical and psychological clinical practice, as well as in the introduction and popularization of eastern meditation techniques to the general public.

Meditation.

Most religious organizations have employed meditation as a means to an altered state of consciousness. Records of branches of Christianity, Judaism and Islam have been documented showing well developed practices of meditation (Underhill, 1967; Scholem, 1961; Trimingham, 1971).

Maharishi Mahesh Yogi popularized an Indian Yoga technique in the West called Transcendental Meditation. "TM" is now widely practised by the general public. Wallace and Benson describe the basic elements of Transcendental Meditation.

> The practitioner sits in a comfortable position with eyes closed. By a systematic method he has been taught, he perceives a "suitable" sound or thought. Without attempting to concentrate specifically on this cue he allows his mind to experience it freely, and his thinking, as the practioners themselves report, rises to a "finer and more creative level in an easy and natural manner". (Wallace and Benson, 1972, pp. 80-94).

In one of the most detailed physiological examinations of a relaxation technique Wallace and Benson performed extensive measurements on thirty-six subjects who were transcendental meditators. The results of their study are summarized below.

Physiologic changes consistent with decreased sympathetic nervous system activity were present during the practice of this relaxation technique. The following variations were noted: decreases in oxygen consumption, carbon dioxide elimination, respiratory rate, and minute ventilation. Arterial blood lactate decreased markedly. Arterial blood pH and base excess decreased slightly. Skin resistance increased considerably while muscle blood flow increased to a lesser extent.

The electroencephalogram revealed increased relative intensity of slow alpha waves and occasional theta wave activity. The aforementioned changes are believed to represent activation of an integrated hypothalmic response which results in generalized decreased sympathetic nervous system activity and perhaps also a corresponding increase in parasympathetic activity. This response is referred to as the "relaxation response" (Benson, 1974), which seems to be the counterpart of the emergency reaction of Cannon described earlier.

A number of the above changes should be discussed in greater detail to explain how these changes are related to anxiety.

It was noted through this relaxation technique there was a decrease in oxygen consumption, carbon dioxide elimination, respiratory rate, and ventilation per minute. It was also noted that the ratio of carbon dioxide elimination to oxygen consumption (in volume) remained essentially unchanged throughout the testing; (i.e., the ratio of carbon dioxide elimination to oxygen consumption before, during, and after relaxation was the same). This is an indication that the controlling factor involved is the rate of the metabolism and that through relaxation an individual can reduce his metabolic rate. The reduction of metabolic rate means a reduction in the amount of energy consumed needlessly to maintain a state of hyperactivity, and thus, a more efficiently operated organism.

Another change recorded by Benson was a marked decrease in arterial blood lactates. Individuals suffering from anxiety show an excessive rise in lactate levels. In a paper by Pitts (1969) an experiment is described in which researchers at the Washington University School of Medicine were able to produce the symptoms of anxiety neurosis and even acute anxiety attacks by chemical means. They did so by administering enough lactate, which is a normal product of cell metabolism, to raise the blood lactate level about as high as it is during strenuous physical exercise or other heavy physiological stress.[3]

Pitts noted that anxiety could occur in normal people under stress as a consequence of excess lactate production resulting from an increased flow of epinephrine. The rise in the level of epinephrine in the blood is known to stimulate anxiety symptoms as well as to step up lactate production.

Another physiological response tested by Benson was the variation in electrical resistance of the skin. This test, galvanic skin response (GSR) or psychogalvanic reflex (PGR) is a commonly used physiological test for anxiety. It is convenient and probably the most widely used measure of activation of the human organism. It is a cholinergically mediated response which reflects activation initiated in both the physiological and psychological spheres. It has a particular advantage for research because its measurement reflects a more generalized response of the whole being rather than of the more discrete elements of a body tissue or a body part (Mountcastle, 1974, p. 355).

With increased levels of anxiety there is increased sympathetic nervous system activity which will activate the sweat glands. Increased production of sweat results in a decreased resistance between two points on the skin. Therefore a reduction

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[3] When the oxygen supply becomes either unavailable or insufficient for cellular oxidation to occur small amounts of energy can be released by anaerobic glycolysis. Lactate is the end product of anaerobic glycolysis. A rise in blood lactate level is therefore a normal result of anaerobic activity. When oxygen in sufficient supply becomes available again large portions of the lactate are reconverted into glucose. The greatest proportion of this reconversion takes place in the liver (Guyton, 1976, p. 913).

in skin resistance resulting from elevated levels of anxiety would appear to be due to the increased stimulation of the sweat glands (Lader and Mathews, 1970).

In measuring skin resistance to an electric current, if other factors such as environmental temperature and humidity remain constant, a decrease in the skin resistance of an individual would be expected to reflect a greater degree of anxiety in that individual while an increase in skin resistance would be expected to reflect a greater degree of relaxation. Benson's findings fit in well with this information. He discovered a considerable increase in skin resistance takes place in an individual who is in a highly relaxed state.

Benson's observation that there is an increase in the flow of blood to the skeletal muscles of individuals practising trancendental meditation should not be a surprising one. Muscular tension, a state of chronic partial muscular contraction, constricts the vessels which carry the blood to and from the skeletal muscles thereby restricting the blood flow. This restriction of blood circulation would prevent oxygen and the other essential nutrients from reaching the muscles. This occurrence could explain the rapid rise in arterial blood lactate under stress. The main site of lactate production in the body is the skeletal muscle. Any restriction in blood flow to the muscles with its corresponding decrease in oxygen uptake would increase the rate of anaerobic metabolism of which lactic acid is a by-product. The acceleration of blood flow to the skeletal muscles during a relaxed state would speed up the delivery of oxygen to the muscles. The resulting increase in oxidative metabolism could be a substitute for anaerobic metabolism which would account for the marked decrease in production of lactate.

Another potentially significant effect of a diminished oxygen supply to the skeletal muscle would be a state of physiological contracture. In the event of a reduced oxygen supply to the skeletal muscle a depletion of the ATP required to dissociate the actin-myosin bonds may result. This being the case a state of physiological contracture occurs. Under these circumstances the muscle is unable to reduce its tension as the actin-myosin bonds are unable to dissociate (Guyton, 1976, pp. 145-146).

In extreme cases of prolonged isometric muscle contraction a severe restriction of the circulation of the blood will occur. This diminished blood supply can cause tissue to become malnourished and susceptible to infection and disease (Wallace and Benson, 1972).

One final change in psysiologic state Benson noted, which helped confirm the picture of a highly relaxed, although wakeful condition, was the marked intensification of alpha waves recorded by the electroencephalogram. Alpha waves are normally thought to be associated with pleasant day dreaming sorts of activity. However, brain researchers are still unsure exactly how alpha waves are associated with mental effort or the relief of mental effort.

EMG Biofeedback.

An alternative method of promoting deep muscle relaxation has been developed using analog information feedback. EMG biofeedback apparatus measures muscle action potential levels (electromyography) and incorporates the major principles of operant conditioning (e.g., see Skinner, 1953). The shaping of muscle relaxation responses is of considerable interest because it suggests that operant conditioning may facilitate, in human subjects, a greater degree of control over their internal environments.

Reinking and Kohl (1975) explain why they chose to use EMG biofeedback as a method to study relaxation response.

> Though most theories of therapeutic relaxation focus on sympathetic nervous system patterns which the EMG only indirectly reflects, EMG records were still chosen for the following reasons. First, EMG and sympathetic activity covary in a variety of situations. There is evidence that the best single correlate of sympathetic arousal is skeletal muscle action potential... Second, the training procedures of most relaxation therapies focus primarily on skeletal muscle relaxation, despite their theoretical emphasis on general autonomic system functions. Consequently, the EMG seems a useful dependent measure of tension and a reliable means of judging the relative effectiveness of various relaxation methods (Reinking and Kohl, 1975, pp. 595-600).

The basic training method employed would seem potentially applicable to a variety of physiological events, and might be useful both in behavioral therapy and in certain psychosomatic disorders. An obvious candidate for this feedback approach would be the tension headache said to be associated with, and sustained by, contraction of the head and neck musculature.

A particular instrument built by Budzynski and Stoyva at the University of Colorado Medical School, was developed with the following characteristics:

1. There would be continuous tracking of levels of muscle action potential.
2. The subject would receive precise and immediate analog information from a given muscle.
3. The information would be in the form of a tone with a pitch varying with the level of muscle activity.
4. The gain of the feedback loop would be adjustable to permit gradual shaping of the deep relaxation response.
5. The system would permit continuous quantification of performance as measured by levels of muscle action potential from trial to trial (Budzynski and Stoyva, 1969).

This system is an objective, non-verbal indicator of relaxation. By using analog information feedback it becomes possible to accelerate and intensify the process of relaxation.

Essentially the function of the system is to provide the subject with a constant volume tone that varies in pitch as electromygraphic (EMG) activity changes. For example, a higher pitch would correspond with a higher level of EMG activity. Therefore, by noting the pitch a subject is aware of his/her electromygraphic activity and can act toward lowering the pitch and therefore lowering the activity of the muscle involved.

Systematic Desensitization.

This standardized behavioral technique has been an effective tool in the therapy of anxiety, specifically in the therapy of phobic behavior (Greenwood and Benson, 1977). Developed by

Wolpe (1958) systematic desensitization is based upon the postulate that the anxiety response is a learned response and that it reflects increased nervous system activity. The theoretical mechanism for the elimination of neurotic behavior is operantly conditioned inhibition.

> If a response antagonistic to anxiety can be made to occur in the presence of anxiety-evoking stimuli so that it is accompanied by a complete or partial suppression of the anxiety response the bond between these stimuli and the anxiety responses will be weakened (Wolpe, 1958).

In this form of therapy the subject and the therapist construct a heirarchy of anxiety evoking stimuli. The subject is then conditioned to control his/her anxiety by deliberate forms of relaxation while confronting the least provoking stimulus in the heirarchy. This process is systematically repeated, as the subject ascends the scale, one stimulus at a time, until the most anxiety provoking stimulus can be effectively tolerated.

<u>Progressive Relaxation</u>.

One of the deliberate forms of relaxation used in conjunction with systematic desensitization is a program developed by Jacobson (1938) entitled Progressive Relaxation. This technique uses as its base one of the primary tenets of learning and systems theory (Jacobson, 1964). The subject is first taught to recognize tension in specific muscles and subsequently learns to relax these muscles at will. Jacobson was able to test the effectiveness of his program by using electromyography which indicates specific muscle activity. He cited a number of clinical cases ranging from conditions such as colitis and pyloric ulcers to hypertension, excessive anxiety and insomnia which he has treated successfully using Progressive Relaxation methods of tension control (Jacobson, 1964).

Researchers investigating Progressive Relaxation, both with and without systematic desensitization, have met with varying levels of success in producing a competitive alternative to the anxiety response (i.e., the relaxation response — see Benson, 1975).

Paul (1969) showed that physiologic changes consistent with decreased sympathetic nervous system activity were the result of the practice of Progressive Relaxation. The parameters monitored by Paul were forearm muscle tension, heart rate, respiratory rate, and skin conductance. With the exception of skin conductance, he found that normal subjects were able to produce significant reductions in all of the parameters, in relation to a control group.

Edelman, (1971) also reported significant decreases in frontalis EMG activity in subjects who practised Progressive Relaxation. Schandler and Grings (1976), Haynes et al., (1975), and Canter et al., (1975) have produced similarly positive results in their investigation of Progressive Relaxation.

In contrast, Mathews and Gelder (1969) could find no significant reductions in forearm EMG in subjects who practised Progressive Relaxation. Furthermore, they could make no distinction between this group and the control group. Lader and Mathews (1970) also demonstrated no significant differences between control and Progressive Relaxation groups in measure frontalis EMG activity.

Lader and Mathews (1971) discuss the divergences of results in EMG studies of tension by first pointing out that the semantic aspects of the word "tension" have led to confusion. Where in physiology the word tension refers to the force produced by a contracting muscle, in every day usage tension describes a particular emotional state, anxiety. Lader and Mathews distinguish between the physiological and lay meaning referring to the former as muscular tension and the latter as subjective "tension".

They identify another important distinction, that between "relevant" and "irrelevant" activity. Increases in muscular tension are necessary to respond to many physiological needs. These are considered relevant forms of activity. Any concomitant changes in levels of muscular tension that are not essential for motor purposes are irrelevant. They further state that psychological factors can greatly influence irrelevant muscle activity.

The authors relate this information to the varying results produced by EMG studies of tension in the following manner. Although the experience of muscular tension (and autonomic activity) may actually constitute the emotional state and, alternatively, emotional states inevitably evoke increased muscular tension, there is no implied causality. The fact that EMG levels are raised in patients suffering extreme emotional states quite probably reflects general affective over-arousal rather than any more specific mechanism. This implies that controlling (decreasing) levels of EMG activity is not necessarily an effective method of reducing subjective "tension" (anxiety).

The authors conclude their discussion with the following statement:

> ....methods which serve to directly lower EMG levels seem unlikely to effectively reduce subjective "tension" in patients suffering from other psychiatric syndromes. However, in the case of some specific psychosomatic symptoms, enough is known to allow a cautious optimism regarding such techniques, and to anticipate their more widespread application to tension states (p. 484).

Physiological Relaxation.

Mitchell (1977) has developed a modified form of Jacobson's Progressive Relaxation which she has entitled Physiological Relaxation.

Mitchell's basic premise is that states of anxiety and nervousness or such slight body responses as bracing for something unexpected, cause an increase in the tension of skeletal muscle. A problem arises when the stressor (environmental or other) is no longer present but the elevated levels of muscle tension remain because of the absence of a physical outlet to the stressor. Physiologically, the individual is prepared for physical action and none is forthcoming. In this situation, once the stressor is forgotten, the individual loses the awareness that his/her degree of muscle tension is excessive.

Mitchell contends that these excessive levels of muscle tension result in distinct postural variations. She states: "That people suffering from undischarged stress adopt an exact pattern of positioning in all their joints." (Mitchell, 1977, p. 42). Mitchell has identified and described this pattern of joint positioning in the following manner:

The Head: The head comes forward. If the stress is due to grief or pain, the head may bend down with the chin in. If the stress is caused by anger or apprehension, the chin juts out and the whole head moves forward on the neck.

The Arms. The shoulders are lifted upwards towards the ears and held there. The upper arms hug the chest at the sides, or in front, while the elbows bend up.

The Hands. The fingers and thumbs curl up to form a fist and the hands may indeed clench each other. The person may clasp some object tightly, or a man often puts his hands in his trouser pockets and keeps turning his money over.

The Legs, if sitting down. A woman tends to sit sideways on the edge of the chair and wind one leg around the other. Both men and women usually cross their legs and then the top foot is held rigidly upwards, or moves rapidly up and down at the ankle. The accent is on the up movement (dorsiflexion).

The Legs, if standing. The person may cross and uncross his legs continuously. We often see this performance by a platform speaker.

The Body. The body bends forwards and is usually held fairly rigid.

The Breathing. The breath is either held on an inward gasp, or it is quickened so that the upper chest moves rapidly up and down. The accent is always on the inward breath.

The Face. The jaw is clamped tightly shut, and the teeth often grind together. The lips are tightly closed. The tongue cleaves to the roof of the mouth. The brows corrugate and the eyes may either screw up as in grief or pain or open wide as in real or imagined danger (Mitchell, 1977, pp. 26-27).

In order to facilitate the individual in ceasing to maintain the aforementioned stress posture Mitchell has designed a progressive relaxation program which involves the concept of reciprocal relaxation or reciprocal inhibition. According to this concept, when motor neurons are transmitting impulses to muscles causing them to contract, the motor neurons that service their antagonists are simultaneously reciprocally inhibited. The antagonistic muscles therefore remain relaxed and the movers contract without opposition.

By selecting the opposing muscle groups to the muscles showing the stress related tension a mechanism is available to unconditionally relax the affected muscles. By contracting the opposing muscle groups their antagonists will be reciprocally relaxed. The last step is to stop contracting the opposing muscle groups thereby attaining relaxation in both sets of muscles.

To summarize, Mitchell's relaxation training program has identified the stress positions and the corresponding activated muscles, selected the appropriate antagonists to these activated muscles, systematically contracted and then stopped contracting these muscles, and finally, concentrated on the end product of complete relaxation.

RESEARCH DESIGN

Method

Overview of the Study Design

The general aim of this study was to investigate the effectiveness of a physical relaxation technique in deoreasing anxiety in a non-clinical setting. The independent variable was the relaxation technique designed to be taught to the subjects. The dependent variables were the measure of both physiological and psychological parameters of anxiety.

Subjects

Spielberger's State-Trait Anxiety Inventory (STAI) (Spielberger, 1970) was administered to 130 undergraduates at Simon Fraser University. From this group the students with the twenty highest anxiety-state scores were selected to participate in this study. The range in anxiety-state scores of the twenty selected students was from 69 to 44. The total range in anxiety-state scores was from 69 to 22. Anxiety-trait was not considered as a basis for subject selection because it is thought to be the individual's predispositon to manifest anxiety. By definition, therefore, anxiety-trait would be unaffected by environmental stimuli (e.g., a relaxation technique).

The group of twenty students selected for the study was comprised of sixteen females and four males. The average age of the group was 20.2 years.

Procedure

The twenty subjects, chosen on the basis of high state anxiety levels, were randomly divided into two treatment groups comprised of ten subjects each. Group one was taught to promote muscle relaxation using Mitchell's technique of Physiological Relaxation. Group two was a no treatment group used as a control.

Each group was introduced to the study and informed as to what their specific role was in the study. After the introduction each subject met with the experimenter once each week for three weeks. Each of the three meetings between the subject and the experimenter was scheduled at the same time of day in order to minimize diurnal variations in the physiological parameters measured. The individual meetings between the subject and the experimenter were set up to incorporate two training sessions per meeting. Thus each subject actually underwent six training sessions with the experimenter over the three week period.

Each meeting consisted of a thirty minute period in which the subject was connected to the various pieces of apparatus measuring physiological responses; a five minute period prior to the training session where the physiological responses were recorded at one minute intervals; a twenty minute training session; another five minute period to record physiological responses and then a ten minute break. Excluding the time spent connecting the subject to the recorders, this procedure was repeated after the ten minute break.

During the actual training sessions group one was asked to follow, very carefully the directions presented to them for

Mitchell's Physiological Relaxation technique. These directions were pre-recorded on a cassette tape in order to standardize experimenter-subject interaction. Group two was instructed to sit comfortably and attempt to relax as completely as possible.

Spielberger's State-Trait Anxiety Inventory was administered to all subjects prior to their first meeting with the experimenter and again immediately following their final meeting.

The physiological responses being recorded during the five minute pre- and post training session intervals were forehead and trapezious muscle EMG, heart rate, blood pressure, galvanic skin response and respiration rate. Samples of the data in graphic form, recorded directly on the Teca Unit and on the Physiograph can be found in Appendix A.

Relaxation Technique

All of the relaxation techniques described in this paper have been reportedly beneficial in promoting relaxation, but with varying degrees of success. To complicate matters even more, researchers have employed grossly divergent training schedules with concomitantly divergent results.

The decision to select Mitchell's Physiological Relaxation as a technique to promote profound muscle relaxation was based on the reported clinical success of a similar technique, Jacobson's Progressive Relaxation. Physiological Relaxation is a modification of Progressive Relaxations which, according to Mitchell, (1977, pp. 17-18) has also shown positive clinical results. Although there is little information available in the literature on the successful application of her methods, other than her own reports, the modification she has made to Jacobson's Progressive Relaxation Technique seem to be reasonable. Her decision to incorporate reciprocal inhibition into the standard Progressive Relaxation format may improve the success of her program. It was my intent to take a relatively new and untried relaxation technique, which looked sound on paper, and attempt to duplicate Mitchell's impressive results in a university laboratory setting.

As was mentioned previously, there exists a wide variation in training schedules employed by researchers of relaxation therapies. For this reason it would be extremely difficult to produce a definitive statement on which schedule is most effective under each set of specific circumstances. The three week, six session format was chosen on the basis of this schedule's recurrent use in studies similar to the present one, all of which showed considerable success in enabling the subjects to learn effectively the relaxation techniques they were being taught (Schandler and Gringe, 1976, Chesney and Shelton, 1976, Haynes et al, 1975).

Psychological Measures of Anxiety

The measure of state anxiety was the Anxiety State scale of the State-Trait Anxiety Inventory (Spielberger, Gorsuch, and Lushene, 1970). This scale consists of twenty statements that require subjects to indicate how they feel at the particular point in time. The subject indicates his or her answer on a four point rating scale ranging from "not at all" to "very much" (See Appendix B). The measure of trait anxiety was the Anxiety-Trait Scale of the State-Trait Anxiety Inventory. This scale consists of twenty statements which ask subjects to indicate how they feel in general and it also has a four point rating scale (See Appendix B).

Spielberger's state-trait anxiety theory postulates two distinct anxiety constructs. State anxiety is characterized by subjective, consciously felt periods of apprehension, tension, and autonomic nervous system activity. Trait anxiety is seen as the individual's predisposition to manifest anxiety under any given stress situation. By definition trait anxiety is a relatively stable measure; unaffected by environmental stimuli (Spielberger, 1970). This information was supported when it was shown that muscle relaxation training could reliably reduce state anxiety but not trait anxiety (Johnson and Spielberger, 1968).

Although the State-Trait Anxiety Inventory has been available for a relatively short period of time it has been used by a great many researchers in studies involving both state and trait anxiety. Current research with the STAI indicates that there is a high correlation in both state and trait anxiety with other measures of state and trait anxiety. The following studies by Lamb (1969) and Hodges (1967) are a sample of this research, displaying the validity of the State-Trait Anxiety Inventory.

A study on the effects of stress on measures of anxiety-state and anxiety-trait was done using Florida State University students from a public speaking class (Lamb, 1969). It was found that anxiety-state scores and heart rate increase markedly from a pre-speech period in which the students must give a two minute speech (ego threat). Both values returned to their normal pre-speach levels immediately following the speech. In a situation where the students were required to blow up a balloon until it burst (physical threat) a higher increase in both anxiety-state scores and heart rate was observed.

In contrast to the large changes in anxiety-state scores and heart rate produced by experimentally induced stress anxiety-trait scores showed no change as a result of these same stressors.

Hodges (1967) found that anxiety-state scores increased from a rest period to a stress period. In a failure-threat situation (stress condition) in which each subject was told that he/she was not performing up to the levels of others, anxiety-state scores were markedly increased. The anxiety-state increase was higher for those subjects with high anxiety-trait scores (as measured by TMAS) than for those with low anxiety-trait scores.

APPARATUS

Electromyography (EMG)

The EMG recording was done on a TE-4 Electromyograph System manufactured by the Teca Corporation. The muscle action potential signals were preamplified by three PA 62A preamplifiers and then amplified by three AA 6MK 11 amplifiers. These signals were then fed into a signal processor where they were rectified and then summed. The summed signal was sent through a reset integrator which produced an output reading each time the integrator reset. The output reading was assumed to be a form of pulse rate of muscle activity. Its measures were proportional to the short term average of the sum of the three channels' intensity. The changes in the intensity of EMG activity were recorded by a U.V. recorder on Kodak Linagraph Photographic Paper.

All electrodes used were Beckman 16 mm silver- silver chloride discs. The electrode sites were cleaned with ethanol and abraded with sand paper. The electrodes were filled with Beckman Electrode Electrolyte and attached with circular adhesive collars. Each pair of electrodes was checked for electrical impedance with an impedance meter after they had been attached to ensure good skin contact. The impedance between each pair of electrodes was kept below 5 Kohms. Higher electrode impedance reduces the EMG signal which is introduced to the amplifier and can be the cause of considerable interference (Davis et al., 1978).

The two muscles, or more accurately, muscle groups, chosen to be monitored for EMG activity were the muscles of the forehead and the upper portion of the right and left trapezius muscles. Activity in the muscles of the forehead causes corrugation of the brows while activity in the upper portion of the trapezius muscles causes an elevation of the shoulder girdles. These muscle groups were selected because they are most commonly active in the stress postures described by Mitchell (1977).

The placement of the electrodes over the trapezius muscles followed the format outlined by Delagi et al., (1975) (See Appendix C). Electrode placement for the muscles of the forehead followed the convention of J.F. Davis' Manual of Surface Electromyography (1952). Davis stated that his suggested positioning of electrodes (See Appendix C) gives an accurate measure of frontalis EMG whereas this researcher expected to receive an accurate measure of all the muscles in the general area of the forehead. (C.M. Davis _et al._, 1978) observed that J.F. Davis' (1952) placement of electrodes over the two frontalis muscles produces a more general measure of forehead EMG and has suggested an alternative unilateral bipolar electrode placement. Since a general EMG measure for the forehead more adequately represents the muscles active in the stress posture, the conventional electrode placement of J.F. Davis (1952) was chosen.

An E and M Physiograph 4-channel recorder was used to monitor electrocardiogram (ECG), systolic blood pressure (BP), galvanic skin response (GSR), and respiration rate (RR). These four physiological parameters were selected for recording because variations in their measures reflect autonomic nervous system activity.

> Reflex reactions engaging efferent pathways to autonomic effectors commonly accompany the somatic motor responses to noxious stimulation... They are parts of the more generalized mobilization for defensive or aggressive reaction to attack, or to the threat of it, which depend for integration upon executant neural mechanisms of the forebrain, particularly of the hypothalmus (Mountcastle, 1974, p. 355).

The reflex reactions include cardiac acceleration and peripheral vasoconstruction with resulting rise in blood pressure, dilatation of the pupils, and secretion from the sweat glands which increases the conductivity of the skin — all signs of intense activity in the sympathetic efferent nerve fibers. Respiration rate, although not directly controlled by the autonomic nervous system, is also increased by noxious stimulation. A possible explanation of this phenomenon is that noxious stimulation initiates a generalized excitation or arousal which includes the respiratory neurons. The increased respiration rate would facilitate improved oxygen transport and deposition at the tissue level which would be imperative in the event of a physical reaction to the noxious stimulation (Mountcastle, 1974, p. 1443).

Galvanic Skin Response (GSR)

The GSR Preamplifier is a transducer/preamplifier designed to record quantitative information on the variations in skin resistance which result from the interaction between the autonomic nervous system and the internal and/or external environment.

The resistance between two electrodes attached to the skin of the subject is an indication of the subject's autonomic response to an environmental stimulus. A constant DC current of 20 microamperes is passed through the electrodes with the voltage across the electrodes then amplified and recorded. By maintaining a constant current, the voltage across the electrodes is directly proportional to the resistance between electrodes.

The two electrodes used to measure GSR are the sensing electrode and the ground electrode. The sensing electrode was made of soft lead in order for it to be molded around the right index fingertip and was secured there with masking tape. The ground electrode was a plate electrode attached to the right wrist and applied with Lectron II conductivity gel.

Heart Rate (HR) and Respiration Rate (RR)

The respiratory transducer consisted of an impedance pneumograph and its electrodes. The conductivity path between a pair of electrodes placed on the chest is altered by changes in the volume of the air in the lungs. As air is drawn into the lungs the passage of a currect between electrodes is impeded. As air is expelled the impedance is diminished (Geddes and Hoff, 1962). With appropriately placed electrodes a recording of trans-thoracic conductivity changes can be obtained which constitutes an effective means of measuring respiration. The electrodes were placed along a mid-axillary line between the fourth and fifth ribs (Geddes and Hoff, 1962, pp. 791-793).

For reasons of simplicity the researcher recorded only the rate of respiration and not respiratory volume.

While recording respiration rate with the impedance pneumograph the electrocardiogram (EGG) was also recorded using the same electrodes (Medi-Trace disposable electrodes). This was achieved by attaching the electrodes to the ECG preamplifier (Geddes and Hoff 1962, pp. 791-793).

Systolic Blood Pressure was recorded from the left brachial artery using an E and M Electrosphygmograph in which cuff pressure and deflation rate are regulated by a Narco Bio Systems Automatic Cycling Cuff Pump. The cuff pressure and deflation rate were preset at 220 mm Hg and ten seconds respectively. Arterial sounds were detected through a microphone in the electrosphymograph and superimposed on a pressure curve.

Measures of heart rate, respiration rate, and systolic blood pressure were estimated from the graph recordings produced by the E and M physiograph. Both heart rate and respiration rate were counted over a one minute period. The accuracy of these estimations was ± 0.5 beats per minute and ±0.5 breaths per minute for heart rate and respiration respectively. Systolic blood pressure measures were read with an accuracy of ± 1.0 mm Hg. Diastolic blood pressure measures were not evaluated because of the extreme difficulty encountered in reading an accurate measure off the pressure curve.

The subjects, throughout the three sessions with the researcher, were sitting in a standard, high backed reclining chair. The chair was set in its reclined position which permitted the subjects to lie in an almost horizontal fashion.

The recorded instructions listened to by the subjects in group one followed the format outlined by Mitchell (1977, pp. 42-62). These instructions were played back by a portable cassette tape player (See Appendix D).

The laboratory used for this experiment was situated at one end of a portable trailer unit. It's dimensions were ten feet by ten feet. The floor plan of the laboratory is shown in Appendix E. The room temperature of the trailer/laboratory was maintained at approximately 20°C. The trailer was located in an area where the general noise level was low. However, distinctive loud sounds and other interruptions of the peace were not uncommon. More will be written on this subject in the discussion of the results of this experiment.

RESULTS

Introduction

An analysis of variance was used to analyze the results from the seven dependent variables of this study. The dependent variables were: State Anxiety (STAI-S), Trait Anxiety (STAI-T), Electromyographic Activity (EMG), Galvanic Skin Response (GSR), Respiration Rate (RR), Systolic Blood Pressure (BP), and Heart Rate (HR). The analysis of variance employed a 2 x 3 x 3 (Groups x Days x Training Periods) factorial format with repeated measures on all but the first factor for all physiological measures. The format for state and trait anxiety was 2 x 2 (Groups x Trials).

The results are presented in tabular form under the major headings of individual dependent variables. The level of statistical significance chosen, unless otherwise specified, was $p < .05$. All raw data can be found in Appendix F.

State Anxiety

The processed data for state anxiety is presented in tables 1 and 2. In table 1 the mean scores for both treatment and control groups across training periods can be found. While the treatment group displayed a reduction in state anxiety from 58.0 to 37.2 the control group reduced its scores from 52.4 to 33.7. The mean reduction in state anxiety for both groups was from 55.2 to 35.4.

An analysis of variance for the state anxiety scores of the treatment and control groups is shown in table 2. Although a significant ($p < .001$) training effect was evident across training periods there is no significant variation between groups.

Table 1

State Anxiety Presented by Groups as a Function of Training Periods

GROUP	TRAINING PERIOD 1	TRAINING PERIOD 2
Treatment	58.00	37.20
Control	52.40	33.70
Mean	55.20	35.45

Table 2

Analysis of Variance for Dependent Measurement of State Anxiety

Source of Variance	df	Error Term	Mean Squares	F
Groups (G)	1	S (G)	207.02	3.42
Training Period (T)	1	ST (G)	3900.62	78.29*
Subjects (G)	18	---	60.51	---
GT	1	ST (G)	11.02	0.22
ST (G)	18	---	49.82	---

* $p < .001$

Trait Anxiety

The processed data for trait anxiety is presented in tables 3 and 4. In table 3 the mean scores for both treatment and control groups across training periods can be found. While the treatment group displayed a reduction in trait anxiety from 52.2 to 45.6 the control group reduced its scores from 50.6 to 46.8. The mean reduction in trait anxiety for both groups was from 51.4 to 46.2.

An analysis of variance for the trait anxiety scores of the treatment and control groups is shown in table 4. Although the reductions in trait were not as extreme as those on state anxiety a significant ($p < .001$) training effect was evident across training periods. Once again there was no significant variation between groups.

Table 3

Trait Anxiety Presented by Groups as a Function of Training Periods

	Training Period	
Group	1	2
Treatment	52.20	45.60
Control	50.60	46.80
Mean	51.40	46.20

Table 4

Analysis of Variance for Dependent Measurement of Trait Anxiety

Source of Variance	df	Error Term	Mean Squares	F
Groups (G)	1	S (G)	0.40	0.0025
Training Period (T)	1	ST (G)	270.40	9.22 *
Subjects (G)	18	---	157.00	---
GT	1	ST (G)	19.60	0.67
ST (G)	18	---	29.33	---

* $p < .001$

Electromyographic Activity

The processed data for EMG activity is presented in tables 5 through 7. In table 5 the mean scores for both treatment and control groups across training periods can be found. While the treatment group EMG activity measures show no significant variation over the training periods the control group shows a significant increase in EMG activity measures across the training periods.

In table 6 the mean scores are presented for both treatment and control groups across training periods for each day. Both the treatment and control groups show a reduction in EMG activity measures across the three test days.

An analysis of variance for the EMG activity measures of the treatment and control groups is shown in table 7. An examination of this table reveals significant differences between treatment and control groups ($p < .01$), between daily sessions ($p < .05$), and across training periods ($p < .001$). A significant variation also appeared when treatment and control groups were presented as a function of training periods ($p < .01$). In each of these cases the control group displayed significantly higher EMG values when compared with the treatment group.

Table 5

Electromyographic Activity Presented by Groups as a Function of Training Periods

Group	Training Period 1	2	3
Treatment	110.01	107.66	113.80
Control	117.10	128.18	141.63
Mean	113.55	117.92	127.71

Table 6

Electromyographic Activity Presented by Groups as a Function of Training Periods Within Days

Group	Day 1			Day 2			Day 3			
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	Mean
Treatment	129.53	118.00	121.58	97.05	99.45	108.05	103.46	105.53	111.76	110.49
Control	126.52	135.69	149.40	114.40	127.14	139.38	110.39	121.70	136.11	128.97
Mean	128.02	126.85	135.49	105.72	113.30	123.72	106.92	113.62	123.94	

Table 7

Analysis of Variance for Dependent Measurement of Electromyography

Source of Variance	df	Error Term	Mean Square	F
Groups (G)	1	S (G)	15367.30	6.74 *
Days (D)	2	SD (G)	4862.07	3.64 *
Training Period (T)	2	ST (G)	3153.48	13.81 ***
Subjects (G)	18	---	2278.94	---
GD	2	SD (G)	557.65	0.42
GT	2	ST (G)	1659.56	7.27 **
DT	4	SDT (G)	193.49	1.31
SD (G)	36	---	1337.45	---
ST (G)	36	---	228.26	---
GDT	4	SDT (G)	108.46	0.73
SDT (G)	72	---	147.68	---

* $p < .05$

** $p < .01$

*** $p < .001$

Galvanic Skin Response

The processed data for GSR is presented in tables 8 through 10. In table 8 the mean scores for both treatment and control groups across training periods can be found. The treatment and control groups both show significant increases in GSR across training periods.

Table 9 displays a distinct patterning of GSR in the subjects of both groups. An increase in GSR after the first training period is followed by a decrease in GSR after the second training period. This pattern is consistent for all three test days for both groups. The pattern is further distinguished by the fact that the increase in GSR after the first training period is substantially larger than the decrease in GSR after the second praining period.

An analysis of variance for the GSR of the treatment and control groups is shown in table 10. An examination of this table showed a significant treatment effect ($p < .05$) between the treatment and control groups. The GSR was significantly higher for the treatment group when compared with the control group. A significant difference ($p < .001$) in GSR was also evident across the training periods. The GSR was significantly higher after the two training periods than it was for the initial GSR before the training periods.

Further examination of table 10 reveals that no significant differences occur when the treatment and control groups are separated by training periods. Both groups show similar increases in GSR across training periods with the difference being an initially higher measure of GSR for the treatment group.

Table 8

Galvanic Skin Response Presented by Groups as a Function of Training Periods (kilohms)

Group	Training Period 1	2	3
Treatment	0.42	0.77	0.66
Control	0.07	0.43	0.24
Mean	0.24	0.60	0.45

Table 9

Galvanic Skin Response Presented by Groups as a Function of Training Periods Within Days (kilohms)

	Day									
	1			2			3			
Group	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	Mean
Treatment	.37	.63	.60	.46	.77	.55	.42	.92	.82	.62
Control	.05	.16	.14	.05	.61	.32	.11	.52	.25	.25
Mean	.21	.39	.37	.26	.69	.44	.27	.72	.53	

Table 10

Analysis of Variance for Dependent Measurement

Galvanic Skin Response

Source of Variance	df	Error Term	Mean Square	F
Groups (G)	1	S (G)	6.16	5.30 *
Days (D)	2	SD (G)	0.54	2.42
Training Period (T)	2	ST (G)	1.92	15.65 **
Subjects (G)	18	---	1.16	---
GD	2	SD (G)	0.16	0.51
GT	2	ST (G)	0.03	0.24
DT	4	SDT (G)	0.13	1.74
SD (G)	36	---	0.22	---
ST (G)	36	---	0.12	---
GDT	4	SDT (G)	0.09	1.17
SDT (G)	72	---	0.07	

* $p < .05$

** $p < .001$

Respiration Rate

The processed data for RR is presented in tables 11 and 12. In table 11 the mean score for both treatment and control groups across training periods can be found. The treatment and control groups both show significant decreases in RR across training periods.

An analysis of variance for the RR measures of the treatment and control groups is shown in table 12. An examination of this table showed no significant differences between the treatment and control groups. A significant treatment effect ($p < .001$) was observed for both groups across the training periods. When the two groups were separated as a function of training periods a difference approaching significance ($p < .08$) was also evident with the treatment group displaying a greater reduction in RR than the control group.

Table 11

Respiration Rate Presented By Groups as a Function of Training Periods (breaths/min.)

	Training Period		
Group	1	2	3
Treatment	15.80	13.67	13.13
Control	15.87	14.47	14.73
Mean	15.83	14.07	13.90

Table 12

Analysis of Variance for Dependent Measurement

of Respiration Rate

Source of Variance	df	Error Term	Mean Square	F
Groups (G)	1	S (G)	30.42	0.35
Days (D)	2	SD (G)	4.42	1.19
Training period (T)	2	ST (G)	67.49	21.02 **
Subjects (G)	18	---	87.41	---
GD	2	SD (G)	0.96	0.26
GT	2	ST (G)	. 2	2.75 *
DT	4	SDT (G)	1.44	0.93
SD (G)	36	---	3.71	---
St (G)	36	---	3.21	---
GDT	4	SDT (G)	1.31	0.84
SDT (G)	72	---	1.55	---

* $p < .083$

** $p < .001$

Systolic Blood Pressure

The processed data for systolic BP is presented in tables 13 and 14. In table 13 the mean scores for both treatment and control groups across training periods can be found. The treatment and control groups both show significant reductions in systolic BP across training periods.

An analysis of variance for the systolic BP measures of the treatment and control groups is shown in table 14. An examination of this table showed no significant treatment effect between the treatment and control groups. A significant decrease in systolic BP ($p < .001$) was observed for both groups.across the training periods. When the two groups were separated as a function of training periods a difference approaching significance ($p < .06$) was also evident with the treatment group displaying a greater reduction in systolic BP than the control group.

Table 13

Systolic Blood Pressure Presented by Groups as a Function of Training Periods (mmHg)

	Training Period		
Group	1	2	3
Treatment	104.37	98.97	99.03
Control	101.53	97.93	100.20
Mean	102.95	98.40	99.62

Table 14

Analysis of Variance for Dependent Measurement of Blood Pressure

Source of Variance	df	Error Term	Mean Square	F
Groups (G)	1	S (G)	33.80	0.04
Days (D)	2	SD (G)	76.74	1.30
Training Period (T)	2	ST (G)	332.94	17.57**
Subjects (G)	18	---	818.04	---
GD	2	SD (G)	56.45	0.96
GT	2	ST (G)	60.05	3.17*
DT	4	SDT (G)	21.69	1.47
SD (G)	36	---	58.84	---
ST (G)	36	---	18.94	---
GDT	4	SDT (G)	8.30	0.56
SDT (G)	72	---	14.75	---

* $p < .06$

** $p < .001$

Heart Rate

The processed data for HR is presented in tables 15 and 16. In table 15 the mean scores for both treatment and control groups across training periods can be found. The treatment and control groups both show significant reductions in HR across training periods.

An analysis of variance for the HR measures of the treatment and control groups as shown in table 16. Although a significant reduction in HR ($p < .001$) is evident across training periods there is no significant treatment effect which separates the two groups.

Table 15

Heart Rate Presented by Groups as a Function of Training Periods (beats/min.)

	Training Period		
Group	1	2	3
Treatment	60.67	56.83	56.57
Control	67.63	63.00	62.70
Mean	64.15	59.92	59.63

Table 16

Analysis of Variance for Dependent Measurement

of Heart Rate

Source of Variance	df	Error Term	Mean Square	F
Groups (G)	1	S (G)	1856.02	1.32
Days (D)	2	SD (G)	14.07	0.26
Trials (T)	2	ST (G)	384.02	37.45 *
Subjects (G)	18	---	1405.90	---
GD	2	SD (G)	11.02	0.20
GT	2	ST (G)	3.34	0.32
DT	4	SDT (G)	3.43	0.50
SD (G)	36	---	53.80	---
ST (G)	36	---	10.25	---
GDT	4	SDT (G)	5.59	0.82
SDT (G)	72	---	6.82	---

* $p < .001$

In figure 2 a general display of the subjects' responses to the training periods is presented. Both the treatment and control groups displayed reductions in respiration rate, systolic blood pressure, heart rate, and state and trait anxiety scores across training periods. Galvanic skin response measures showed increases for the two groups. Electromyographic activity showed a small increase for the treatment group and a much larger increase for the control group over the training periods. While the electromyographic activity was significantly lower for the treatment group than for the control group after the training periods, respiration rate, systolic blood pressure, heart rate and state and trait anxiety measures displayed no significant differences between the two groups. The galvanic skin response was significantly higher for the treatment group than for the control group; however, this difference is thought to be the result of initially higher treatment group GSR values.

		Treatment Group			Control Group		
Sessions		1st	2nd	3rd	1st	2nd	3rd
EMG		↓	↑	↑	↑	↑	↑
HR		↓	↓	↓	↓	↓	↓
RR		↓	↓	↓	↓	↓	↓
GSR		↑	↑	↑	↑	↑	↑
BP(s)		+	↓	+	↓	↓	↓
STAI	State		↓			↓	
	Trait		↓			↓	

+ no change

Figure 2 Subject Response to the Practice of Physiological Relaxation

DISCUSSION

Introduction

The majority of research into relaxation training has been specific, employing a technique for relaxation training and examining the consequent reduction in frequency of tension headaches, decrease frontalis EMG, or decreased levels of anxiety. In this study an attempt was made to examine the relationship between levels of anxiety and levels of muscle tension, thereby developing a possible mechanism for exerting more control over an individual's degree of anxiety. This mechanism is relaxation training. One of a large number of relaxation techniques was employed in theis study, Physiological Relaxation.

In order to obtain a general picture of the subject's physiological and psychological states a number of variables were measured. The discussion of the results of this investigation is presented under the headings of these dependent variables: State-Trait Anxiety Inventory (STAI), Electromyography (EMG), Galvanic Skin Response (GSR), Respiration Rate (RR), Blood Pressure (BP) and Heart Rate (HR). An explanation and discussion of the findings is presented in conjunction with the related literature.

State-Trait Anxiety Inventory (STAI)

For both the treatment and control groups significant reductions were shown in state and trait anxiety. Experiments using relaxation training to reduce state anxiety have been reproduced by a number of researchers (Johnson and Spielberger, 1968, Stoudenmere, 1972 and Paul, 1969). However, these same researchers were unable to produce reductions in trait anxiety using relaxation training techniques. Townsend et al., (1975) were able to demonstrate significant variations in trait anxiety scores through the use of an EMG biofeedback relaxation group.

Spielberger describes trait anxiety as being an individual's predisposition to manifest anxiety under any given stress situation. By definition, trait anxiety is unaffected by environmental stimuli.

The results of this study give cause to seriously re-evaluate the validity of a psychological test such as the State-Trait Anxiety Inventory (STAI) where the subject is required to subjectively assess his/her own level of anxiety. A subject involved in a relaxation study of this type could feel considerable pressure to produce "the desired results" (i.e., a more relaxed and less anxious state of mind). With an experimental design of this form and a subjective analysis such as the STAI it is quite conceivable the subject's responses are more a product of what he or she would like to feel rather than what he or she actually feels.

Another explanation of the results, showing reductions in both state and trait anxiety, is that actual reductions did in fact occur and that trait anxiety needs to be re-defined. It is possible that an individual's predisposition to manifest anxiety under any given stress situation can, over a period of time, be altered.

There was no significant difference between the reductions of the two groups in either state or trait anxiety. Therefore, although both groups subjectively assessed themselves as being less anxious after the three training sessions, the relaxation technique employed by the test group appears to be no more effective in producing a self-stated reduction in anxiety than simply sitting quietly and attempting to relax.

Electromyography (EMG)

A significant treatment effect was shown in EMG activity measures between the treatment and control groups. The apparent treatment effect between daily sessions was not evaluated. The latter result should not be misinterpreted. Because of the delicacy of electrode placement and function in EMG studies it is poor practice to relate EMG measures resulting from differently placed electrodes. With this in mind, any relationship between the EMG results of the three successive daily sessions (each falling on different days) has been disregarded in favor of the EMG results from within each training period.

By separating the two groups by training periods a significant variation between groups was discovered. While the treatment group shows minimal fluctuation across training periods the control group displayed successive increases in EMG activity over the training periods.

These results are the apparent antithesis or what was anticipated for this study. A subject, trained to relax his/her muscles through some form of relaxation training, would be expected to reveal a reduction in EMG activity. However, the results of this study show this not to be the case.

The findings of this study are not in agreement with a proportion of the research discussed in the introduction. Paul

(1969), Edelman (1971), and Haynes et al., (1975) reported significant decreases in EMG activity in their relaxation studies. However, the current study supports the finds of Mathews and Gelder (1969) and Lader and Mathews (1970) who demonstrated no significant decreases in EMG activity with their studies of relaxation training. The results of this investigation show a significant increase in levels of EMG activity only for the control group.

An explanation of these apparent contradictions might be found by examining the experimental environment. It was mentioned previously that the noise level of the laboratory used for this study was extremely inconsistent. Although the general atmosphere was reasonably quiet there were irregularly spaced, disturbing interruptions of the peace. An environment of this sort well promote an increase in muscle tension, more so than an environment with a more consistent, higher level of noise; the inconsisitency being the key factor in this case. It should be noted that Mitchell (1977) recommended that training be conducted in a "normal" (i.e., not totally silent) environment.

However, if the experimental environment could be described as one which facilitated elevations in muscle tension then an alternative method of explaining the fluctuations in EMG activity presents itself. Under the described conditions the treatment group was more effectively able to control their levels of muscle activity, maintaining them at a reasonably constant level across training sessions whereas the control group, under similar conditions, was less effectively able to control their levels of muscle activity as shown by the significant increases in EMG activity across training periods.

Another possible cause for the rising EMG measures observed across training periods in this investigation was "the relaxing posture" of the subjects in the reclining chair. It is conceivable that the body positioning in the chair was such that it slowly increased levels of muscle tension. The elevated levels of muscle tension could be caused by the subject lying in a position which was unnatural to him/her for an extended period of time.

Galvanic Skin Response (GSR)

For measures of GSR the treatment group showed significantly higher measures of skin resistance than the control group. Any relationship between the GSR results of the daily sessions has once again been disregarded for reasons mentioned in the preceding section. Across training periods, an increase in skin resistance after the first training period was followed by a decrease in skin resistance after the second training period. However from initial to final measurements within each daily session significant increase in skin resistance was revealed.

Further examination of the results reveal that when treatment and control groups are separated by training periods no significant variation appears. Both groups show similar increases in GSR across training periods with the difference being an initially higher meausre of GSR for the treatment group.

These results are an indication of a decreased state of arousal for both groups. A measure of GSR ".... appears in part to reflect the affective state of the subject, his attitude toward the situation in which he receives a stimulus and the meaning he attaches to such stimuli" (Mountcastle, 1974, p. 355) If the intent of the relaxation training periods was to reduce levels of anxiety, then the researcher would anticipate elevated levels of GSR, if the training periods were successful.

The results of this study have revealed increasing levels of GSR with similar increases for both the treatment and control groups. These findings may indicate that the technique for relaxation used in this study was effective in reducing levels of anxiety, as indicated by GSR increases, but no more effective than simply sitting quietly in a chair and attempting to relax.

These results are supported by Paul (1969), Mathews and Gelder (1969), and Edelman (1971) whose research reveals significant increases in skin resistance for both the treatment group and the control group, with no significant differences between them. This information is an indication that Physiological Relaxation is no more effective in regulating galvanic skin response than attempting to relax passively while sitting quietly on a chair.

Respiration Rate (RR)

No significant treatment effect was shown in RR measures between the treatment and control groups. Also there were no significant fluctuations in RR within daily sessions. Both the treatment group and the control group showed reductions in RR across the training periods.

When the two groups were separated by training periods it became apparent that although both groups displayed reductions in RR there was a difference approaching significance ($p < .08$) in these reductions between groups with the treatment group revealing the greater reduction. The observed decrease in respiration rate is consistent with the findings of Paul (1969), Wallace (1972), and Benson (1974), who reported reductions in respiration rate concomitant with the acquisition of a relaxation technique.

Systolic Blood Pressure (BP)

Measures of systolic BP showed no treatment effect between groups or between daily sessions. A significant reduction in systolic BP did occur across training periods. When the treatment and control groups were separated by training periods it became apparent that although both groups displayed reductions in systolic BP there was a difference approaching significance ($p < .06$) in these reductions between groups with the treatment group revealing the greater reduction.

Researchers have proven inconsistent in their findings on BP as it is affected by the practise of a relaxation technique. Wallace and Benson (1972) and Benson (1974) showed no changes occurring in BP measures after the practice of Transcendental Meditation while Schandler and Gringe (1976) displayed significant decreases in BP with the practice of Progressive Relaxation.

Experimental studies have indicated that elevated levels of systolic BP may be related to conditions which require continuous behavioral and physiologic adjustments through chronic arousal of the hypothalamic emergency reaction which is associated with increased sympathetic nervous system activity (Benson et al., 1974). If behavioral conditions can lead to elevations in systolic BP, alterations in behavior which are associated with decreased sympathetic nervous system activity may lead to depressions in systolic BP. It was the author's belief that employing the technique of Physiological Relaxation would correspond to decreased sympathetic nervous system activity and thus, depressed measures of systolic BP. This, in fact, was the case in this study. Both treatment and control groups displayed reductions in systolic BP; however, the treatment group's systolic BP were distinctly lower ($p < .06$) than the control group's systolic BP when examined across training periods.

Heart Rate (HR)

HR measures showed no treatment effect between groups or between daily sessions. A significant reduction was shown across training periods. It would appear that the relaxation training technique used in this study was no more effective at reducing HR than having the subject simply sitting quietly and attempting to relax. Both methods were able to produce significant reductions in HR within each daily session.

In their research on modified forms of Progressive Relaxation techniques Mathews and Gelder (1969), Lader and Mathews (1970), and Greenwood and Benson(1977) all show no significant differences in reductions in heart rate between treatment and control groups.

GENERAL CONSIDERATIONS

The results of this investigation are in general agreement with the related literature. All measures of the dependent variables, with the exception of EMG, were reduced after completion of the training periods. The treatment group displayed significantly lower EMG values and significantly higher GSR values than did the control group after the training periods. As previously mentioned, GSR measures between treatment and control groups displayed significant differences; however, these differences occurred as a result of initial differences between the groups. Although STAI, RR, systolic BP and HR values were also reduced after the training periods there were no significant differences between the treatment and control groups.

These changes support Benson's hypothesis that the practice of a relaxation technique will elicit a relaxation response. Benson stated that "The relaxation response appears to be an integrated hypothalamic response which results in generalized decreased sympathetic nervous system activity, and perhaps also increased parasympathetic activity" (Benson, 1974, p. 37).

The findings of this study also support Lacey's (1953) observations on the clinical phenomenon of specific symptom selections in psychosomatic neuroses.

> The autonomic nervous system does indeed respond to stress "as a whole" in the sense that all autonomically innervated structures seem to be activated, usually in the direction of apparent sympathetic predominance. But it does not respond "as a whole" in the sense that all autonomically innervated structures exhibit equal increments or decrements of functions. Striking intra-individual differences in the degree of activation of different physiological

> functions are found when the different reactions are expressed in equivalent units. (Lacey, 1953, p. 8).

The subjects participating in this study displayed wide variations in their patterning of physiological responses to the practice of a relaxation technique. Although the general response was one of decreased sympathetic nervous system activity distinct differences between individuals in the degree of activation of different physiological functions were found.

These results are contrary to those which would be expected on the basis of the usual interpretation of Cannon's research's on the functioning of the autonomic nervous system. Cannon has described a state of autonomic nervous system arousal in which all physiological functions are activated to an equivalent degree (Cannon, 1939). Conversely, a reduction in autonomic nervous system activity, as a result of practice of a relaxation technique, would also be expected to vary all physiological functions by an equivalent amount. The findings of this investigation show this not to be the case. As was previously noted, wide variations in the patterning of physiological responses to the practice of a relaxation technique were discovered between subjects.

Conclusions

Although further research in this area is necessary, the results of this study begin to establish a relationship between levels of anxiety and levels of muscle tension. The Physiological changes observed in this study, which are consistent with Benson's "relaxation response" correlated well with reductions in state and trait anxiety scores as measured by Spielberger's State-Trait

Anxiety Inventory (STAI).

Unequivocal success of the relaxation technique employed in this study, Physiological Relaxation, is clearly not evident. Whereas significant differences occur, between treatment and control groups, with measures of EMG no significant variation appears between groups with measures of GSR, RR, systolic BP, HR, and state and trait anxiety. Both practising the technique of Physiological Relaxation and sitting quietly in a reclining chair attempting to relax seem effective in decreasing sympathetic nervous system activity and correspondingly increasing parasympathetic nervous system activity. Although the practice of Physiological Relaxation demonstrated a more consistent and more substantial effect on the autonomic nervous system, it failed to establish itself as significantly superior to simply sitting quietly in a reclining chair and attempting to relax.

There are two factors which may help to explain the lack of distinction between the treatment and control groups of this study. Firstly, the group termed as a control is not a true control group. The subjects in this group were asked to sit quietly and attempt to relax. As a group these individuals proved to be able to do this quite effectively. A more realistic control group would not be asked to attempt to relax but rather to spend the fifteen minutes in some more normal fashion such as discussing a specific topic with the researcher. The topic would hopefully be one which would be neutral with respect to anxiety arousal for all subjects.

Secondly, an examination of the mean scores of the dependent variables for both treatment and control groups reveals a distinct patterning of responses by the subjects. Quite large changes in dependent variable measures after the first training period are followed by distinctly reduced variations after the second training period. In some instances the variations in measures after the second training period are in the opposite direction to those following the first training period (see GSR).

One explanation of this phenomenon is that the subjects were unable to direct themselves to the task presented them for the entire daily session. It's quite possible that the subjects became restless before the two hour daily session was completed.

Previously in this thesis it was mentioned that studies in relaxation training were complicated by the fact that researchers have employed grossly divergent training schedules which yielded concomitantly divergent results. The research presented in this thesis supports this claim. Using only the results recorded after the first training period and extending the number of training periods, each falling on separate days, would undoubtedly have changed the complexion of the findings presented in this thesis.

Recommendations

The quality of this investigation might have been improved by incorporating the following suggestions into the experimental design.

1. A larger subject number may produce more reliable results. It is suggested that an increase in size of both the control group and the treatment group be considered.

2. A two hour session with the researcher may reduce the subject's ability to relax. It is suggested that each daily session be decreased from two hours to forty-five minutes. The lost training time could be made up by increasing the number of sessions from three to six.

3. An inconsistent level and quality of background noise may reduce the subject's ability to relax. It is suggested that by selecting an environment with a more consistent (natural) level and quality of background noise the subject will be able to relax more readily and more profoundly.

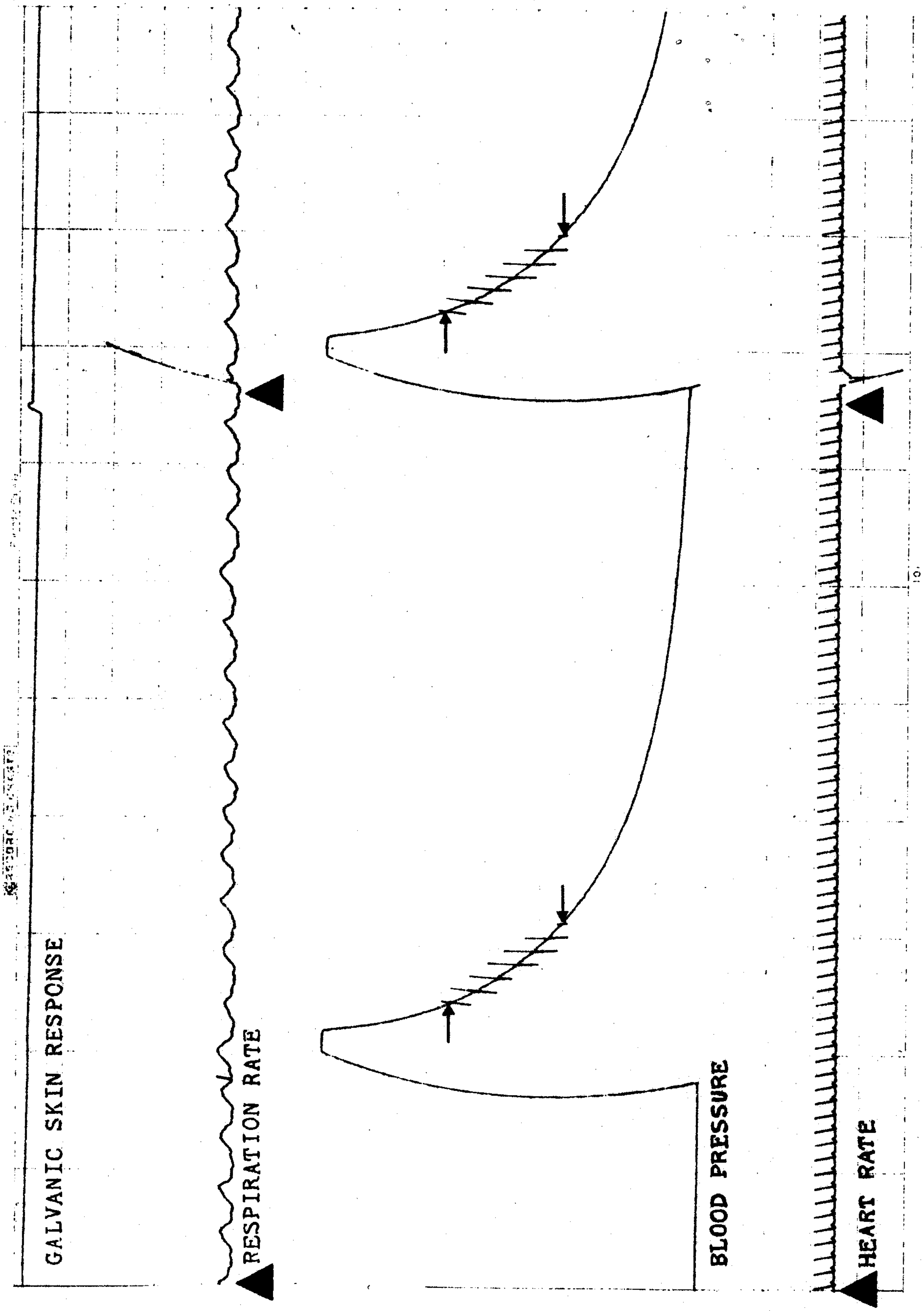
4. The control group in this study was not a true control because its members were instructed to sit quietly and attempt to relax. Future studies could incorporate a true control group in their research to establish any differences which may occur between treatment groups and a group not attempting to relax.

APPENDICES

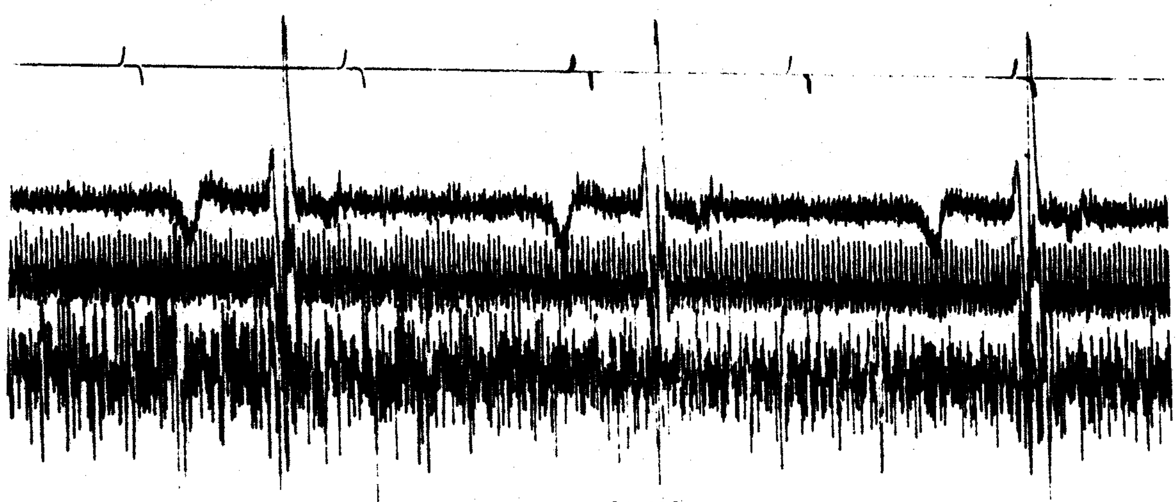
APPENDIX A

Samples of Data Measure Before Quantification

PHYSIOGRAPH RECORDING



EMG RECORDING



AFTER TRAINING

BEFORE TRAINING

Appendix B

State-Trait Anxiety Inventory

Self Evaluation Questionnaire

SELF-EVALUATION QUESTIONNAIRE

Developed by C. D. Spielberger, R. L. Gorsuch and R. Lushene

STAI FORM X-1

NAME ______________________________ DATE ______________

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

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1. I feel calm	①	②	③	④
2. I feel secure	①	②	③	④
3. I am tense	①	②	③	④
4. I am regretful	①	②	③	④
5. I feel at ease	①	②	③	④
6. I feel upset	①	②	③	④
7. I am presently worrying over possible misfortunes	①	②	③	④
8. I feel rested	①	②	③	④
9. I feel anxious	①	②	③	④
10. I feel comfortable	①	②	③	④
11. I feel self-confident	①	②	③	④
12. I feel nervous	①	②	③	④
13. I am jittery	①	②	③	④
14. I feel "high strung"	①	②	③	④
15. I am relaxed	①	②	③	④
16. I feel content	①	②	③	④
17. I am worried	①	②	③	④
18. I feel over-excited and "rattled"	①	②	③	④
19. I feel joyful	①	②	③	④
20. I feel pleasant	①	②	③	④

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SELF-EVALUATION QUESTIONNAIRE

STAI FORM X-2

NAME ______________________________ DATE ______________

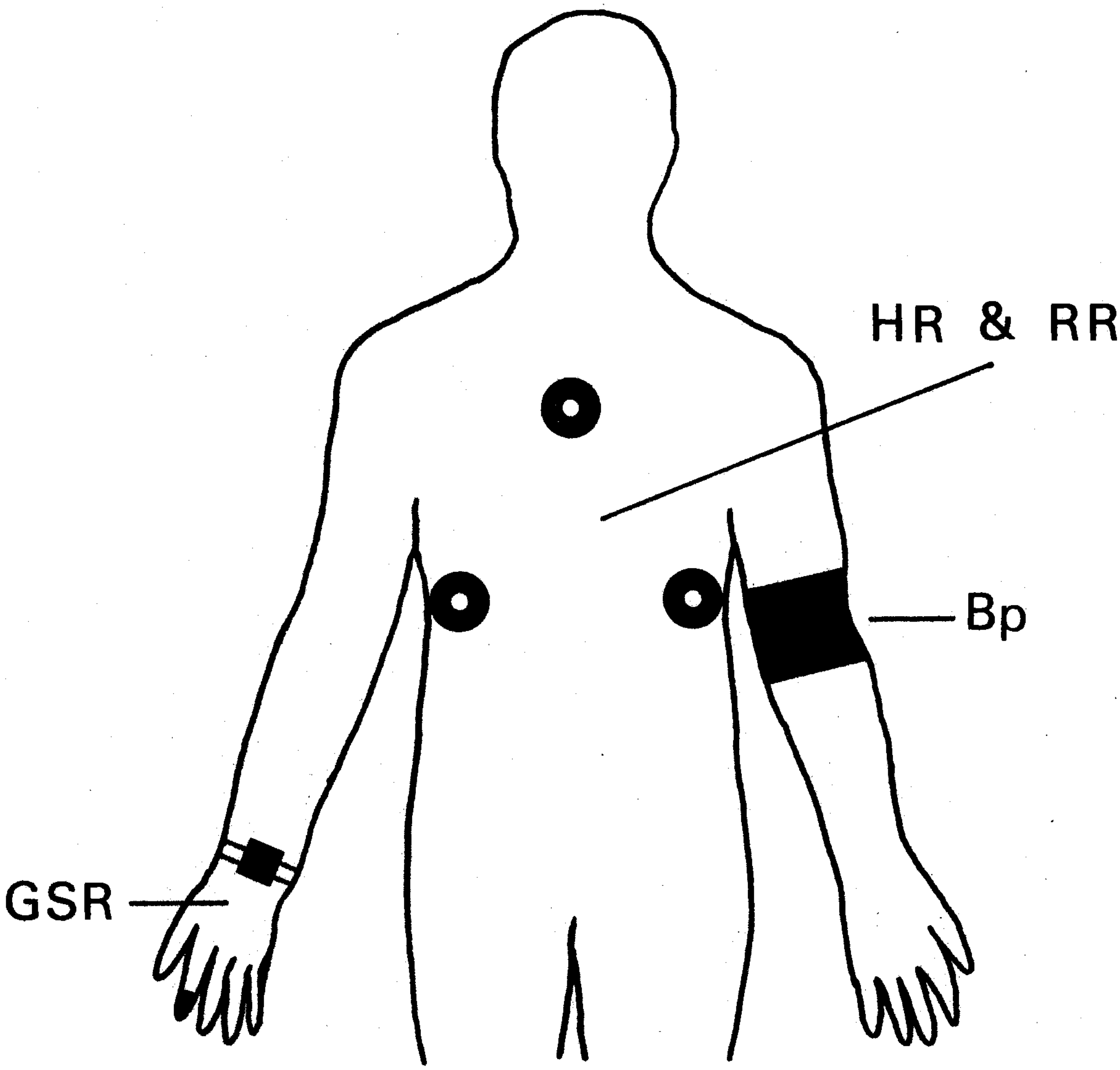
DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21. I feel pleasant	①	②	③	④
22. I tire quickly	①	②	③	④
23. I feel like crying	①	②	③	④
24. I wish I could be as happy as others seem to be	①	②	③	④
25. I am losing out on things because I can't make up my mind soon enough	①	②	③	④
26. I feel rested	①	②	③	④
27. I am "calm, cool, and collected"	①	②	③	④
28. I feel that difficulties are piling up so that I cannot overcome them	①	②	③	④
29. I worry too much over something that really doesn't matter	①	②	③	④
30. I am happy	①	②	③	④
31. I am inclined to take things hard	①	②	③	④
32. I lack self-confidence	①	②	③	④
33. I feel secure	①	②	③	④
34. I try to avoid facing a crisis or difficulty	①	②	③	④
35. I feel blue	①	②	③	④
36. I am content	①	②	③	④
37. Some unimportant thought runs through my mind and bothers me	①	②	③	④
38. I take disappointments so keenly that I can't put them out of my mind	①	②	③	④
39. I am a steady person	①	②	③	④
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	①	②	③	④

APPENDIX C

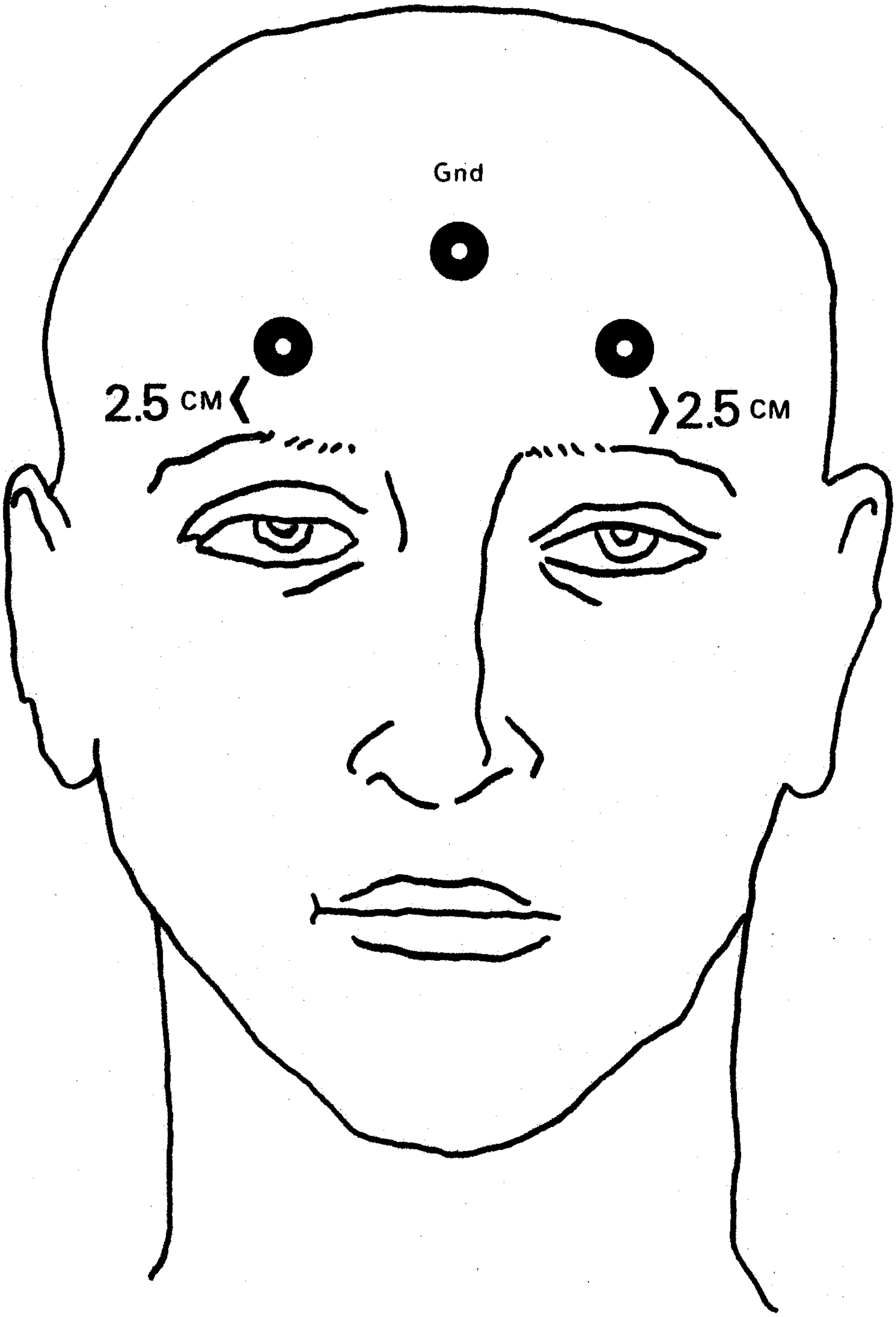
Site Selection of Physiological Relaxation

Site Selection for Physiological Measures



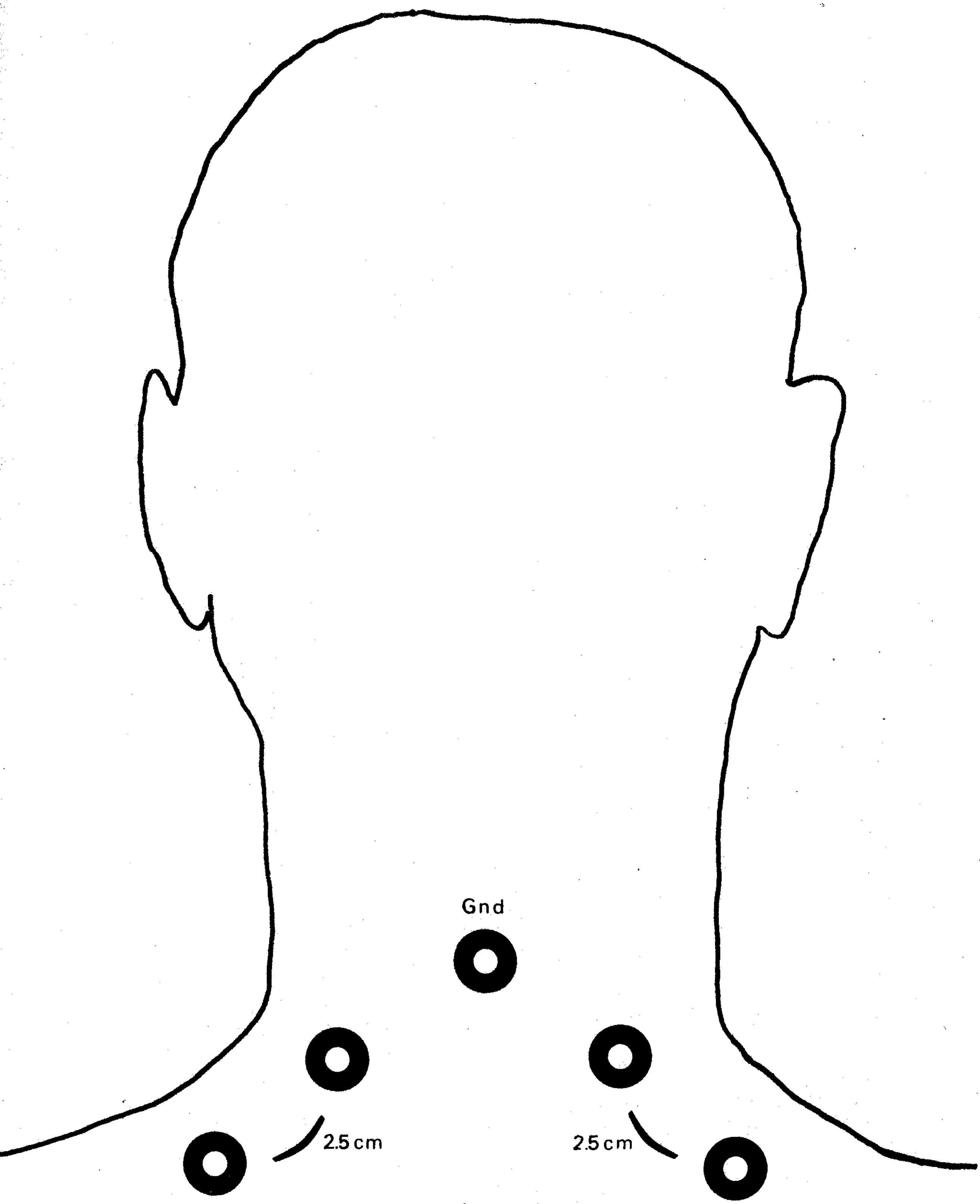
Anterior View

EMG Electrode Placement



Anterior View

EMG Electrode Placement



Posterior View

Appendix D

Text of Physiological Relaxation Technique

The Technique of Physiological Relaxation

The purpose of this tape is to teach you to relax. You will learn how to change tension to ease. The method is completely simple, easy to learn, and can be practiced and used in the course of everyday life. There are some important facts to remember:

1. The order that I have chosen for you to give each joint will produce relaxation in the tense group of muscles, if you perform the movement exactly indicated by the words. When I say pull your shoulders towards your feet, I mean pull, not drop.
2. When I say stop, I mean just that. You stop moving the part and you do not move it again.
3. You register the feeling of the new position as accurately as you possibly can. This requires concentration if you are not accustomed to it.
4. I shall not be trying to mesmerize you or persuade you. I shall only be helping you to train your own conscious brain in discriminating sensations that have always been received there, but which you may not have recognized until now.

The sequence for the exercises is:

1. arms
2. legs
3. breathing
4. body

5. head
6. face

The orders I will give for each joint are:

1. move and feel
2. stop
3. feel

The words are so simple that very soon you will have memorized them and will be able to perform entirely on you own account.

<u>The Room</u>

Have the room comfortably warm because you will lose heat as your muscles relax. Otherwise make no special preparations. It is better not to insist on absolute quietness as this is too artificial and quite unnecessary.

<u>Starting Position</u>

Sit on a chair. The back should be high enough to rest the head against it. Sit well back in the chair so that your back is supported and both feet rest on the floor. The forearms should rest on the arms of the chair, as do the hands, which must not hang over the edge. The chair arms must be long enough and broad enough to support the length of all the fingers when stretched out. Now we will start the exercises.

<u>Orders to the Arms</u>

The order is: pull your shoulders towards your feet .....
Go on gently pulling them straight down away from your ears and

feel what is happening....stop....stop pulling..... Now register the new position of ease....You will probably be able to register that the tops of your shoulders are lower down than they were, that is, further away from your ears....You may therefore feel your neck is longer...

<u>Elbows</u>

The order is: elbows out and open...Push your upper arms slightly away from your sides...You are moving at your shoulder joints ...Now, gently open the angle at your elbows by moving your forearms on their support away from your upper arms...Your upper arms will rest across the chair arms...The elbow will be just outside the chair arms with your forearms lying on the chair arms...Be sure the fingers also lie on them and not over the edge...When you feel this position to be comfortable, stop moving... Now recognize the new position by feeling...Realize both arms are away from your sides and resting on something and that there is an open angle at the elbows...Concentrate on feeling....

<u>Hands</u>

The order is: long... Keep the heel of your hand resting where it is and only move your fingers and both thumbs...Stretch them out to be as long as possible...go on stretching...Feel them opening out and stiffening and the thumbs stretching away from the fingers...Now stop...and you will feel them lying on the support ...Now feel those fingers...notice the pads are resting, touching something... the nails on top and the fingers separated... Do not allow the fingers to move as you register the exact texture on which each is resting... Now the thumbs... can you feel that they too are open and separated from the rest of the hand... resting on a support and quite heavy... Feel your heavy separated thumbs... Now, please do the hand exercise over again... The order is long... Keep the heel of your hand resting where it is and only move your fingers and both thumbs... Stretch them out to be as long as possible...go on stretching... Feel them opening out and stiffening and the thumbs stretching away from the fingers... Now stop... and you will feel them lying on the chair arm ... Now feel those fingers... Notice the pads are resting touching something... Feel the pads of the fingers touching something ... the nails on top and the fingers separated... Do not allow the fingers to move as you register the exact texture on which it is resting... Now the thumbs...Can you feel that they too are open and separated from the rest of the hand... resting on a support and quite heavy... Feel your heavy separated thumbs...

Orders to the Legs

Hips

The order is: turn your hips outwards... You will feel your knees swing outwards... Now feel this new position at your hips ...

Knees

The order is: move your knees until they are comfortable and then stop... Feel the comfort in your knees...

Feet and Ankles

The order is: push your feet away from your face... Stop... Feel the comfort in your feet... You will have induced relaxation in the muscles in the backs of your legs... Just enjoy the sensation of your limbs lying there where you have arranged them... quite still...resting...

Breathing

I will explain briefly what you have to do and then ask you to perform it three times... Think about your lower ribs and the triangular area enclosed in front between the curves of your lower ribs on either side and your waist below... As your breath in this area, gently expands forwards and to either side slightly lifting your ribs out like the wings of a bird... As you do so the air will flow into and through your nose to fill up your lungs... You have been using your diaphragm but you will not be able to feel its movement as you do not have any suitable sensory nerves there to inform you... Obviously, also, you can not feel it by touch as it lies entirely inside your ribs... but you will feel the result of its work as a slight increase of pressure in your abdomen and in the rib movement... Never hold your breath but when you are ready breathe out slowly and easily, not for unduly long... You will feel your ribs fall inwards and downwards again... Now... breathe in... Feel the area between your lower ribs gently expand forwards and to either side... Breathe out... slowly and gently... Breathe in... Feel your ribs expand... Breathe out... slowly and gently... Breathe in... Feel your ribs expand... Breathe out... slowly and gently...

Orders to the Body

The order is: push your body into the support... Push your body against the chair back... Stop... Feel the support holding your weight... You will be registering this by skin pressure...

Orders to the Head

The order is: push your head into the support... that will be the same direction in which you pushed your body... When you feel the head thoroughly supported, stop pushing... Now feel that support holding your heavy head for you... You will probably find this most comfortable... Enjoy the comfort.

Orders to the Face

Mouth

The order is: drag your chin downwards... Keep your lips closed or your mouth gets dry... You separate your lower teeth from your top teeth and slowly pull the jaw down... Feel as it happens... When your teeth are comfortably separated and you feel your heavy jaw hanging inside your mouth, stop... Now, feel the slackness of your lips and savor this feeling as much as you can... You may also feel the stretching of the skin of your cheeks... Is your tongue fixed to the roof of your mouth? If so, it is in the stress position... Gently loosen it and make it lie in the middle of your mouth... Take your time... feel your tongue loose in your mouth...

Eyes

If your eyes are open, the order is: close your eyes...You lower the upper lids down over the eyes and that is all you do... Stop the movement and feel the result... The result is darkness... This is very pleasurable... Enjoy this darkness...

Forehead

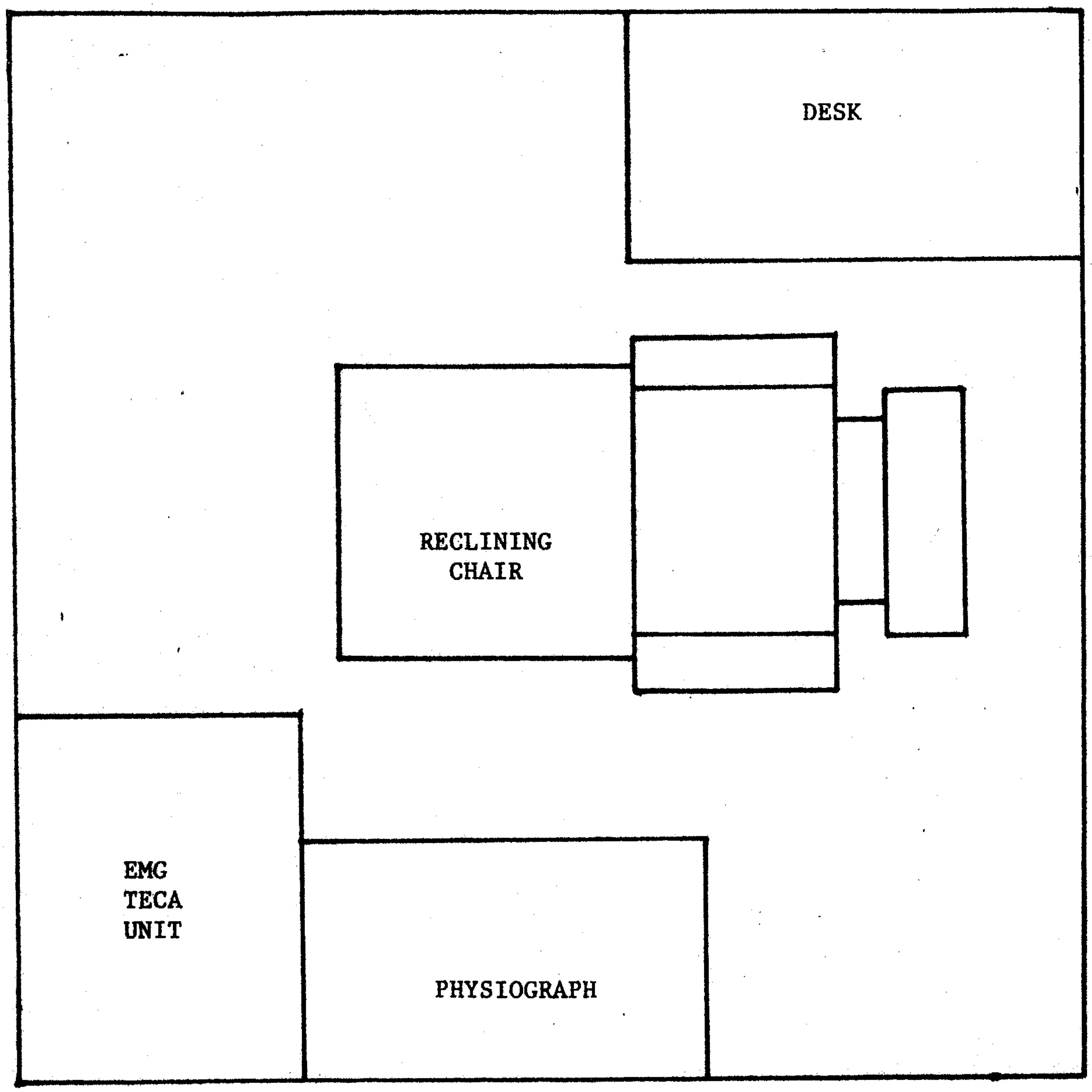
Before you try to smooth this I want to explain that there is a large thin muscle enclosing your head just under your scalp... This is called occipital frontalis and extends from your eyebrows to the lower part of your skull at the back... It is a large close fitting cap which gets smaller when it contracts... It is difficult to relax this muscle as it does not control any joint ... neither does it have an opposite muscle that would assist us ... so try this... Begin to think of the area just above your eyebrows... do not lift these upwards... think of smoothing, up into your hair... over the top of your head... and down the back of your neck... You may feel your hair move... Once more... think of the area just above your eyebrows... think of smoothing up into your hair... over the top of your head... and down the back of your neck... Feel the comfort...

You have now completed the course around the body.... and I hope you find yourself comfortable and enjoying a sense of ease... which you recognize as total relaxation... Stay relaxed and comfortable all over for a few minutes.

— 15 minutes

APPENDIX E

Floor Plan of Laboratory


DESK
RECLINING
CHAIR
EMG
TECA
UNIT
PHYSIOGRAPH

APPENDIX F

Raw Data

STAI (Treatment)

	State		Trait	
	Initial	Final	Initial	Final
S_1	60	34	34	32
S_2	62	62	55	54
S_3	57	47	52	50
S_4	60	28	66	38
S_5	69	27	35	32
S_6	57	29	52	36
S_7	44	37	54	48
S_8	66	37	60	67
S_9	57	38	58	45
S_{10}	45	33	56	54
Mean	57.7	37.2	52.2	45.6

STAI (Control)

	State		Trait	
	Initial	Final	Initial	Final
S_1	54	29	55	45
S_2	50	36	66	61
S_3	56	35	43	42
S_4	50	26	42	47
S_5	56	40	63	56
S_6	57	41	43	42
S_7	45	28	51	48
S_8	52	29	44	42
S_9	52	40	56	51
S_{10}	52	33	43	34
Mean	52.4	33.7	50.6	46.8

<u>EMG</u> (Treatment)

	D_1			D_2			D_3		
Training Periods	I	1	2	I'	3	4	I"	5	6
S_1	116.36	81.15	90.44	125.0	91.56	96.28	110.42	107.10	108.76
S_2	71.70	57.30	76.6	104.3	71.1	80.9	87.2	71.4	92.7
S_3	115.4	95.10	100.0	100.0	70.4	75.0	83.5	61.5	68.9
S_4	90.00	82.5	80.5	90.5	99.4	83.3	137.8	130.7	139.1
S_5	83.30	150.0	105.68	93.6	107.1	106.0	92.68	83.3	72.12
S_6	211.71	217.96	198.26	80.29	104.26	124.04	101.42	121.16	134.12
S_7	155.01	77.8	120.20	86.24	110.42	130.7	82.87	98.14	114.57
S_8	209.02	143.20	153.34	96.90	112.08	122.10	107.93	125.0	96.90
S_9	112.08	131.84	134.12	91.56	107.10	123.08	121.16	132.98	147.28
S_{10}	130.70	143.20	156.68	102.13	121.16	139.12	109.59	124.04	143.20
Mean	129.5	118.1	121.6	97.1	99.5	108.1	103.5	105.5	111.8

<u>EMG</u> (Control)

Training Periods	D_1 I	D_1 1	D_1 2	D_2 I'	D_2 3	D_2 4	D_3 I"	D_3 5	D_3 6
S_1	92.7	107.1	121.2	108.8	128.52	145.92	127.3	139.0	156.7
S_2	126.1	135.3	147.3	136.4	145.9	147.3	127.3	134.12	153.3
S_3	121.16	126.14	140.48	107.10	120.20	140.48	107.10	128.42	145.92
S_4	134.12	148.64	158.35	119.24	140.48	156.68	126.14	143.2	155.01
S_5	128.42	145.92	160.02	105.68	110.42	124.04	99.38	104.97	115.40
S_6	134.12	141.84	155.01	114.57	127.28	140.48	136.40	144.56	156.68
S_7	163.36	166.7	166.7	124.04	130.7	147.28	84.28	97.52	115.40
S_8	100.	123.08	137.76	118.28	136.4	147.28	124.04	126.14	130.70
S_9	103.55	123.08	140.48	137.76	137.76	136.40	87.71	102.84	118.28
S_{10}	161.69	139.12	166.7	72.12	93.80	107.93	84.28	96.28	113.74
Mean	126.5	1 5.7	149.4	114.4	12.71	139.4	110.4	121.7	136.1

GSR (Treatment)

		D_1			D_2			D_3	
Training Periods	I	1	2	I'	3	4	I"	5	6
S_1	0.4	0.47	0.38	0	0.43	0.03	0.29	0.67	1.05
S_2	0.45	0.16	0	0.33	0.81	0.56	0.09	1.02	0.37
S_3	0	0.25	0.28	0.21	0.45	0.48	0.94	1.14	0.99
S_4	0.78	1.46	1.53	0.05	1.12	0.87	0	1.18	1.01
S_5	0.93	0.98	1.52	2.69	1.78	1.20	1.73	1.48	1.33
S_6	0	0	0	0	0	0	0	0	0
S_7	0	0.58	0.32	0	0.53	0	0.22	0.56	0.46
S_8	0.24	0.30	0.23	0.57	0.85	1.02	0.27	0.41	1.19
S_9	0.08	0.45	0.34	0.03	0.56	0.51	0	0.18	0.16
S_{10}	0.81	1.62	1.38	0.73	1.20	0.86	0.70	2.53	1.65
Mean	0.36	0.63	0.60	0.46	0.77	0.55	0.42	0.92	0.82

GSR(Control)

	D_1			D_2			D_3		
Training Periods	I	1	2	I'	3	4	I"	5	6
S_1	0.48	0.22	0.75	0	1.90	0	0	0	0
S_2	0	0.17	0.05	0	0.44	0.29	0.13	0.64	0.5
S_3	0	0.15	0	0	0.22	0.08	0.24	0.42	0.08
S_4	0	0.39	0.34	0.08	0.24	0.33	0.75	1.96	1.13
S_5	0	0	0	0	0.13	0.04	0	0	0
S_6	0	0.12	0.27	0.12	1.17	1.12	0	0.63	0.32
S_7	0	0.57	0	0.20	0.43	0.15	0	1.25	0.05
S_8	0	0	0	0.09	1.06	0.83	0	0.33	0.38
S_9	0	0	0	0	0	0	0	0	0
S_{10}	0	0	0	0.02	0.47	0.39	0	0	0
Mean	0.48	0.16	0.14	0.051	0.61	0.32	0.11	0.52	0.25

<u>RR</u>(Treatment)

	D_1			D_2			D_3		
Training Periods	I	1	2	I'	3	4	I"	5	6
S_1	19	14	16	21	19	17	20	15	13
S_2	18	17	15	18	14	16	18	16	16
S_3	15	13	13	14	14	14	14	14	14
S_4	16	14	16	20	17	15	17	15	11
S_5	11	9	5	10	6	7	10	10	9
S_6	15	8	10	12	7	10	13	11	9
S_7	15	17	16	20	19	18	18	18	17
S_8	17	14	14	17	13	14	18	16	15
S_9	15	14	10	13	8	8	14	15	11
S_{10}	16	15	16	16	15	15	16	13	14
Mean	15.5	13.5	13.1	16.1	13.2	13.4	15.8	14.3	12.9

RR(Control)

	D_1			D_2			D_3		
Training Periods	I	1	2	I'	3	4	I"	5	6
S_1	14	11	14	16	13	13	18	14	18
S_2	21	17	19	20	19	20	20	19	20
S_3	16	19	13	14	18	15	15	16	15
S_4	15	17	17	21	18	19	20	18	19
S_5	12	10	10	12	9	9	13	9	12
S_6	16	13	15	14	13	14	14	13	14
S_7	8	9	10	11	11	8	7	10	8
S_8	19	16	16	21	16	17	17	17	16
S_9	17	16	16	20	15	18	20	16	14
S_{10}	15	13	13	15	14	14	15	15	16
Mean	15.3	14.1	14.3	16.4	14.6	14.7	15.0	14.7	15.2

$\underline{BP}_{(S)}$ (Treatment)

Training Periods	D_1 I	1	2	D_2 I'	3	4	D_3 I"	5	6
S_1	109	98	102	88	94	90	96	92	100
S_2	95	92	90	98	90	90	92	40	88
S_3	110	100	102	110	100	100	108	100	98
S_4	90	92	86	86	82	80	92	94	98
S_5	115	110	112	115	114	112	116	114	116
S_6	105	100	90	104	106	110	116	106	108
S_7	90	96	90	100	98	96	100	95	94
S_8	104	98	102	94	90	88	108	95	100
S_9	104	100	98	119	100	101	110	108	108
S_{10}	120	100	108	125	108	110	112	104	104
Mean	104	98	98	104	99	98	105	100	101

$\underline{BP}_{(S)}$ (Control)

		D_1			D_2			D_3	
Training Periods	I	1	2	I'	3	4	I"	5	6
S_1	86	90	104	94	98	94	98	96	103
S_2	90	88	94	104	92	93	92	89	85
S_3	110	100	108	102	100	98	104	94	110
S_4	98	92	94	103	99	102	106	106	108
S_5	122	119	118	116	122	120	114	118	122
S_6	124	112	114	116	104	106	104	104	110
S_7	110	116	112	108	98	96	118	104	109
S_8	105	98	104	100	98	94	98	98	94
S_9	88	83	86	84	76	82	84	82	80
S_{10}	94	96	94	86	78	80	88	88	92
Mean	103	99	103	101	90	96	101	98	101

HR (Treatment)

	D_1			D_2			D_3		
Training Periods	I	1	2	I'	3	4	I"	5	6
S_1	57	54	58	60	54	62	61	56	51
S_2	51	50	47	51	49	49	46	44	45
S_3	60	56	49	64	56	55	60	58	58
S_4	64	62	63	66	65	65	66	58	63
S_5	52	52	52	59	56	55	58	56	54
S_6	99	94	93	89	76	77	83	79	80
S_7	60	55	55	59	59	58	48	48	51
S_8	59	56	56	65	55	50	80	76	60
S_9	52	51	51	50	47	50	56	51	53
S_{10}	52	46	45	44	41	45	49	45	47
Mean	60.6	57.6	56.9	60.7	55.8	56.6	60.7	57.1	56.2

HR (Control)

		D_1			D_2			D_3	
Training Periods	I	1	2	I'	3	4	I"	5	6
S_1	79	72	68	73	62	67	78	74	74
S_2	90	88	87	96	96	92	98	92	85
S_3	62	54	54	52	49	51	55	50	52
S_4	50	49	48	56	50	52	52	50	51
S_5	76	72	76	74	74	72	76	70	73
S_6	60	57	52	65	64	68	62	59	57
S_7	57	52	50	48	48	43	57	50	47
S_8	83	76	77	77	71	70	86	72	71
S_9	65	58	55	68	61	62	73	68	74
S_{10}	57	51	50	52	50	50	52	51	53
Mean	67.9	62.9	51.7	66.1	62.5	62.7	68.9	63.6	63.7

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