5-1974

The Use of E.M.G. Biofeedback to Promote Relaxation and Relief of Chronic Low Back Pain

Esther Fashina

Dorothy Holm

LOMA LINDA UNIVERSITY

Graduate School

THE USE OF E.M.G. BIOFEEDBACK TO PROMOTE RELAXATION AND RELIEF OF CHRONIC LOW BACK PAIN

A Thesis in Partial Fulfillment

of the Requirements for the Degree

Master of Science

in the Field of Nursing

May 1974

by

Esther Fashina and Dorothy Holm

Each person whose signature appears below certifies that this thesis in his opinion is adequate, in scope and quality, as a thesis for the degree Master of Science.

Dorothy M. Martin, Chairman
Dorothy M. Martin, Professor of Nursing

Lucile Lewis
Lucile Lewis, Professor of Nursing

Clarence E. Carnahan
Clarence E. Carnahan, M.D., Associate Professor of Psychiatry.

ACKNOWLEDGMENTS

We wish to acknowledge those persons who have contributed to making this research study possible. A special thanks goes to our advisor, Dr. Dorothy Martin, Professor of Nursing, who was a constant source of help and encouragement. We are also grateful for the counsel and assistance of the other members of our thesis committee, Miss Lucile Lewis, Professor of Nursing, and Dr. Clarence Carnahan, M.D., Associate Professor of Psychiatry.

We wish to express our gratitude to Dr. Grenith Zimmerman for her help with the statistical analysis of our data. Thanks is also rendered to Dr. Lois Ritchie, M.D., Dr. Donald Peterson, M.D., and to staff members of the emergency department and the employee health service departmemt of Loma Linda University Medical Center for their cooperation and assistance in various ways.

The opportunity for advanced study, of which this research project was a part, was made possible by the financial assistance from traineeship grants from the Department of Health, Education and Welfare of the United States. We are sincerely grateful for this assistance.

Finally, we wish to express our appreciation to our husbands, Mr. Samson Fashina and Dr. Melvin Holm, for their encouragement and advice during the time of this study, and to our children for their patience and understanding.

Esther Fashina

Dorothy Holm

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Pain in the lumbo-sacral region of the back is a common symptom and an important cause of loss of work-time in industry, (Smith et al., 1971, p. 360; Beal and Hickman, 1972; Shealy, 1974). The sufferers from low back pain also comprise the largest group of disabled persons of all psychogenic disorders (Sternbach, 1973c). Beal and Hickman reported that 1.25 million Americans sustain injuries to their back and spine annually and about 65,000 of these have some permanent disability (Beals and Hickman, 1972). The problem of low back pain affects the national economy adversely in terms of loss of work, time, and money. Sternbach and his associates (1973c) estimated that this single disorder costs about a billion dollars each year in America. In addition to industrial claims, these patients also seek medical and surgical relief continuously, thereby increasing the demand on the health care system.

NEED FOR THE STUDY

Patients suffering from low back pain are often treated with bed rest, analgesics, muscle relaxants, sedatives as well as physical therapy measures. Tranquilizers may be prescribed to treat the depression which often accompanies low back pain. Since there is no drug without some undesirable side-effects, pain relief without medicine would be desirable.

Rest is a measure that has been given high priority in the treatment of low back pain (Clanville, 1972). However, before patients can benefit fully from rest, they need to learn how to relax. Jacobson (1938)

pointed out that many patients who are put on bed rest are just lying in bed but are not really resting because they do not know how to relax, and that the average person needs training before he can truly relax (pp. 2, 38). This view is also supported by Jacobs and Felton (1969), who wrote that when many patients are asked to relax by their physicians they tense their muscles instead of relaxing them. The above findings point to the need of a relaxation training program that will include some objective measure to show the patients how they are progressing. Relatively inexpensive, self-applied measures that contribute to the relief of low back pain would be welcomed by physicians, nurses and patients as well.

PURPOSE

The purpose of this exploratory study was to determine if relaxation achieved by planned instruction and the use of electromyographic (E.M.G.), biofeedback would reduce low back pain and consequently reduce the amount of medication taken for the relief of the pain. A secondary aim of the study was to determine whether persons with internal locus of control would be able to achieve more positive results from the relaxation training, than those with external locus of control.

DEFINITION OF TERMS

1. Electromyograph (E.M.G.): An instrument used to measure the level of summated surface muscle voltage.
2. Audio E.M.G. Feedback: An auditory signal the pitch and volume of which is directly related to the level of summated surface muscle voltage.
3. Visual E.M.G. Feedback: A visual display on a dial which is directly related to the level of summated surface muscle voltage.

4. Chronic Low Back Pain: Pain in the lumbo-sacral region of the back that persisted for three months or longer.
5. Relaxation Sessions: A period of thirty minutes during which muscle relaxation technique was taught, and the level of relaxation achieved was monitored with E.M.G. Biofeedback.

CONCEPTUAL FRAMEWORK

The conceptual basis of this study is founded on the relationship between pain and relaxation, and biofeedback as a positive reinforcement of learning. Muscle tension and spasm have been identified as factors which aggravate pain (Egbert et al., 1964; Guyton, 1971, pp. 579-582). Low back pain is one type of pain which is intensified by muscle spasm (Cailliet, 1968, p. 19; Guyton, 1971, p. 582; Freyberf, 1970, p. 212). In fact, Freyberg wrote that "pain in the back frequently results from spasm of muscles, which occurs as part of a protective mechanism for a lesion in the spinal column", (Freyberg, 1970, p. 212). Kessler, (1955) also views muscle spasm as a reflex action designed to protect and immobilize the lumbo-sacral joint (p. 56). It has also been pointed out that there is a viscious cycle between pain and muscular spasm. Muscle spasm augments pain, and in turn pain may initiate muscular spasm at the local level (Guyton, 1971, pp. 582, 659; Cailliet, 1968, p. 19). The following physiological reasons are given for muscle spasm causing pain:

(1) Muscle spasm increases metabolism of the local area affected and thereby increases the demand for blood supply with possibility of demand for blood flow exceeding the vascular capability.

(2) Muscle spasm leads to ischemia in local tissues affected which, in turn, leads to the production of

acidic metabolic end-products or tissue degenerative products that stimulate the pain nerve endings (Guyton, 1971, pp. 582-83).

(3) Muscle spasm aggravates low back pain in particular because it causes irritation and compression of the interposed intervertebral disk and nerve roots (Cailliet, 1968, p. 19).

Anxiety has been recognized as having a major influence on pain. When the anxiety level is high, pain perception and response are also high. Sternbach wrote that the individual's response to pain is largely determined by his capacity for and style of dealing with anxiety. He observed that persistent pain was more common with neurotic patients who had a high level of anxiety (Sternbach, 1968, p. 160). There are many reasons for anxiety to be a major factor in patients with low back pain, among them is the disabling nature of the syndrome.

Because of the relationship between anxiety, muscle spasm and low back pain, it seemed logical that muscular relaxation could relieve the pain by reducing the anxiety and the muscle spasm. According to Gellhorn (1958), neuromuscular relaxation lessens cortical excitability due to reduction in proprioceptive impulses from the muscles. Jacobson believed that as neuromuscular relaxation deepened, emotions and other mental activities subsided (1967, p. 151). Aiken (1971) used relaxation training with cardiac patients to reduce their stress and anxiety. Other investigators have successfully used relaxation and E.M.G. biofeedback to relieve the pain of tension headaches (Budzynski, Stoyva and Adler, 1970; Sargeant, Green and Walters, 1972; Fichtler and Zimmerman, 1973). Gessel and Alderman (1971) found muscle relaxation training helpful for six out of eleven subjects suffering from myofacial pain.

Jacobson differentiated true relaxation from ordinary rest, and advocated a training program as the best method for the average person to learn relaxation (1967, p. 17).

Numerous investigators have used behavioral modification to facilitate the learning of responses beneficial to health (Berni and Fordyce, 1973, pp. 8-10, 19-25; Green and associates, 1969; Fordyce, 1968). Behavioral modification and operant conditioning are based on the learning theory which states that the probability of a behavior occurring is increased when the behavior is associated with a positive reinforcement (Piggot, 1969). Desired bodily responses could be reinforced by electromyographic biofeedback and verbal encouragement.

The concept of locus of control is based on the social learning theory as set forth by Rotter, (1966). This describes the degree to which an individual believes that his reinforcements are contingent on his own behavior. Those who feel that they are able to control their own behavior and destiny to a marked degree are said to have greater internal locus of control. Those who believe that their reinforcements are under the control of others, fate, or other outside forces are said to have external locus of control. Recent laboratory investigations concerning the parameters of autonomic conditioning have suggested a relationship between success in learning by operant conditioning, biofeedback measures and locus of control (Ray, 1971). There appears to be a relationship between the locus of control variable and an individual's awareness of his reinforcements (Strickland, 1962), the degree and direction of his response to conditioning (Ray, 1971; Fotopoulas, 1970) and his tendency to resist outside influences (Getter, 1966; Biondo and MacDonald, 1971). Since biofeedback conditioning seems to exemplify control by the self, there may be a relationship between success in learning

relaxation therapy and locus of control.

Chronic low back pain is a source of considerable suffering for many, many patients. The condition challenges nurses and points out a need for more alternative measures for relief of pain. If relaxation training were successful in diminishing pain, it could be added to the alternatives available for nursing intervention. When a measure without known undesirable side effects becomesavailable, it could be used as a substitute for or an adjunct to medication. Another advantage of relaxation training could be the part that the patient could have in relieving his suffering by a means within his control.

HYPOTHESES

Based on the conceptual framework and the purpose of the study, the following working hypotheses were proposed to guide the conduct and analysis of this exploratory study:-

1. Subjects who learn to relax with the use of E.M.G. biofeedback and relaxation instruction will report a general decrease in the intensity of their low back pain as the sessions progress.
2. Subjects with low back pain who participate in the relaxation training program will use less medications (pain medications, muscle relaxants, sedatives and tranquilizers) as the training sessions progress and after the training is over, than before they learned to relax.
3. Subjects who reported a decrease in the intensity of pain during the relaxation training sessions will report that the improvement in their low back pain has been maintained for two more weeks after discontinuing the training sessions.
4. Subjects with chronic back pain who have an internal locus of control will achieve more positive results than those whose locus of control is

external (i.e. those with internal locus of control will be able to relax more, reduce the intensity of their pain more and reduce the amount of medications that they take for their pain more than those with external locus of control).

ASSUMPTIONS

The following conditions were assumed to be true and were not tested during the study:

1. Relaxation will reduce muscle tension and spasm.
2. The subjects will give an honest subjective report of pain.
3. The subjects will give an honest response to the various questionnaires.
4. Records of medications taken for low back pain will be accurate.
5. The number of pain medications taken is an index of the intensity of pain.

METHOD

Patients with chronic low back pain aged 26 to 62 years were the subjects of this exploratory study. Each patient served as his own control. The training was done with the use of E.M.G. audio and visual feedback and the reading of relaxation instructions (Appendix F) to the subjects. The subjects were also required to practice relaxation two times daily at home, for fifteen to thirty minutes each time. The effect of the relaxation training on pain was measured subjectively and objectively by comparing pain rating scales, the number of medications taken and E.M.G. recordings before, during and after the training sessions.

CHAPTER II

REVIEW OF RESEARCH AND RELATED LITERATURE

I. INTRODUCTION

The problem of pain has challenged man since the beginning of time. Many attempts have been made at defining and analyzing this complex psychophysiological response with the hope that an increased understanding of the nature of pain would enable man to deal more effectively with suffering. According to Engel, pain can be defined on the basis of its clinical characteristics as "a basically unpleasant sensation referred to the body, which represents the suffering induced by the psychic perception of real, threatened or phantasied injury" (Engel, 1970, p. 45). Pain is an abstract concept which is influenced by the physical, mental and social aspects of life. It can best be defined by the subject experiencing it and therefore evaluations of pain must depend largely on subjective responses (McCaffery, 1972, p. 8; Engel, 1970, p. 44-46).

Pain refers to sensation, stimulus and response (Sternbach, 1968, p. 12). It involves a variety of feelings on both the somatic and psychological levels. Bodily pain is most commonly thought of as being the result of stimuli due to physical and chemical agents. Tension and pressure are among these physical agents. Sometimes the causative physical stimulus is not obvious and psychosomatic and psychogenic factors may be the major contributors toward the particular pain experience (Keele, 1967; McCaffery, 1973, p. 2-3).

It is beyond the scope of this study to deal with all aspects of

the pain experience and its alleviation. We have confined ourselves chiefly to literature that concerns: (1) The interrelationship between muscle spasm, anxiety, pain and relaxation and (2) Certain aspects of chronic low back pain. Literature has also been reviewed in two areas that relate to the methodology of the experimental aspects of the study. These areas are: (1) Research studies that are concerned with the facilitating effect of electromyographic feedback on muscular relaxation and pain relief; (2) The relationship between the locus of control dimension and those factors that may influence an individual's ability to benefit from electromyographic feedback learning.

II. THE INTERRELATIONSHIP OF MUSCLE SPASM, ANXIETY, PAIN AND RELAXATION

Muscle spasm and pain. Muscle spasm and ischemia are important causative factors of pain. One reason why muscle spasm causes or increases pain may be that spasm causes compression of the intramuscular blood vessels, which in turn, leads to ischemia in specific areas. It is believed that bradykinin or histamine are produced due to tissue ischemia and that these chemicals stimulate the pain receptors. Spasm also increases local metabolism. Muscle spasm also increases the local metabolic rate to the point that there is a painful response (Engel, 1970, p. 57; Guyton, 1971, p. 579).

Pain causes both reflex motor reactions and psychic reactions. Among the psychic reactions are anxiety and muscular excitability. Hence there is a vicious cycle between pain and muscle spasm. Pain is aggravated by muscle spasm and muscle spasm is caused at the local level by pain (Guyton, 1971, p. 581-82, 659).

Anxiety and Pain. There is evidence that increased anxiety is

associated with increased pain. This may be because there is a tendency for the pain threshold to be lower and the emotional responses to be higher in the presence of anxiety (Folkins, 1968; Sternbach, 1968, p. 160; Thomson, 1965). Lynn and Eysenck (1961) state that anxiety decreases the pain tolerance. Guyton maintains that the pain threshold remains fairly constant but that the response varies (Guyton, 1971, p. 581).

Anxiety and Tension. In a series of experiments, Jacobson, (1938) demonstrated that increased muscular contraction accompanies states of nervous irritation and excitement. Muscle tension has been found to be high in states of anxiety; hence some have proposed that muscle relaxation and anxiety are incompatable (Jacobson, 1938, p. XV, 396-411; 1967, p. 151; Wolpe, 1958, p. 72). This hypothesis has been tested by several investigators with varying degrees of support (Goldstein et al., 1964; Jacobson, 1967, p. 85-118; Mathew and Gelder, 1969; Wilson and Wilson, 1970). Wilson and Wilson (1970) found only partial support for this hypothesis. They studied a group of sixty-three general medical patients in a veteran's hospital and found that relaxation only decreased the anxiety in the high anxiety group. Goldstein and associates (1964) studied depressed patients with structured interviews. They produced varying degrees of anxiety in these patients and found that some individuals responded with autonomic activation, some with muscle tension and others with overt muscular activity.

If tension and anxiety intensify the problem of pain then it appears that relaxation should help to modify discomfort.

Relaxation. Jacobson (1967) states that real relaxation differs from ordinary rest in that in ordinary rest, skeletal and smooth muscle are only partially relaxed (p. 17). With training, states of deeper relaxation may be achieved.

Several approaches have been used in an effort to promote muscle relaxation and relieve tension-related problems. Jacobson (1938) developed a series of exercises to teach progressive relaxation (p. 42-80). Wolpe and Lazerus (1966) modified Jacobson's technique and integrated it into a program they called systematic desensitization (p. 177-180). Shultz and Luthe (1959) used autogenic phrases with suggestions of warmth, heaviness and serenity (p. 13-95). Others have attempted to teach relaxation by the use of hypnosis, alpha brain wave training, electromyographic feedback, or a combination of two or more of these methods (Green et al., 1969; Barber and Hahn, 1963; Mathews and Gelder, 1969).

Cailliet (1968) states that relaxation of muscle spasm is an important element in the treatment of intervertebral disk herniation syndrome (p. 110).

III. CHRONIC LOW BACK PAIN

The back is exposed to many sources of injury and lesions due to its multiple functions and its anatomical relationship with other parts of the body. Many back pains are caused by muscular spasms which may arise from elsewhere in the body. Pain in the back also frequently results from muscle spasm which occurs as a protective mechanism for a lesion in the spinal column. The majority of intervertebral disc lesions occur in the lumbar region around the fourth and fifth lumbar vertebrae, accounting for the high incidence of low back pain and sciatica (Guyton, 1971, p. 587, 582; Freyberg, 1970, p. 212' Mersky and Spear, 1967, p. 56).

Psycho-social aspects of chronic low back pain. Chronic pain has been found to be influenced by many factors. Severe emotional stress may activate psycho-physiologic mechanisms that cause muscle spasm, vasoconstriction and visceral disturbances which lead to chronic pain (Bonica,

1973, p. 82). Positive reinforcement by people in the environment of the chronic sufferer may increase the pain and associated behavior (Fordyce, 1973).

Psychosocial factors play as important a role in low back pain as they do in other forms of chronic pain. Although some people who complain of backache have no organic disease, some physical findings are present in most of these patients. These physical findings, however, may not account for all the pain (Freyberg, 1970, p. 212; Sternbach, 1973b).

In a study of one hundred and seventeen patients with low back pain, Sternbach and associates (1973a, 1973b) found that these patients scored higher on the invalidism and depression scale than did normal subjects or those with rheumatoid arthritis. Patients whose litigation (court action to get social security, industrial compensation and other benefits) was yet unsettled had a poor prospect for improvement.

Levy (1955) reported that careful study of certain patients with low back pain revealed unusual locations of the pain, or bizzare radiation which did not conform to any anatomical pattern.

Acute pain is often a sign of bodily injury, but chronic intractable pain is often a sign of the sufferer wishing a sick role and may constitute a career which the patient does not want to relinquish. This may be true of some patients with low back pain (Szaz, 1968; Sternbach et al., 1973b)

IV. BIOFEEDBACK

> Biofeedback .... refers to techniques whereby the bioelectric analog of physiological responses is connected to visual, auditory or tactile display which is seen, heard, or felt by the user. Because information about the physiological response is brought back to the brain via an external path, the technique is called biofeedback (Mulholland, 1972, p. 1).

Biofeedback training is based on two factors that are part of the

theory of operant conditioning: the immediate knowledge of what is happening and the systematic shaping of the response (Budzynski and Stoyva, 1969). This immediate knowledge of the event is important because "a variable cannot be controlled unless information about the variable is available to the controller" (Gaarder, 1972, p. 50). Biofeedback conditioning differs from operant conditioning in that it does not give an explicit reward for a correct response. The compelling valence of operant conditioning may have greater motivational value than the more neutral type of feedback given by the dial or sound of a machine (Gaarder, 1972).

Biofeedback and muscular relaxation. Jacobson (1938) first developed a string galvanometer that measured electrical activity of skeletal muscle at a fractional microvolt level. He used this equipment to measure the effectiveness of his progressive relaxation techniques and noted that relaxed patients had lower muscular electrical activity than those who were tense (p. 310-311). This process of recording the very small bioelectric potentials of the muscle fibers became known as electromyography.

It is only within the last the to twelve years that the electromyograph as an instrument for teaching muscle relaxation has come into wider use.

Basmajiian (1963) showed that under experimental conditions, a subject could be taught to relax and tense a specific motor unit at will, within a short period of time if he was supplied with cues of the activity within that motor unit. All sixteen of his subjects were able to learn to do this within fifteen to thirty minutes. They also learned to relax and activate whole muscles. Other investigators had similiar results (Harrison and Mortenson, 1962; Carlsoo and Edfeldt, 1963; Baginsky, 1969). The facilitating effect of electromyographic feedback on voluntary muscle

control was demonstrated.

It was noted that relaxation could spread from one muscle to another or a subject could learn to isolate relaxation to a specific muscle (Green et al., 1969).

Jacobs and Felton (1969) saw therepeutic possibilities in the use of E.M.G. feedback measures. They monitored the myoelectric activity of the trapezius muscle of ten normal subjects and ten subjects who had sustained neck injuries and found that visual feedback facilitated relaxation of the trapezius in both groups.

Budzynski and Stoyva, (1969) used E.M.G. feedback to produce deep muscle relaxation. Their fifteen subjects were able to reduce their muscle action potentials by fifty percent within a training period of only three, thirty-minute sessions. Control subjects who received no feedback decreased their recorded E.M.G. tension levels by only twenty-eight percent during the same period of time.

E.M.G. recordings from some parts of the body seem to be more easily reduced by relaxation attempts than others. Balshan (1962) found that the following muscles are the best indicators of overall muscle tension: trapezius, neck extensors, frontalis, biceps, forearm, quadriceps and gastrocnemius. In a later study, it was noted that certain personality factors correlated with tension in specific muscles. People who were high in trait anxiety and depression, and who were low in emotional stability exhibited the greatest increase in trapezius tension. In some individuals, the tension may dominate in the head-neck-back region while others may tend to have dominent tension in the limbs (Skipman et al., 1964).

E.M.G. biofeedback and chronic low back pain. We are aware of the fact that at least one other group of investigators are using E.M.G.

feedback for teaching deep muscle relaxation to patients with chronic low back pain in conjunction with other rehabilitative measures. To date no reports of this type of program are found in scientific literature.

V. LOCUS OF CONTROL

It is widely recognized that reinforcements and rewards are factors that mold human behavior and influence man's acquisition of knowledge and skill. An individual tends to behave in a way that, past experience has taught him, will bring him the greatest reward in a particular situation (Rotter, 1966; Dua, 1970). Because of experiences with success and failure in the past, some individuals tend to become highly dependent on forces outside of themselves for reinforcement. Rotter labeled these people as having a greater "external locus of control". In contrast, there are those who believe that their destiny is largely contingent on their own actions and that they can exercise control over their reinforcements. These are said to have a greater "internal locus of control". Most individuals rank somewhere on the continuum between the two extremes. It is possible that the feeling that one can control his environment may be related to the feeling that one can control himself (Rotter, 1966).

Locus of control and motivation. Motivation is of prime importance in determining the success of biofeedback training (Lawrence, 1972, p. 100). It is suggested that the difference between the "externals" and the "internals" is one of expectancy rather than of motivation (Rotter, 1966; MacDonald, 1970). Tseng, (1970) found that both groups may be equally motivated in that they want to bring about change and avoid failure. The "externals", however feel powerless because they do not believe that they have the ability or the opportunity to influence their future (Seeman and Evans, 1962). There may be a relationship between a person's

belief that he can control his rewards and his tendency to try to exert such control (Lefcourt, 1966). Feather (1963) suggests that expectancy may constitute one of the motivational factors that helps an individual decide how to achieve a relevant goal.

Locus of control and learning and achievement. A number of research studies have been done to try to establish some relationship between the expectancy variable and learning. In a study of hospitalized tuberculosis patients, Seeman and Evans (1962) found that there was an association between "powerlessness" and poor learning. The "internals" had a greater knowledge of their disease condition than their "external" counterparts.

Differences in the learning rate may depend on the nature of the material being learned. In a study of reformatory inmates, Seeman (1963) found that the "internals" learned more rapidly only when the information was relevant to personal control of important goals. Phares (1968) found that the "internals" were more able to utilize the information they received but that they did not differ from the "externals" in the amount of material they learned. There is some evidence that "externals" may not perform as well under skill conditions (Rotter and Mulray, 1965; Julian and Katz, 1968). Internal subjects seem to improve more under self reliance conditions (Cromwell et al., 1961).

Locus of control and pain and anxiety. There is some indication that an individual's belief in his own lack of control tends to produce anxiety (Watson, 1967; Ray and Katahn, 1968). On the basis of the idea that anxiety increases the perception of pain, Bowers (1968) hypothesized that greater externality of control might be related to the increased perception of pain. His study, conducted on thirty-two male students, did not bear this out. The "externals", though more anxious, tended to

perceive the experimental shock as slightly less painful than did the "internal" subjects.

In a study of sixty-two female patients who had undergone abdominal surgery, Johnson and Leventhal (1971) found that the "internals" tended to obtain more analgesic medicine. Perhaps this was so because these patients believed they could influence their care and therefore felt more free to ask for medication.

Locus of control and conditioning. The reaction of an individual toward attempts to influence him may vary according to his general expectancy. The "internals" seem to be more resistive to subtle attempts to influence them (Getter, 1966). Biondo and MacDonald (1971) found that the "externals" tended to conform more readily to both high (overt) and low (covert) levels of influence, whereas the "internals" tended to resist high level influence. In verbal conditioning trials of one hundred-and eight undergraduate students, Getter (1966) found that the "externals" conditioned more easily. The "internals" were more likely to experience latent conditioning. Strickland (1962) found that there was no difference in the rate of conditioning between the two groups though the "internals" were more aware of the reinforcements. Others noted similiar response (Ude and Vogler, 1969).

As biofeedback training is of relatively recent origin, studies relating biofeedback measures to the expectancy variable are few. Fotopoulas (1970) tested the ability of thirty-two subjects to increase their heart rate by thinking, under feedback and no-feedback conditions. The "internals" were able to increase their heart rate under both feedback and no-feedback conditions, with an average increase of 1.14 beats per minute in the latter condition over the former. "External" subjects were unable to raise their heart rate by thinking alone. They were,

however, able to do almost as well as the "internals" when they were given information feedback from an oscilloscope. Ray and Lamb (1974) had similiar results. The fact that the "externals were unable to increase their heart rate in the absence of feedback may "indicate that they are less sensitive to internal signals" (Shapiro et al., 1972, p. 304).

Ray (1971) studied forty subjects for their ability to control heart rate. He found feedback measures to be facilitating. "Internal" subjects were found to have greater ability to raise their heart rate and "external" subjects in lowering the rate. Subjects reported using different strategies to bring about the rate changes.

Intensive biofeedback training may alter an individuals locus of control. Leeb (1974) reported that after an intensive two-day multimodality feedback training session of 14 volunteers, most of his subjects tended to become more internal in their control expectations and reported a greater sense of self-esteem. A few, however, shifted toward the external end of the scale. These reported that they found the relaxation training quite stress-producing.

CHAPTER III

METHOD OF STUDY

The problem of this study was to determine if general relaxation, taught in six electromyographic (E.M.G.) feedback sessions would help to moderate or alleviate back discomfort and/or decrease the amount of medication required by a selected group of adult subjects who suffered from chronic low back pain. A second aspect of the problem was to determine if there was any relationship between the control expectancy variable and the degrees of success that the subjects might achieve from the training session.

Selection of a research method. The exploratory method was selected as the one most appropriate for achieving the purposes of this study. The one-group method was used in that each of a group of individuals participated in a single treatment plan and the results were measured. Each subject served as his own control. A baseline for each participant's pain and medication level was established on the basis of a record of the three days prior to the first relaxation training session.

Criteria for the selection of subjects. Selection of the sample subjects was done using the convenience sampling method. The criteria for the selection of subjects were as follows:

1. Age range of 21 to 65 years
2. Absence of any disability that might make positioning difficult
3. Ability to communicate (read, write and speak) in the English language at the level that enabled the subject to understand verbal and

written instructions and to answer the questionnaires

4. Ability to see and hear so as to be able to observe the electromyograph microvolt meter signals and to hear instructions, verbal discussion and the audiofeedback signals

5. Voluntary participation in the study

6. Should not be an in-patient in the hospital

7. Have had a problem with low back pain for at least three months

8. Be referred by a physician or have his physician's consent to his participation in the training program.

The researchers. The two researchers were registered nurse graduate students. Each subject was followed throughout his entire program by the same researcher. The tools, the setting and the procedure used by each researcher were identical.

The tools. The tools used in the study consisted of the following:

1. A brief interview record, which was used by the researcher during the first interview with the prospective subject in order to gain some basic information that might be relevant to the study. (Appendix A)

2. Rotter's Internal-External Scale. This is a twenty-nine item forced choice questionnaire which consists of twenty-three test and six filler items. This scale has been widely used and its test-retest reliability has been shown to be satisfactory, ranging between .49 and .83 for a variety of samples and intervening time periods (Hersch and Scheibe, 1967). The results obtained by the use of this scale have been fairly consistent with other measures for the same variable (Rotter, 1966). In this study Rotter's Internal-External scale will be referred to as the I-E Scale. (Appendix B)

3. A card was prepared for the subject to use for recording (1) the amount of analgesic, sedative, relaxant or tranquilizing medication that he required each day; (2) his own evaluation of the amount of discomfort he suffered in his low back each day, and (3) the number of times that he practiced relaxation at home. This record was referred to as the Daily Record. (Appendix C)

The measurement of the intensity of pain has been a problem to researchers since no currently available method seems to be accurate in all situations. Ernest Hilgard (1967), a psychologist who studied pain extensively wrote "there is no physiological measure of pain which is either as discriminating of fine differences in stimulus conditions, as reliable upon repetition or as lawfully relating to changed condition, as the subjects verbal report" (p. 107). Several researchers have used graded scales on which a record of the severity of the pain was recorded at regular intervals by the subject (Hewer et al., 1949; Keele, 1948; Houde, Wallenstein and Rogers, 1960). Lasagna (1960) suggested that daily recording of the pain evaluation rather than relying on memory is likely to provide more accurate data. Medication records have been used to evaluate pain intensity (Egbert et al., 1964).

Home practice sessions between E.M.G. biofeedback sessions have been found to be useful (Green et al., 1970; Peper, 1973; Raskin et al., 1973). The purpose of the recording of these sessions was to encourage subjects to practice faithfully.

4. A brief questionnaire was used to allow the subject to evaluate the total program at the end of the sixth E.M.G.

feedback relaxation session. (Appendix D)

5. The researcher used a record form on which to note the amount of relaxation each subject achieved at the beginning of each relaxation training session and at regular intervals throughout the session. This was referred to as the E.M.G. Relaxation Record. (Appendix E)

6. A short reading of instruction for relaxation techniques was used. This was adapted from Wolpe and Lazarus' (1966, p. 177-180) modifications of Jacobson's (1938) progressive relaxation and on Shultz and Luthe's (1959) autogenic training suggestions. (Appendix F)

7. A brief instruction sheet was constructed for the purpose of assisting subjects with their relaxation practice at home. This was based on Wolpe and Lazurus (1967) modifications of Jacobson's progressive relaxation and Shultz and Luthe's (1959) autogenic training and was similiar to the relaxation suggestions that were used at the training sessions. (Appendix G)

8. An anecdotal record was kept by the researcher of each training session. Variables that seemed to relate to the subject's response to the program were noted. Specific attention was given to references to the subject's ability to sleep and to the amount and nature of activity he engaged in.

The setting. The relaxation training was done in a quiet, air-conditioned laboratory. The room was furnished with a bed, a reclining chair, a bedside table, a lamp and lamp table, two easy chairs and a moveable table on which the E.M.G. equipment was placed. Provision was made for private, undisturbed sessions. Pillows and blankets were provided for the subject's comfort. A bedboard was used under the mattress

to add firmness to the bed. Jacobson (1938, p. 38) stressed the importance of a suitable environment for the purpose of relaxation.

Instrumentation. A feedback myograph (BFT 401) and a time period integrator (BFT 215) manufactured by Bio-Feedback Technology Incorporated were used to determine the microvoltage from the muscle activity of the trapezius muscle. This equipment was selected for its convenience in that it provided an average percentage of a selected microvoltage over a predetermined period of time (30 seconds in this study). A sound component was used with the E.M.G. equipment in order to provide continuous audiofeedback, the nature of which was that the pitch and the volume of the sound increased with the muscle tension level.

Surface electrodes were used. This type of skin electrode is most commonly used for E.M.G. feedback muscle training (Green et al., 1969; Budzynski et al., 1970; Jacobs and Felton, 1969).

The pilot study. Prior to the major project, a pilot study was done on two subjects who had chronic low back pain. One subject was referred by her physician and one volunteered to participate in the study. The pilot study provided the experimenters with the opportunity to become familiar with the operation of the equipment and allowed for the testing of the adequacy and practicality of the tools and for the refinement of the experimental design. On the basis of the findings of the pilot study it was decided to moniter relaxation levels by electrodes on the trapezius rather than on the frontalis muscle as originally planned. It seemed that recordings from the trapezius reflected more closely, tension changes in the low back muscles. Although the purpose of the relaxation training was to produce deep relaxation of all skeletal muscles the prime concern was that relaxation of the back muscles be achieved.

PROCEDURE OF DATA COLLECTION

The initial interview. Upon the referral of a subject by his or her physician or self-referral, the researcher made an appointment with the potential subject for the initial interview. If the subject was self-referred, permission was obtained to consult with the subject's physician and gain his approval for the subject's participation in the training program.

The initial interview consisted of a brief assessment of the subject and his low back pain problem. Recordings of this information were made on the Interview Report. (Appendix A) A brief explanation of the principles of biofeedback training was given. The subject's written consent to participate in the study was gained. (Appendix J) An attempt was made to indicate to the participant that this program was not meant to replace any other therepeutic measures that he might be using or to interrupt the patient-physician relationship, but rather that this training might be an adjunct to other therapy, if it was successful. The importance of home practice between the training sessions was emphasized.

A schedule of six appointments was set up for relaxation training. The sessions were given within a period of eleven to twenty-two days. Forty-five minutes to an hour were alloted for each session. This time schedule was set on a somewhat arbitrary basis. Other researchers, however, have used similiarly timed programs. Wolpe and Lazerus were able to train individuals to relax deeply without using feedback, in only six, twenty-minute sessions (Wolpe and Lazerus, 1967, p. 61). In the treatment of patients with tension headaches Budzynski and associates (1971) used from four to eight weeks of two to three E.M.G. biofeedback sessions each week. Wickramasekera (1972) was able to train twelve normal subjects to relax the forearm and the frontalis to below four mocrovolts on

the E.M.G. recording by the end of six, forty-five minute training sessions.

Each subject was given a Daily Record card (Appendix C) and asked to begin recording the amount of analgesic, sedative, relaxant and tranquilizing medications that he required each day. The subject was also asked to rate his discomfort each day according to a predetermined scale on which 0 indicated no pain, 1 - a little discomfort, 2 - moderate amount of discomfort, 3 - moderately severe discomfort, and 4 - severe discomfort. He was asked to keep this record for at least three days and to bring it to his first training sessions. This record became the baseline with which later medication and pain records were compared.

Each participant completed Rotter's I-E Scale questionnaire at this time. (Appendix B) These scores were then ranked. Those that were eight or above were rated as having greater external locus of control and those scoring seven or below, greater internal control.

The first training session. At the time of the first training session the subject came to the E.M.G. Biofeedback laboratory. The investigator tried to set the participant at ease by conversing in a relaxing manner. A brief explanation of the purpose of the relaxation sessions was repeated. The function and purpose of the dial on the feedback myograph and of the audiosound was explained. The subject was reassured regarding the safety of the procedure. Emphasis was placed on the fact that the subject would be controlling his own rate of muscle relaxation and that the instrumentation was merely there to help him be aware of how he was doing. Time was allowed for questions and observations.

Surface electrodes were applied, one on each side of the upper back about midway between the top of the humerus and the cervical spine and slightly posterior to the shoulder line. The ground electrode was placed

on the forehead. The electrodes were then tested to ensure that the resistance was well below twenty thousand ohms. The use of the integrator was explained briefly as an instrument that would help the researcher make periodic recordings of the tension level. This instrument was positioned so that the readings were not visible to the subject. A filter was used to decrease interference from heart sounds. All microvolt values in this study were recorded with the filter in the "on" position.

The subject was then asked to lie down on the bed and assume as comfortable a position as he could. Blankets and pillows were provided as necessary. During the first five minutes the subject was asked to relax as well as he was able, without feedback or instruction. At the end of five minutes the E.M.G. Feedback myograph (BF 401) was switched on and three recordings were taken, at thirty-second intervals, from the summations on the Integrator (BFT 215). These recordings were entered on the subject's E.M.G. Feedback Relaxation record and were used as a baseline for comparison with subsequent E.M.G. recordings throughout the training program. The sound component was then turned on low and the subject was told that some suggestions for relaxation would be read to him and that he should try to implement them.

The Relaxation Instructions (Appendix D) were then read to the subject. The researcher read in a low even tone of voice and allowed the subject time to follow the directions given. After the portion of the reading that requires muscle tightening exercises was completed, the sound was turned up somewhat and the researcher continued to record the summations from the integrator, taking three, thirty-second readings at the point of each five-minute interval, while she read the suggestions for relaxation. Care was taken not to take a recording at the moment when a subject was changing his position or being otherwise disturbed.

After five, five-minute interval recordings had been made, beyond the baseline recordings, the session was completed. The subject was given a Daily Record care (Appendix B) and was encouraged to keep a daily record of medications, pain evaluations and practice sessions. The initial Daily Record care on which the subject had recorded his medications and his pain evaluations of the previous three days became part of the subject's file and became the baseline record for comparison with data collected during the project.

A relaxation instruction sheet (Appendix G) was given to the subject to assist him with his home practice sessions.

Five subsequent sessions At each subsequent relaxation session the initial ten or fifteen minutes were allowed for application of the electrodes and for any discussion or questions that the subject might have. A baseline recording was taken of three, thirty-second interval summations after the subject had tried to relax for five minutes. Five similiar recordings, made at five minute intervals, were taken. The relaxation instructions (Appendix D) that were used at the first session were read to the subject only if he felt that they would be helpful to him. Otherwise the subject progressed with the assistance of the audiovisual feedback alone. The researcher remained seated near the subject. She gave periodic reports of the summations on the integrator or suggestions to the subject if she felt they might be helpful.

If the readings on the microvolt meter dropped to the one-third of the scale the sensitivity of the visual and auditory feedback of the BFT 401 myograph was increased. This was done in order to "shape" the subject's response. "Shaping" of the response is produced by gradually increasing the difficulty of the task. This may involve recording body changes at progressively higher sensitivities. In working with a subject

who suffered from tension headaches, Budzynski and associates (1971), maintained the sensitivity of the biofeedback machine so that the tone level was low, eighty percent of the time. This indicated success to the subject, for the larger proportion of the time and thereby promoted learning and did not produce frustration. An evaluation of his progress was given to the subject at the end of each session. He was permitted to see the record of the summations from the integrator if he desired. New Daily Record cards were given to the subject when he required them.

After the sixth session the subject was asked to complete the evaluation questionnaire (Appendix D). He was then given enough Daily Record cards to enable him to continue keeping his medication, discomfort and practice recordings for another fourteen days. This was done in order to determine if any gains from the E.M.G. relaxation training were maintained without the aid of the frequent E.M.G. feedback sessions.

The seventh session. A final session was held at the end of the two week interval. The purpose of this session was to allow the subject to check for himself his own ability to relax and also to give the researcher an opportunity to evaluate the retention of the E.M.G. biofeedback learning.

CHAPTER IV

FINDINGS AND ANALYSIS OF THE DATA

This chapter contains the report and analysis of the data on fourteen subjects with chronic low back pain. All subjects received relaxation training with the aid of electromyographic feedback and verbal and written instructions for relaxation. Assessment of the results was made on the basis of daily subjective recordings of the pain level, on the amount of analgesic and sedative-relaxant medication required by the subjects, and on the decrease in the tension levels as recorded by the electromyograph. The degree of relaxation and pain relief that a subject achieved was analyzed as it related to the subject's rank on the Internal-External Scale (Rotter, 1966). The subjects' reports on changes in their ability to sleep and in their activity levels, as well as a summary of their responses concerning the training methods are also presented.

Subjects served as their own controls in this exploratory study. Statistics were used for comparison of achievement and differences within the group. No control group was used so no generalizations can be made to another group.

The sample. The sample consisted of fourteen subjects, of which five were men and nine were women. The age range was from twenty-six to sixty-two with a mean age of 45.6. The age distribution is shown in Table I.

Six of the subjects were employed at the time of the project, four were housewives, and four were unemployed or on medical leave because of

TABLE I

AGE DISTRIBUTION OF SUBJECTS

Age Group	25-35	35-45	45-55	55-65
Number of Subjects	4	1	4	5

their low back pain.

All subjects reported that they had had pain in the lumbo-sacral area either persistantly or intermittantly for a period of at least three months. Table II shows the distribution of the time periods during which low back pain had been a problem to the experimental subjects.

No attempt was made to specifically categorize the subjects according to the nature of their chronic low back problem. Data gained from the interview and the available medical records indicated that two subjects had had low back surgery; one had two laminectomies and the other a spinal fusion. Radiological reports on medical records suggested the possibility of some organic changes in the lumbosacral area of three other subjects. The records of the other members of the group give no indication that organic changes in the lumbo-sacral area had been

TABLE II

DURATION OF SUBJECTS' LOW BACK PAIN PROBLEMS (N=14)

Time	3 mos. to 1 year	1-5 yrs.	5-15 yrs.	15-25 yrs.	25-36 yrs
Number of Subjects	1	6	2	1	4

demonstrated.

All subjects were outpatients who were able to come to the relaxation sessions without assistance. Ten had been referred by physicians of the employee health service, or the emergency service of the medical center. Of the ten subjects who were referred directly, five were individuals who had consulted their physician recently because of an acute episode of back pain that complicated a more chronic back problem. These subjects are starred on data sheet in Appendix H.

Pain levels. Subjects evaluated their low back discomfort every day and recorded their decisions according to a given pain scale. For the sake of comparison, averages were calculated on the basis of the following three periods of time: A represented the three days prior to the first relaxation session; B represented the seven days prior to the sixth relaxation session, and C represented the seven days prior to the seventh and final relaxation session.

The average daily discomfort level for all subjects during period A was found to be 2.46. Four subjects rated their pain during this period as being below 2 while ten subjects rated their pain as being 2 or above, indicating at least a moderate amount of pain. The average daily discomfort level reported by all subjects during period B was 1.47, showing a decrease of .83 from period A. This represents a decrease of 40.2 percent.

In order to determine if any changes in the discomfort rating could be maintained for at least two weeks after the E.M.G. biofeedback relaxation sessions, an average of the pain ratings during the period represented by point C was calculated. The mean of the daily discomfort level recordings for all subjects during this period was 1.28.

From period A until the end of period C was an interval of four to

TABLE III

AVERAGE DAILY DISCOMFORT LEVEL
(N=14)

Time period	A	B	C
Average Daily Discomfort Level	2.46	1.47	1.28
Standard Deviation	(±.93)	(±.93)	(±1.04)

five weeks. The average daily level of back discomfort of the subjects of this study decreased 47.9 percent during this time. The average daily discomfort levels for individual subjects during periods A, B and C are given in Appendix H.

In order to determine whether there was a significant difference between the average daily discomfort ratings during periods A, B and C, the scores between periods A and B, B and C, and A and C, were subjected to t-tests. Student's t-test were used throughout this analysis. Levels of significance were calculated on the basis of a one-tailed test. Tables IV-a, IV-b, and IV-c give the results of the t-tests of the differences of the average daily discomfort ratings during these periods of time.

A t-value of 3.4204 was obtained in the differences between the means of the discomfort ratings during periods A and B.

A t-value of 1.771 was needed for significance at the .05 level with 13 degrees of freedom. The difference between the means of period A and period B was significant, with a P-value of less than .005.

A t-value of .9486 was obtained in the differences between the means

TABLE IV-a

THE DIFFERENCE BETWEEN THE MEANS OF THE DAILY DISCOMFORT RATINGS DURING PERIODS A AND B

Statistic	Period A	Period B
N	14	14
Means	2.460	1.471
SD	.938	.930

t-value for paired comparison = 3.4204

P-value = .0021

df = 13

TABLE IV-b

THE DIFFERENCE BETWEEN THE MEANS OF THE DAILY DISCOMFORT RATINGS DURING PERIODS B AND C

Statistic	Period A	Period B
N	14	14
Means	1.471	1.28
SD	.930	1.0405

t-value for paired comparison = .9486

P-value = .180

df = 13

of the discomfort ratings during periods B and C. The difference between the means of period B and period C was not significant at the .05 level of confidence.

TABLE IV-c

THE DIFFERENCE BETWEEN THE MEANS OF THE DAILY DISCOMFORT RATINGS DURING PERIODS A AND C

Statistic	Period A	Period C
N	14	14
Means	2.510	1.28
SD	.8892	1.040

t-value for paired comparison = 3.341

P-value = .0025

df = 13

A t-value of 3.340 was obtained in the differences between the means of the discomfort ratings during periods A and C. The difference between period A and period B was significant, with a P-value of less than .004.

The subjects were asked to evaluate their progress at the end of the sixth session by answering a questionnaire (Appendix D). Thirteen of the fourteen subjects indicated that they had experienced some decline in the amount of low back discomfort. Seven of these noted that they felt a marked improvement. Twelve subjects stated that the discomfort occurred less often.

Medication levels. It was hypothesized that the subjects who participated in this relaxation training program would use less analgesic, relaxant, sedative, and tranquilizing medication as the training sessions progressed and after the six training sessions were over.

Each subject kept a daily recording of the amount of medication he required from the time of the three days prior to the first relaxation

session until the time of the seventh session. It was noted that the medications they took could be catagorized into two groups: analgesics and sedative-relaxants. Those medications that comprised the analgesic group were: aspirin, darvon, tylenol, tylenol #3 and indomethacin. Those that could be classed in the sedative-relaxant group were: metaxalone, diazepem, meprobamate and carisoprodol. All were oral medications.

Five of the subjects took no medication of the type that was directly related to the problem of this study, at any time during the four to five week period that the records were kept. Two subjects took less than four tablets during the same time period. Of the remaining eight, five showed a decrease in the average daily number of tablets they took during period B (the seven days prior to the sixth relaxation session), as compared with period A (the three days prior to the first session). Two subjects who showed an increase in the amount of medication required during period B took no medication during period A. The third subject who reported an increase in the amount of medication also reported that there had been no decline in the amount of pain that he suffered. He stated that his problem was a long-standing, persistant one that required him to remain on a routine program of medication in order to give him enough pain control to allow him to hold down a job and lead a moderately active life. For this individual the increase during period B was slight and possibly could reflect slight variation in his pain control regime.

The average daily number of sedative-relaxant and analgesic tablets that all subjects took during period A was 1.19. The average number of tablets required during period B was .77, showing a decrease of .42 tablets or 35.2 percent. The average number of tablets required during the seven days prior to the seventh session, period C was .54. Ten subjects took no medicine during period C and three others took less medication

TABLE V

AVERAGE DAILY NUMBER OF TABLETS TAKEN
BY FOURTEEN SUBJECTS

Time Periods	A	B	C
Average Number of Tablets Per Day	1.19	.77	.54

during this time than during any other period.

Data concerning the average daily number of tablets required by each subject during the three time periods, A. B, and C is given in Appendix I. No attempt was made to analyze the data regarding medication statistically because of the small number of subjects who required medication with any degree of consistancy. Only four of the fourteen subjects took medication during all three time periods (A, B and C).

Relaxation levels. A purpose of this study was to teach relaxation techniques and to evaluate the degree of relaxation learning and its effect on perceived pain. Three, thirty-second recordings of the microvolt level of the tension of the trapezius muscle were taken from the integrator five minutes after the relaxation session had commenced. These recordings were average and became the baseline for comparison with future recordings within the same session and with those of future and previous sessions.

Tension levels varied considerably from subject to subject and from session to session. The baseline tension level was not always indicative of the trend during the remainder of the session. An elevated baseline level with a gradual decrease in the tension level during the relaxation session was characteristic of some subjects and some sessions. Often,

however, subjects were able to demonstrate a relatively low tension level when they first assumed the recumbent position but were unable to maintain this level of muscle relaxation. It was difficult to evaluate all the variations within the relaxation sessions. The analysis was derived from the baselines of the relaxation sessions and the means of the remaining twenty-five minutes of the session. The two catagories of means have been referred to as baseline means and session means.

The trend of the average microvolt levels for the whole group are demonstrated in Table VI. The baseline and session means of individual subjects are recorded in Appendix K. They are demonstrated on Figures 1 - 8 (Appendix L).

Though the general trend was for subjects to show some progress in their ability to relax, not all were able to lower their tension level with any degree of consistency. When the average microvolt level of the sixth session was compared with that of the first session it was noted

TABLE VI

MEANS OF E.M.G. MICROVOLT LEVELS OF ALL SUBJECTS DURING THE SIX TRAINING SESSIONS AND ONE EVALUATION SESSION

Sessions	1	2	3	4	5	6	7
Baseline Means	31.86	24.68	28.15	18.86	18.59	21.34	30.62
Standard Error	4.87	6.36	5.07	3.4	4.8	3.8	6.5
Session Means	20.4	20.9	18.44	14.14	12.45	15.25	21.27
Standard Error	4.34	2.97	3.6	2.1	1.9	2.74	4.0

that eight subjects showed a lower baseline mean and seven, a lower session mean. As it is possible that one session might be atypical, the baseline means and the session means of the first three sessions were also compared with the means of the last three sessions. It was noted that eleven subjects showed a decrease in their baseline means, and ten, their session means.

In response to the questionnaire (Appendix D) at the end of the sixth session, seven subjects indicated that they were able to relax a little more easily than before the training program. The other seven indicated that they were able to relax much more easily.

T-tests were done on the total sample group to ascertain if there were significant differences between the average E.M.G. microvolt levels ecorded during the baseline of the first session (x), the mean of the sixth session (Y) and the mean of the seventh session (Z). The results are shown on tables VI-a, VI-b and VI-c.

A t-value of 2.667 was obtained in the difference between the E.M.G.

TABLE VI-a

DIFFERENCES BETWEEN AVERAGE E.M.G. MICROVOLT LEVELS OF X AND Y

Stastic	X (first session baseline)	X (sixth session mean)
N	14	14
Mean	31.84	15.23
SD	18.19	10.23

t-value of paired comparison = 2.667

P-value = .0095

df = 13

microvolt levels of X and Y. A t-value of 1.771 was needed for significance at the .05 level with 13 degrees of freedom in a one-tailed test. The differences between X and Y were significant with a P-value less than .01

A t-value of -1.736 was obtained in the comparison of the average E.M.G. microvolt levels of Y and Z. The differences between Y and Z were not significant at the .05 level. It should be noted, however, that there was a negative t-value and that the P-value was .053.

A t-value of 1.616 was obtained in the comparison of the average E.M.G. microvolt levels of X and Z. The differences between Y and Z were not significant at the .05 level. They did show a strong trend for difference with a P-value of .065.

Some of the variables that were reported as interfering with the subjects' ability to relax were: feelings of cold and hunger, emotional proglems, pain due to peptic ulcer, pain in the cervical spine, pain due

TABLE VI-b

DIFFERENCES BETWEEN AVERAGE E.M.G. MICROVOLT LEVELS OF Y AND Z

Statistic	Y (sixth session mean)	Z (seventh session mean)
N	14	14
Mean	15.23	21.27
SD	10.23	15.05

t-value for paired comparison = -1.736

P-value = .053

df = 13

TABLE VI-c

DIFFERENCES BETWEEN AVERAGE E.M.G. MICROVOLT LEVELS OF X AND Z

Statistic	X (first session baseline)	Z (seventh session mean)
N	14	14
Mean	31.84	21.27
SD	18.19	15.05

t-value for paired comparison = 1.616

P-value = .065

df = 13

to "tennis elbow', pain due to a hernia, severe low back pain, chest pain, chest congestion due to congestive heart failure, general malaise due to influenza, muscle twitching and cramping in the legs, and nasal congestion due to coryza.

The seventh E.M.G. biofeedback relaxation session was conducted two weeks after the sixth session. The purpose of this session was to determine if the subject could now relax without the frequent training sessions. In comparing this seventh session with the sixth, it was found that five displayed a decreased baseline mean at the seventh session, and five, a decreased session mean. (See Appendix K for individual values)

Relaxation and pain. A comparison was made between the differences of the reported pain scores in periods A and B and decreases in baseline and session mean tension levels.

Of the twelve subjects whose discomfort ratings showed a decrease between period A and period B, nine decreased their mean baseline tension levels between sessions one and six. The session means of seven of

these twelve subjects also showed a decrease at session six. Of the five subjects who showed no decrease in their session mean at the time of their sixth session, two were able to decrease their microvolt levels during session two, three, four and five, to below the mean of the first session. Several of the subjects reported that they did not feel well at the time of the sixth session and therefore did not perform as well as they had at some of the other sessions.

It is of interest to note that the two subjects who reported no decrease in their discomfort level between period A and B, showed an increase in both their baseline and session means between session one and session six. An attempt was made to determine if there was a correlation between the degree of discomfort level decreases and decreases in the tension levels at the training sessions. The correlation coefficient of the tension level differences between X (first session baseline) and Y (sixth session mean), and pain differences between periods A and B was .0712. Five of the subjects did not show decrease. Therefore correlation was also done, using the X-Y relaxation scores and the A-B pain scores of only those ten subjects who showed a decrease in their X-Y relaxation scores. The correlation between relaxation and decrease in discomfort in these subjects was .2208.

THE LOCUS OF CONTROL VARIABLE

All fourteen subjects completed Rotter's (1966) Internal-External (I-E) Scale at the time of the initial interview. Their scores ranged from 2 to 12, with seven scores of 7 or below and seven scores of 8 or above. Means and standard deviations of scores of subjects in previous studies have varied considerably, according to the type of population tested. Rotter (1966) reported a number of trials in which the means

varied between 5.94 and 10.

The subjects of this study were dichotomized on the basis of whether their scores fell below or above 7.5. Those whose scores were above 7.5 were classed as having a greater external locus of control, and those whose scores ranked below 7.5 as having a greater internal control. Lefcourt, Lewis and Silverman (1968) used this method of differentiating between subjects with external and internal control.

Locus of control and pain. The seven subjects who ranked below 7.5 were classed as "internals" and became Group I. The seven subjects who ranked below 7.5 were classed as "externals" and comprised Group II. During period A, those subjects in Group I had a mean discomfort level of 2.5. This decreased to 1.60 during period B, showing a decrease of 41.8 percent. The two subjects who showed no decrease in their discomfort level between periods A and B fell in this catagory. One of these subjects, however, showed a considerable decrease in pain level during period C. The average discomfort level for Group I during period C was 1.18.

Group II reported a mean discomfort rating of 2.17 during period A. During period B, they reported an average daily pain level of 1.34, showing a decrease of 40.2 percent. During period C, their average daily pain level decreased to 1.30.

Group I and group II scores of the differences in the mean discomfort ratings between periods A and B, periods B and C, and periods A and C were subjected to a t-test. Tables VIII-a, VIII-b, and VIII-c give the results of the t-test of the differences between the discomfort ratings of the two groups during periods A and B, B and C, and A and C.

A t-value of .3734 was obtained in the differences of the discomfort means of the two groups during periods A and B. A t-value of 1.860 was required for significance at the .05 level with 8 degrees of freedom in

TABLE VII

A COMPARISON OF THE AVERAGE DAILY DISCOMFORT LEVELS ACCORDING TO LOCUS OF CONTROL GROUPING

Group	Period A	Period B	Period C
Group I (Internals) (N=7)	2.74	1.60	1.18
Group II (Externals) (N=7)	2.17	1.34	1.30

TABLE VIII-a

MEAN DISCOMFORT LEVEL DIFFERENCES FROM PERIOD A TO PERIOD B, BETWEEN THE TWO LOCUS OF CONTROL GROUPS

Statistic	Group I (Internals)	Group II (Externals)
N	7	7
Means	1.148	.93
SD	1.452	.537

t-value for unequal variances = .3734

P-value = .3592

df = 8

a one-tailed test. The group differences were not significant, with a P-value of .359.

A t-value of 1.162 was obtained in the differences of the discomfort means of the two groups during periods B and C. A t-value of 1.796 was needed for significance at the .05 level with 11 degrees of freedom in a

TABLE VIII-b

MEAN DISCOMFORT LEVEL DIFFERENCES FROM PERIOD B TO PERIOD C, BETWEEN THE TWO LOCUS OF CONTROL GROUPS

Statistic	Group I	Group II
N	7	7
Means	.4228	-.399
SD	.835	.641

t-value for unequal variances = 1.1622

P-value = .1348

df = 11

TABLE VIII-c

MEAN DISCOMFORT LEVEL DIFFERENCES FROM PERIOD A TO PERIOD C, BETWEEN THE TWO LOCUS OF CONTROL GROUPS

Statistic	Group I	Group II
N	7	7
Means	1.528	.89
SD	1.813	.8741

t-value for unequal variance = .8393

P-value = .2119

df = 9

one-tailed test. The group differences were not significant of the .05 level, but a P-value of .13 indicated a slight trend for Group I, the "internals", to have a greater decrease in mean discomfort levels.

A t-value of .8393 was obtained in the differences of the discomfort means of the two groups during periods A and B. A t-value of 1.833 was needed for significance at the .05 level with 9 degrees of freedom, in a one-tailed test. The group differences were not significant at the .05 level, with a P-value of .2199.

Locus of control and amount of medication required. Group I took an average of 1.75 tablets per day during period and 1.25 tablets per day during period B, and .81 during period C.

Group II took an average of .59 tablet per day during period A and .29 tablet per day during period B, and .1 tablet per day during period C.

It is evident that the subjects in Group II required less medication initially and throughout the time of the study. No statistical analysis was attempted in comparing locus of control and the amount of medication taken because of the small number of subjects who took medication regularly.

Locus of control and relaxation. Tables X-a and X-b show a comparison between the E.M.G. microvolt levels of the "internals" and the "externals" during the first, sixth and seventh sessions.

TABLE IX

GROUP COMPARISON OF THE AVERAGE DAILY NUMBER OF ANALGESIC OR SEDATIVE-RELAXANT TABLETS TAKEN DURING PERIODS A, B AND C

Time Period	A	B	C
Group I (Internals) (N=7)	1.75	1.25	.81
Group II (Externals) (N=7)	.59	.29	.1

TABLE X-a

THE BASELINE MEAN E.M.G. MICROVOLT LEVELS OF GROUP I AND GROUP II

Group	First Session Baseline	Sixth Session Baseline	Seventh Session Baseline	Average Baseline Mean (all sessions)
I. (Internals) (N=7)	25	29.11	25.91	44.05
II. (Externals) (N=7)	24.78	34.61	16.77	17.2

TABLE X-b

THE SESSION MEAN E.M.G. MICROVOLT LEVELS OF GROUP I AND GROUP II

Group	Session Mean, First	Session Mean, Sixth	Session Mean, Seventh	Average Session Mean (all sessions)
I. (Internals) (N=7)	19.1	18.55	28.8	18.96
II. (Externals) (N=7)	21.6	11.9	13.75	16.79

It is evident that the mean of the first session baseline level of Group II was higher than that of Group I.

Between the first and the sixth session the members of Group I were able to decrease their average baseline E.M.G. microvolt level by 10.9 percent and their average session mean level by 2.87 percent. During the same period of time the members of Group II were able to decrease their average baseline E.M.G. microvolt levels by 51.5 percent and their average session mean level by 44.9 percent.

T-tests were done to test the level of significance of the difference

TABLE XI-a

MEAN RELAXATION LEVEL DIFFERENCES FROM X TO Y, BETWEEN THE TWO LOCUS OF CONTROL GROUPS

Statistic	Group I (Internals)	Group II (Externals)
N	7	7
Means	10.5571	22.6628
SD	22.8452	23.8523

t-value for unequal variances = -.9697

P-value = .1756

df = 12

between the two locus of control groups as they relate to their ability to alter their tension levels between the first session baseline mean (X) and the sixth session mean (Y) relaxation levels; between the sixth session mean (Y) and the seventh session mean (Z) relaxation levels; and between X and Z relaxation levels. The results are shown on tables XI-a, XI-b, and XI-c.

A t-value of -.9697 was obtained in the differences of X (first session baseline) and Y (sixth session mean) relaxation levels of the two locus of control groups. A t-value of 1.782 was needed for significance at the .05 level with 12 degrees of freedom in a one-tailed test. The group differences were not significant at the .05 level.

A t-value of 1.2311 was obtained in the differences of Y (sixth session mean) and Z (seventh session mean) relaxation levels of the two locus of control groups.

TABLE XI-b

MEAN RELAXATION LEVEL DIFFERENCES FROM Y TO Z,
BETWEEN THE TWO LOCUS OF CONTROL GROUPS

Statistic	Group I	Group II
N	7	7
Means	-10.2429	-1.84
SD	10.1374	14.9436

t-value for unequal variance = 1.2311

P-value - .1219

df = 11

TABLE XI-c

MEAN RELAXATION LEVEL DIFFERENCES FROM X TO Z,
BETWEEN THE TWO LOCUS OF CONTROL GROUPS

Statistic	Group I	Group II
N	7	7
Means	.3142	20.8143
SD	28.2982	15.8078

t-value for unequal variances = -1.6732

P-value = .0645

df = 9

A t-value of 1.796 was needed for significance at the .05 level with 11 degrees of freedom in a one-tailed test. The group differences were

ot significant at the .05 level.

A t-value of -1.673 was obtained in the differences of X and Z relaxation levels of the two locus of control groups.

A t-value of 1.833 was needed for significance at the .05 level with 9 degrees of freedom in a one-tailed test. The group differences were not significant at the .05 level.

However a P-value equal to .064 indicated that Group II (externals) showed a greater tendency to a difference between the first session baseline and the seventh session mean relaxation level than did Group I.

RELATED VARIABLES

Sleep. At the time of the initial interview all except two subjects indicated that their low back pain problem interfered with their ability to sleep. Six subjects stated that the problem only affected their sleep occasionally or to a minimal degree. At the time of each relaxation session the researcher attempted to ascertain by informal questionning if the relaxation training and home practice was influencing the subject's sleep patterns. Eight subjects reported some improvement in their ability to sleep by the time of the second to the fourth session. Typical statements were: "I find that I can fall asleep more quickly"; "I seem to be dreaming less"; "I find that I am sleeping better".

In response to the question concerning sleep on the questionnaire, (Appendix D) eight subjects reported some improvement in their ability to sleep.

Activity. It was conceived that as the subjects' discomfort level decreased their activity levels would increase and therefore activity might be an indicator of an improvement of the low back problem. Eleven subjects reported being able to be more active or to maintain positions

of sitting or standing more comfortably by the third to fifth sessions. At the end of the program ten stated that they were able to be more active than before the relaxation training began.

Other reports of changes in life style were: "Generally, I feel less nervous"; "I feel more rested"; "I am now aware of my tension level and therefore I am able to consciously relax"; "It is easier for me to cope with groups of people and with company now".

Concomitant therapy. Two of the subjects received several physiotherapy treatments consisting of deep heat and massage during the time they were having relaxation training sessions. Three reported that they applied heat to the low back at home in order to try to get some relief from the discomfort. Four wore some type of back support part of the time. One subject wore a back brace at all times when she was ambulatory.

SUBJECTIVE RESPONSE TO THE TRAINING METHODS

An attempt was made to evaluate the methods of the training program. The responses of the subjects to questions on the questionnaire which concerned the training methods are reported on Table XII.

TABLE XII

SUBJECTIVE EVALUATION OF THE RELAXATION TRAINING METHODS

Method	Very Useful	Fairly Useful	Not Helpful	Irritating
Visual Feedback	5	2	6	1
Audiofeedback	3	6	4	1
Instrictions read (Appendix F)	10	4	0	0
Home instructions (Appendix G)	7	7	0	0

Three subjects thought that longer sessions might have been helpful. Two thought the sessions should have been closer together; one, farther apart. Six subjects felt that more sessions might have been helpful; one, felt that the program was longer than necessary.

CHAPTER V

DISCUSSION

This chapter contains discussion regarding implications of the findings and of intervening variables that may have influenced the process and the results of the relaxation training program.

Prime factors that influence the success of biofeedback learning are motivation and involvement (Schwartz, 1973). If the results produce immediate pleasure or relief of pain, this may be reward enough. If, however, the changes are more obscure, the functions that are achieved may be more difficult to maintain (Shapiro and Schwartz, 1972). Though no measure for motivation was used to test this variable, it was noted that not all subjects were equally motivated. Some entered the program with some suspicion that they had been referred to this program because nothing else could be done for them. This barrier seemed to disappear as the training progressed. Notations on the daily record cards indicated that some subjects practiced relaxation at home more faithfully than did others. One subject who started the training program dropped from the study after the first training session. The fourteen remaining subjects seemed to find the program rewarding enough to maintain their interest and participation. Some reported improvements in their ability to sleep and in their ability to increase their activity with less discomfort as early as the second, third and fourth sessions, and it is conceivable that these favorable changes increased the subjects' confidence in the value of the training program. Participation in this study involved no financial

expense or gain for the subject. This may have affected the level of motivation in some subjects.

Just as disease cannot be isolated as an independent thing, but is influenced by all factors; the home, marriage, job, beliefs, and attitudes, so biofeedback training will be influenced by all of these and other variables. Those who have a need for their illness will be the most difficult to help (Peper, 1973). Balshan (1962) suggests that personal adjustment may also influence the effectiveness of biofeedback training. The subjects of this study reported many variables that they felt had an immediate influence on their progress in the individual training sessions and the total program. These are listed in Chapter IV, p. 39. Other more obscure factors may have influenced motivation in the subjects of this study. A study by Gessel and Alderman (1971) suggests that depressed patients may not relate to the results of relaxation training as well as those who are not depressed. Those with a chronic low back pain problem are frequently depressed (Sternbach, 1973b). It is possible that those who have tried many remedies for pain over a period of years may not expect much in the way of results from a new and experimental program and therefore have limited motivation.

Pain levels. One of the main findings was, as hypothesized, that subjects who participated in this training program would report a decrease in the intensity of their low back pain as the sessions progressed. Thirteen of the fourteen subjects indicated on their questionnaire (Appendix D) that they had experienced some pain relief by the time of the sixth session. An average of the daily scores during the week prior to the seventh sessions showed that five subjects had some increases in their discomfort level as it compared with the week prior to the sixth session. Eight continued to report improvement. Two reported that they

were without pain during the last week of the program. These two subjects stated at the time of the first training session that the low back discomfort had decreased from the time of the initial interview. These two subjects were among five who reported that their presenting back pain was due to an acute episode of a more chronic type of back problem. One subject reported a decrease in discomfort prior to the seventh session even though he had shown no improvement during the training period. He attributed this change to a period of enforced bedrest due to another illness. Some subjects reported that as their low back discomfort decreased, they became more active. This activity, in turn, increased the discomfort somewhat. In spite of this, most of the subjects felt that they had improved in some way. A follow-up evaluation after three or four months would be helpful in evaluating the results of this program.

E.M.G. levels. It was noted that the average E.M.G. microvolt levels were increased, for a number of subjects, at the time of the seventh session. These increases did not necessarily correlate with the increases in pain. This increase in the average E.M.G. microvolt levels between the sixth and seventh sessions seemed to indicate a tendency toward regression. It may be that a training program designed to follow each subject until they have reached their maximum level of relaxation would reduce the tendency to revert to higher tension levels. Of the ninety-eight relaxation sessions in the total program, only nine session means were at the five microvolt level or less. Three of these nine sessions involved one subject. Raskin and associates (1963) used the criteria level of 2.5 microvolts or less to indicate profound relaxation of the frontalis muscle. Nine subjects in this study were able to decrease their E.M.G. microvolt level to five microvolts at some time during the training program; two relaxed to the two microvolt level for short periods

of time.

Lawrence (1972) states that biofeedback learning, once achieved, seems to last without further reinforcement (p. 130). Two studies involving small groups of subjects lend some weight to this theory. Engel, (1972) trained a few subjects to regulate their heart rate and retested them six months to one year after they had been trained with feedback measures and found that they performed successfully. Budzynski, Stoyva and Adler (1971) did a follow-up on five subjects who had been given relaxation training for the relief of tension headaches. They found that the frequency of their headaches remained low, two to three months after the training program was completed.

For maximum effectiveness, it may be necessary to plan the relaxation program according to the subject's needs. Budzynski and associates (1971) used a flexible plan of four to eight weeks to train patients with tension headaches to relax. Raskin, et al., (1973) taught relaxation to ten subjects with chronic anxiety. The time necessary for all to learn ranged from two weeks to three months.

Relaxation and pain. No significant correlation was found in the differences between the average discomfort ratings of the three days before the training program and the seven days prior to the final training session, as they relate to the tension level differences between the first session baseline and the sixth session mean. More valid data for a correlation study might have been gained by having the subjects rate their discomfort levels during each training session and then correlating this value with the E.M.G. microvolt average of that session. It is possible that the performance of the subject at the training session was somewhat different from his ability to relax at home or at work, expecially during the first portion of the training period. The degree to

which factors other than tension and relaxation entered into the changes in the pain levels of some or all of the subjects was not analyzed although their influence was noted in the verbal reports of the subjects.

Jacobson (1967) stated that in his work with subjects in pain he found that pain was reported diminished if and when the electrical activity of the muscles became sufficiently decreased. He found that pain and tension do not diminish step by step proportionately and that extreme relaxation is necessary in order to block the processing of information in the neuromuscular system, including information regarding pain. He noted that the most marked decrease in discomfort came late in advancing relaxation (p. 22). As mentioned previously, during only nine sessions did the average microvolt level fall to five or less microvolts. This seems to indicate that deep relaxation was not achieved very often.

The influence of two investigators. It is conceivable that even though the procedure for the administration of the relaxation training program was identical for both investigators, the personality of the investigators and the relationship that each developed with the individual subjects differed. The training program required that the investigator spend about seven hours with each subject. During some of this time the investigator was actively involved in giving encouragement, support and indirect feedback to the subjects. This relationship that the researcher had with the subject may have exerted an influence on the pain or tension levels, quite apart from the E.M.G. biofeedback training. Due to the small sample sizes of the sub-categories of variables, and the limitations of the evaluation tools, the influence that the investigator had on the rate of learning and on the total response of the subject to the training program was not considered statistically. Note the unequal distribution of the "internals" and the "externals" in each investigator's

group of subjects, as it is described in the next section.

Locus of control. It was hypothesized that those with greater internal locus of control would learn the techniques of relaxation more rapidly and effectively and thereby gain more pain relief. The basis for this hypothesis rested on research reports that the "internals" were more able to utilize the information they received (Phares, 1968), that they try harder to improve themselves (Seeman, 1963), that they are more aware of their reinforcements (Ude and Vogler, 1969), and that they seem to be able to control their own impulses better (James, et al., 1965). This working hypothesis was not supported in this group of subjects. There was some indication that the "externals" may have been more successful in learning to reduce E.M.G. tension levels, though the level of this difference lacks statistical significance. The "internals" showed a slightly greater decrease in pain intensity.

It was noted in Fotopoulas' (1970) study, that the "externals" improved greatly in their ability to control their heart rate when given feedback, compared to prior no-feedback conditions. Although the "internals" improved their performance with feedback they also were fairly successful without feedback. Under feedback conditions the performance of both groups was almost equal. In this study, six of the seven subjects who stated that they did not find the visual feedback helpful, had a greater internal locus of control. Five of these belonged to the group assigned to researcher B. It was difficult to ascertain whether the low dependence on the visual feedback by the "internal" group was related to the approach of the researcher, the locus of control variable or some other dimension that is not as apparent.

Factors that were not directly related to the expectancy variable may have influenced the results of each group. It was noted that, on the

average, the "external" group had less pain initially. Subjects reported that it was more difficult to relax when the pain level was up. The elevated discomfort level may have retarded the learning rate of some of the "internal" group. The "externals" began the training program with a higher average E.M.G. baseline. On the basis of their extensive experience with E.M.G. biofeedback training, Budzynski and Stoyva (1973) concluded that biofeedback relaxation training is valuable for those subjects who are muscularly tense. Those whose E.M.G. levels are low before the training program do not get much lower as a result of training. This implies that those with high tension levels should show more pronounced improvement.

By chance, five of the six subjects that were followed by investigator A were ranked as having external locus of control and all except two of the subjects taught by investigator B ranked as having internal locus of control. It is possible that this circumstance influenced the findings related to the two sub-groups.

Training methods. The relaxation instructions that were read to the subjects and the similar ones that were taken home were rated as being more helpful than the biofeedback instrumentation, even though the visual and audio feedback were used at every session while the read instructions were not. The program of instruction was adapted from Wolpe and Lazarus' (1966) modification of Jacobson's (1938) relaxation techniques and from Shultz and Luthe's (1959) autogenic training program (p. 13-95). These instructions have been used for many years with some success but also with certain limitations. Much time is often required to achieve the desired depth of relaxation, making their use, at times, impractical. Shultz and Luthe (1959) indicated that considerable relief from anxiety could be expected within six to eight weeks of autogenic training (p. 182).

Several factors may have contributed to the subject's evaluation of the training methods. The verbal instructions may have represented support from the researcher and therefore became more meaningful than feedback from a machine. On the basis of results from two experimental studies using relaxation instructions with E.M.G. feedback, Mathew and Gelder (1968) stated that the content of the material that is read to the subjects is perhaps not as important as the fact that by providing a low level of afferent and proprioceptive input the attention is focused to internal events and environmental stimuli is limited. One subject expressed this idea by saying, "When you are reading, my mind does not wander as easily to problems at the office". When there was no reading, another said, "It's too quiet". Although some instruction concerning biofeedback techniques and principles were given to the subjects, it is possible that a greater understanding of the meaning of feedback would have helped the subjects to make better use of the biofeedback equipment.

Certain physical factors may have interfered with the subject's use of the microvolt meter on the myograph. Positioning of the biofeedback myograph on a table so as to enable the recumbent subject to view it without increased tension on the neck muscles presented some difficulty. The subdued lighting decreased visibility. A lighted dial on the myograph might have been helpful. Several subjects wore glasses which they preferred to remove when relaxing. This made observations of the visual feedback difficult and these subjects depended almost entirely on verbal instructions, verbal feedback and the audio feedback. Others found the sound signals disturbing. Some subjects seemed to display boredom with the minor changes indicated on the microvolt meter. Even though a filter was used, there was some interference from the heart sounds in a few individuals.

Other researchers have found that combinations of E.M.G. feedback and verbal instruction quite effective (Green, et al., 1969), Wickramasekera (1972). Biofeedback enhances the rate of learning of internal control mechanisms by sharpening an individual's ability to recognize internal cues. Some subjects may not be as relaxed as they say or think they are. The ability to recognize proprioceptive cues varies with individuals and does not always provide the feedback necessary to improve a person's control over his muscle activity (Jacobs and Felton, 1969).

CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY OF DESIGN

It was the purpose of this exploratory study to determine the effect of relaxation training using electromyographic (E.M.G.) feedback and verbal relaxation instructions for patients with chronic low back pain. A secondary aim was to determine if the locus of control variable as defined by Rotter would influence the results obtained.

Fourteen non-hospitalized subjects (five males and nine females) participated in the study. Ages ranged from twenty-six to sixty-two years. The reported duration of the subject's back pain problem varied from three months to thirty-six years. At the initial baseline evaluation session all the subjects completed Rotter's I-E Scale. This was followed by six relaxation training sessions with the use of E.M.G. audio and visual feedback and relaxation instruction. A seventh session was conducted two weeks post-training for the purpose of evaluation. The subjects practiced relaxation twice daily at home between training sessions. A daily record of analgesics, sedatives and muscle relaxants was kept by the subjects during the three days prior to the training program, the training period and the two weeks after the sixth training session.

Four working hypothesis were proposed to guide the conduct and analysis of this exploratory study. Subjective and objective descriptive data were collected throughout the study.

II. CONCLUSIONS

The first hypothesis which stated that subjects would achieve a reduction in their pain intensity during the training session was supported. There was a 40.2 percent mean decrease in the discomfort rating between the baseline rating and the mean rating of the last week of the training period, P = .0021. However, the relationship proposed in the first hypothesis was conditional upon "subjects who learn to relax". According to the method of comparison used in this study, there was no significant correlation between mean E.M.G. level changes and reported changes in pain intensity among the fourteen subjects studied. The second hypothesis stated that the subjects would use less medications as a result of the relaxation training program. Although the use of medications decreased during the study, no statistical analysis was done on the amount of medications taken because not all subjects took medications consistently during the program. The third hypothesis stated that the subjects will be able to retain the benefits of the relaxation training for two weeks after the training period was supported in part. Most of the subjects were still able to maintain a decrease in their pain intensity and the amount of medications they used, but there was some regression in their relaxation level as measured by E.M.G. at the evaluation session two weeks after the training period. The fourth hypothesis stated that the subjects with internal locus of control will achieve more positive results throughout the training program than the subjects with external locus of control. T-tests indicated no significant difference between the two locus of control groups.

Limitations. There are limitations on the interpretation of the findings in this exploratory study which should be emphasized. Some of these limitations are as follows: The instructions for relaxation and

the autogenic phrases read by the researchers were rated by the subjects as more helpful than the E.M.G. visual and audio feedback. It is possible that the recumbent position of the subjects during the training sessions might have reduced their ability to see the E.M.G. microvolt dial, thereby reducing the effectiveness of the visual feedback signal. The researchers related to all the subjects in a supportive way. Since no control group was used in this exploratory study, the Hawthorne effect cannot be excluded as an explanation for relief of pain, reduction in medication used, or increases in relaxation. Two researchers administered the training program, each used the same protocol and followed specific subjects throughout the entire session. However, because of small subgroup numbers no attempt was made to evaluate the effect of the differences in the individuality of the researchers on respective subjects. Other intervening variables that were apparent but impossible to control were: pain from other sources; interfering emotional concerns; concomitant therapy and the possibility that the presenting low back pain problem was due to an acute episode of the existing chronic back pain.

Related variables. Descriptive information was recorded regarding the sleep pattern, activity and life style of the subjects. Twelve of the fourteen subjects reported sleep disturbances due to their pain during the initial interview before they started the relaxation training. Improvements in sleep patterns were reported verbally as early as the second to the fourth training sessions. At the end of the training period seven subjects reported a general improvement in their sleep patterns in response to a paper and pencil questionnaire.

Ten of the subjects reported that they were able to increase their daily activities during and after the training period more than before they began relaxation training. Some of the activities they were able

to increase or tolerate better were housekeeping activities, sitting, standing and walking.

Most of the subjects reported changes in their life style. The main changes reported were ability to identify tension level. Eight subjects reported a new awareness of their tension level and their ability to relax voluntarily. As a result of their voluntary relaxation, four stated that they were better able to cope with situations that used to upset them.

III. RECOMMENDATIONS

The findings from this exploratory study indicate that relaxation training may be of some help to selected patients with chronic low back pain. However, generalizations cannot be drawn from this study because of the small sample size and variables that were not controlled. In order to be able to confirm and extend the findings of this study, the following recommendations are made:

1. Conduct a study following the same general design as this one with a modification of:
   a. having a matched control group
   b. having a larger sample
   c. restricting subjects to those having a single etiology of chronic low back pain.
   d. correlating subjective pain evaluation during the training session with the E.M.G. mean microvolt level achieved during the same session.
   e. planning a long term follow-up after three to six months.
2. Make a program of relaxation training assisted by E.M.G. feedback available as a nursing intervention for inpatients and outpatients with chronic low back pain.

3. Study the response of hospitalized patients with chronic low back pain to a program of systematic relaxation training.
4. Compare the response of patients with severe chronic low back pain and those with mild chronic low back pain.
5. Consider family and psychological problems as variables: utilize psychiatric consultation and further psychological testing.
6. Vary the length of training according to the individual's rate of learning with a preset goal of a specific relaxation level.

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APPENDIX A

APPENDIX A

INTERVIEW

Name . . . . . Age . . . Sex . . . Status . . . . (S,M.D.W)

Address. . . . . Telephone. . . . . .

Referring Physician. . . . . .

Occupation . . . . . Currently Employed. . . . . .

If not employed, is it because of back disability? . . . . . .

If unemployed at present, do you have plans to return to work? . . . . . .

Did you enjoy your work when you were feeling well?. . . . . .

History of Current Low Back Discomfort Problem

a. Duration: How long have you had this problem:

b. What do you think percipitated the problem?

c. Have you had surgery for your back? . . . . If so, how many, what type and when?

d. Does activity make your back feel worse?. . . . If so, what type?

e. Does the back discomfort affect your sleep at night?. . . . To what degree?

f. Are you using any physiotherapy, support or traction for the back discomfort?

g. Status of the problem - Improving,? Deteriorating?

h. Height . . . . . Weight . . . . . .

i. Medications being taken on a regular or p.r.n. basis. Particularly relaxants, sedatives, analgesics or tranquilizers.

j. Other Relevant Information -

APPENDIX B

APPENDIX B

Rotter's (1966) Internal-External Scale

For each number choose either A or B. If you believe both statements to be true choose the ONE that you feel to be the truest statement. Be sure to choose only ONE.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

APPENDIX C

APPENDIX C

Daily Record Subject No_____

Card No_____

Date									
Day									
Medications Taken									
Home Practice (Check)									
Discomfort Rating									

Instructions: Rate your average discomfort in the low back according to the following scale. Record it daily.
0=No discomfort 1=A little discomfort 2- Moderate amount of discomfort. 3-Moderately severe discomfort 4=Severe discomfort - a bad day.

APPENDIX D

APPENDIX D

Participant Evaluation of the Training Program

Date _____ S Number _____

I. Choose the answer that you think applies most nearly to your experience.

1. Compared to the time before I started this project the discomfort in my back is -
   a. Worse than before
   b. The same as before
   c. A little less
   d. Much less
   e. Gone most of the time
   f. Gone all of the time

2. I am able to relax my muscles
   a. About as well as before
   b. A little more easily
   c. Much more easily

3. The discomfort in my back occurs
   a. As often as before
   b. Oftener than before
   c. Less often

4. Do you feel that the training sessions helped you to relax better than you could have done on your own?

   a. Yes b. No

II. Rate the following in order of usefulness in helping you to relax. Write one of the following numbers beside each letter.
   1. Very Useful 2. Fairly Useful 3. Not helpful 4. Irritating

____a. The needle on the dial (oscilloscope)
____b. The number readings on the integrator
____c. The sound box
____d. The relaxation instructions read to you at the beginning
____e. The relaxation instructions that you took home to help you practice.

III. Check any of the following that apply. You may write in anything you wish to qualify the statements. Do you think that -

____a. Each session should have been longer
____b. Each session should have been shorter
____c. The sessions should have been closer together
____d. The sessions should have been farther apart
____e. More sessions might have been helpful
____f. The program was longer than necessary
____g. The program seemed to be appropriate in length and frequency.

IV. Do you have any further observations or suggestions? Wirte on the back of the page if you wish.

APPENDIX E

APPENDIX E

E.M.G. Feedback Relaxation Training Record Subject No_____

Session DATE

I.	Relaxation Level	
	Sensitivity	
II.	Relaxation Level	
	Sensitivity	
III.	Relaxation Level	
	Sensitivity	
IV.	Relaxation Level	
	Sensitivity	
V.	Relaxation Level	
	Sensitivity	
VI	Relaxation Level	
	Sensitivity	

Sleep, Mood, Activity Levels

Session I

Session II

Session III

Session IV

Session V

APPENDIX F

APPENDIX F

RELAXATION TRAINING PROGRAM

Adapted from Jacobson (1938), Wolpe and Lazarus (1966) and Schultz and Luthe (1959)

1. Suggestions for Relaxation.
   1. Make sure you are in a comfortable position before the session begins, shift back and forth until you are.
   2. If you are feeling tension anywhere, stretch or tense up and then relax the tense part or parts of your body.
   3. Let your jaw go loose and slack - teeth should not touch, but keep your lips together so your mouth doesn't get dry.
   4. Adopt an attitude toward your thoughts "they are not important", you are not concerned about them - any plans for what you have to do can wait until after you relax.
   5. In order to relax you will have to -
      a. Concentrate so that you don't worry or think anxious thoughts.
      b. Become and stay aware of each part of your body so that tension does not remain or develop anywhere.
      c. Become passive and detached about the whole process, you cannot force yourself to relax, you have to let it happen, it's not so important whether you succeed or fail, it doesn't matter, you just "let go" all over.
   6. Some techniques that may help you relax deeper and deeper are -
      a. Passively concentrating on autogenic formulas for heaviness and warmth.
      b. Keeping your mind blank or imagining yourself in a peaceful pleasant scene. Sometimes imagine total, warm blackness enveloping you.
      c. Breath evenly, but fall deeper and deeper into relaxation with each exhalation.
      d. In your mind, go through your whole body, starting with your toes or head, become aware of each part and let go any tension present.

II. Read the following procedure slowly and deliberately to the subject. Leave at least a five second pause between each phrase.

Lie quietly in a comfortable position....Take a deep breath....Pull your toes toward your head and tighten your leg and calf muscles....Breathe out and let go....Take a deep breath....Make a fist with both hands and tighten your arm and shoulder muscles....Breathe out and let go....Take a deep breath....Bite down with all your might and tighten your jaw muscles....Breathe out and let the muscles go limp....Take a deep breath ....Tighten your stomach muscles, make your abdomen hard....Breathe out and let go....Once more press and tighten your stomach muscles....Relax

and let go....Take a deep breath....Tighten every muscle in your body and feel your body start to tremble with tenseness....Hold the tension.... Breathe out and let go completely....Take a deep breath....Tighten every muscle in your body and feel the tension....Breathe out and let go.... Take a deep breath....Tighten every muscle in your body....Breathe out and let go. Now breathe normally and evenly as you mentally repeat the following phrases to yourself....I feel very quiet....I feel very quiet ....I am beginning to feel quite relaxed....I am beginning to feel quite relaxed....My feet feel heavy and relaxed....My ankles feel heavy and relaxed....My knees feel heavy and relaxed....My hips feel heavy and relaxed....My hips feel heavy and relaxed....My ankles, my knees and my hips feel heavy and relaxed....My back and the whole central portion of my body feel heavy and relaxed....My back and the whole central portion of my body feel heavy and relaxed....My hands feel heavy and relaxed.... My arms feel heavy and relaxed....My arms feel heavy and relaxed....My shoulders feel heavy and relaxed....My hands, my arms and my shoulders feel heavy and relaxed....My hands, my arms and my shoulders feel heavy and relaxed....My neck feels heavy and relaxed....My neck feels heavy and relaxed....My jaws feel heavy and relaxed....My forehead feels heavy and relaxed....My forehead feels heavy and relaxed....My neck, my jaw and my forehead feels heavy and relaxed....My neck, my jaws and my forehead feel heavy and relaxed....My whole body feels heavy and relaxed....My whole body feels heavy and relaxed....My breathing is getting deeper and deeper....The top of my head feels heavy and warm....The warmth flows to my right shoulder....My right shoulder is heavy and warm....My right shoulder is heavy and warm....My breathing is getting deeper and deeper ....The warmth flows down to my right hand....My right hand feels heavy and warm....The warmth flows back up to my right shoulder ....My shoulder

is heavy and warm....My right arm is heavy and warm....My right arm is heavy and warm....My warmth flows across my back to my left shoulder.... I feel the warmth in my back....My back is heavy and warm....The warmth flows into my left shoulder....My left shoulder is heavy and warm....My left shoulder is heavy and warm....The warmth flows down my left arm to my left hand....My left hand is heavy and warm....My left hand is heavy and warm....The warmth flows back up my left arm through my arm through my elbow....My elbow is heavy and warm....My elbow is heavy and warm.... My left shoulder is heavy and warm....My left shoulder is heavy and warm ....The warmth flows to my heart....My heart is heavy and warm....My heart is heavy and warm....My heartbeat is slow and regular....The warmth flows into my stomach....My stomach is heavy and warm....I am breathing deeper and deeper....The warmth flows down into my right thigh....My right thigh is heavy and warm....My right thigh is heavy and warm....The warmth flows down into my right foot....My right foot is heavy and warm ....My right foot is heavy and warm....The warmth flows up through my right calf, to my right knee, to my right thigh, to my right hip....My right leg is heavy and warm....My right leg is heavy and warm...-The warmth flows to my left hip and down my left leg to my left foot....My left foot is heavy and warm....My left foot is heavy and warm....The warmth flows up through my abdomen, through my stomach and into my heart ....My heart is heavy and warm....My heart is heavy and warm....My heart pumps the warmth throughout my entire body....My whole body is heavy and warm....My whole body is heavy and warm....I am breathing deeper and deeper....My whole body feels quiet, comfortable and relaxed....My arms and hands are heavy and warm....My mind is quiet....I withdraw my thoughts from my surroundings....I feel serene and still....I am at east ....I am at east....Deep within my mind I can visualize and experience

myself as relaxed....Deep within my mind I can visualize and experience myself as comfortable and still....My mind is calm and quiet....I feel an inward quietness....I am now relaxed and alert....My hands are heavy and warm....I feel quite quiet....My whole body is relaxed and my hands are warm, relaxed and warm....My hands are warm....Warmth is flowing into my hands....They are warm....warm.

APPENDIX G

APPENDIX G

PRACTICE GUIDELINES

Adapted from Jacobson (1938), Wolpe and Lazarus (1966) and Shultz and Luthe (1959)

This instruction sheet is to help you in your practice sessions at home. Try to practice faithfully 15-30 minutes twice a day. Use whatever portions of this guideline that you find helpful in achieving maximum relaxation. Try to recapture the feeling you had when you relaxed very well with the help of the E.M.G. feedback machine.

General Suggestions for Relaxation

1. Make sure that you are in a comfortable position before the session begins.
2. Let your jaw go loose and slack - teeth should not touch, but keep your lips together so you mouth doesn't get dry.
3. Adopt an attitude toward your thoughts - "they are not important", "you are not concerned about them - any plans can wait until after you relax".
4. Let all thoughts pass through your mind without dwelling on them. Keep your mind blank or think of yourself as being in a peaceful pleasant scene, or in warm enveloping blackness.
5. Become passive about the whole process, you cannot force yourself to relax, you have to let it happen, just "let go" all over.

Steps. Allow some time between steps. You may not need all of these every time.

1. Lie in a comfortable position. Let yourself relax to the best of your ability.
2. Take a deep breath, pull your toes toward your head and tighten your leg and calf muscles. Notice the tension. Breathe out and let go.

Enjoy the contrast.

3. Take a deep breath. Make a fist with both hands and tighten your arm and shoulder muscles. Breathe out and let go. Even when your arms seem fully relaxed, try to go that extra bit further: try to achieve deeper and deeper levels of relaxation.
4. Wrinkle up your forehead now: wrinkle it tighter....now relax and smooth it out. Progress in the same way to tightening and relaxing eyes, jaws, neck, shoulders and upper back....tensing and then relaxing. Try to keep other areas of the body relaxed.
5. Tighten your stomach muscles, make your abdomen hard....then relax. Repeat once or twice. Let the tension dissolve as the relaxation grows deeper.
6. Now direct your attention to your lower back. Tighten up your back, and feel the tension along your spine....and settle down comfortable again, relaxing the lower back....Repeat.
7. Progress in a similar manner to hips, thighs, calves and ankles.
8. Now breathe evenly and spend some time thinking the following phrases to yourself. Try to hear them and feel them as you dwell on them.
   a. I feel quiet, very quiet.
   b. I am beginning to feel quite relaxed.
   c. My feet feel heavy and relaxed.
   d. My ankles, my knees and my hips feel heavy, relaxed and comfortable.
   e. My abdomen and the whole central portion of my body, feel relaxed, warm and quiet.
   f. My hands, my arms and my shoulders feel heavy and relaxed. They are comfortable and relaxed.
   g. My whole body feels quiet, heavy, comfortable and relaxed. Continue to relax for one minute.

h. I feel quiet and relaxed.

i. My arms and hands are heavy and warm.

j. I feel quite quiet.

k. My whole body is relaxed. My hands are warm, relaxed and warm.

l. My hands are warm.

m. My back and the whole central portion of my body feel relaxed and comfortable.

Continue to relax for a minute. Let yourself relax deeper and deeper.

n. My whole body feels quiet, comfortable and warm.

o. My mind is quiet.

p. I am at ease.

q. Deep within my mind I can visualize myself as relaxed, comfortable and still.

r. I feel an inward quietness.

s. My mind is calm and quiet.

When the time for relaxation is concluded, the whole body is re-activated with a deep breath and a stretch. You should then feel fine and refreshed, wide awake and calm.

APPENDIX H

APPENDIX H

Average Daily Discomfort Ratings

Subjects	Period A	Period B	Period C
1.*	2.0	2.1	1.28
2.	3.33	1.4	1.7
3.	1.33	.28	1.14
4.	3.33	3.14	3.7
5.*	3.0	1.28	0
6.*	4.0	1.0	0
7.*	3.3	2.0	1.0
8.	2.3	3.0	2.0
9.	2.0	1.28	2.4
10.	1.0	.14	.28
11.	2.0	1.14	1.0
12.*	3.3	.42	.14
13.	2.6	2.28	2.0
14.	1.66	1.14	1.28
Average	2.46	1.47	1.28

Period A - The three days prior to first relaxation session

Period B - The seven days prior to sixth relaxation session

Period C - The seven days prior to seventh relaxation session

* - Known to have had an acute episode of their chronic low back pain shortly before training program.

APPENDIX I

APPENDIX I

Average Number of Analgesic and Sedative-Relaxant Tablets Required by the Subjects Each Day

Subjects	Period A	Period B	Period C
1.	0	.14	o
2.	1	0	0
3.	0	0	0
4.	.28	0	0
5.	0	0	0
6.	0	0	0
7.	0	0	0
8.	8.0	8.1	5.28
9.	1.0	.57	.42
10.	0	0	0
11.	1.0	.07	.28
12.	4.0	.57	.28
13.	1.4	.57	0
14.	0	.85	0
Average	1.19	.77	.54

Period A - The three days prior to first relaxation session

Period B - The seven days prior to sixth relaxation session

Period C - The seven days prior to seventh relaxation session

APPENDIX J

APPENDIX J

CONTRACT OF AGREEMENT TO PARTICIPATE IN
BIOFEEDBACK RELAXATION TRAINING

The purpose of this study is to promote relaxation with the aid of electromyograph (E.M.G.) biofeedback and audiofeedback signals and thereby attempt to reduce discomfort and muscle spasm in the back.

I, ..., agree to participate in this study. I understand that there will be no risks to me as a result of the technic used in the (E.M.G.) feedback relaxation training. Instead, I may benefit from the training program by learning how to relax, and possibly, to reduce the muscle spasm and discomfort in my back. The program has been explained to me and I have been given the opportunity to ask questions regarding the contemplated procedures and have received satisfactory answers to my questions. I understand that I am expected to attend at least six practice sessions at Loma Linda Medical Center, as well as to practice twice daily in my home; but that I may withdraw from the program at any time if I so desire.

I agree to complete a brief questionnaire at the beginning and at the end of the practice period. I understand that the information thus gained will be kept confidential and anonymous.

I, therefore, give my free and voluntary consent to participate in the project described above, under the supervision of Mrs. Esther M. Fashina, R.N. and Mrs. Dorothy Holm, R.N. of Loma Linda University.

I have been referred by my physician, Dr. . . . . M.D. I understand that the program will be conducted on the ninth floor of the Loma Linda University Medical Center.

I have signed this consent at the Loma Linda University on

(Date) . . . . . Day . . . . . Month . . . . . .

Signature of the Participant . . . . . .

Address . . . . . Telephone No. . . . .

Signature of Witness . . . . . .

Hospital No., if any . . . . . .

APPENDIX K

APPENDIX K

GENERAL DATA ON ALL SUBJECTS

SUBJECTS	RELAXATION MEANS	1st	2nd	3rd	4th	5th	6th	7th	I.E.	AGE	SEX
1	B	51.7	63.3	50	17.6	73	47.6	61	6	27	F
	S	16.4	27	22.6	20.2	18.7	24.6	36.9			
2	B	36.3	24.6	20.6	28.6	17.6	13.3	8.6	9	27	F
	S	29.9	26.5	24.6	27.3	20.1	5.26	7.0			
3	B	47.6	23.6	10.0	10.6	15.0	11.6	12.3	7	27	F
	S	54.4	34.2	9.3	12.6	10.7	9.4	19.2			
4	B	38.6	84.3	36.0	24.0	21.6	48.0	67	2	46	F
	S	26.6	35.0	12.8	19.6	18.5	29.6	34.6			
5	B	7.0	12.3	15.3	19.0	8.6	30.3	28.0	7	42	F
	S	4.6	20.2	6.6	6.0	5.1	19.8	23.6			
6	B	9.0	3.6	3.6	38.3	5.0	9.0	61.6	6	61	M
	S	10.1	3.2	4.0	7.13	5.5	3.9	29.1			
7	B	16.3	42.0	32.6	46.0	29.3	22.6	37.6	11	58	M
	S	18.4	22.8	13.0	23.9	11.8	32.0	20.1			
8	B	8.3	8.0	48.3	11.6	16.0	32.3	64.6	4	56	M
	S	12.6	6.7	48.4	14.8	24.5	31.3	51.5			
9	B	11.6	12.3	13.3	6.3	7.8	19.9	2.3	8	51	F
	S	9,0	5.13	6.8	6.0	6.7	14.6	1.9			
10	B	43.6	33.6	44.3	11.6	10.6	13.6	5.3	12	26	F
	S	14.3	21.6	19.8	10.4	11.0	9.6	4.6			
11	B	35.6	20.0	20.6	29.3	23.6	19.6	5.3	10	62	F
	S	10.0	25.6	28.6	26.2	8.0	7.85	3.6			
12	B	41.6	14.0	9.6	7.0	2.6	2.6	14.0	6	56	M
	S	9.3	6.8	6.6	6.8	5.0	11.3	6.7			

13	B S	35.3 14.0	22.0 24.6	21.3 20.4	5.6 6.9	6.0 6.1	5.3 5.0	28.7 26.5	10	53	F
14	B S	63.6 56.0	61.0 33.3	68.6 34.7	8.6 10.2	13.6 22.6	24.0 9.0	37.0 32.6	9	36	M

B - Relaxation Baseline E.M.G. Level Mean

S - Relaxation Session E.M.G. Level Mean

I-E - Score on the Internal-External Scale

APPENDIX L

Figure 1.

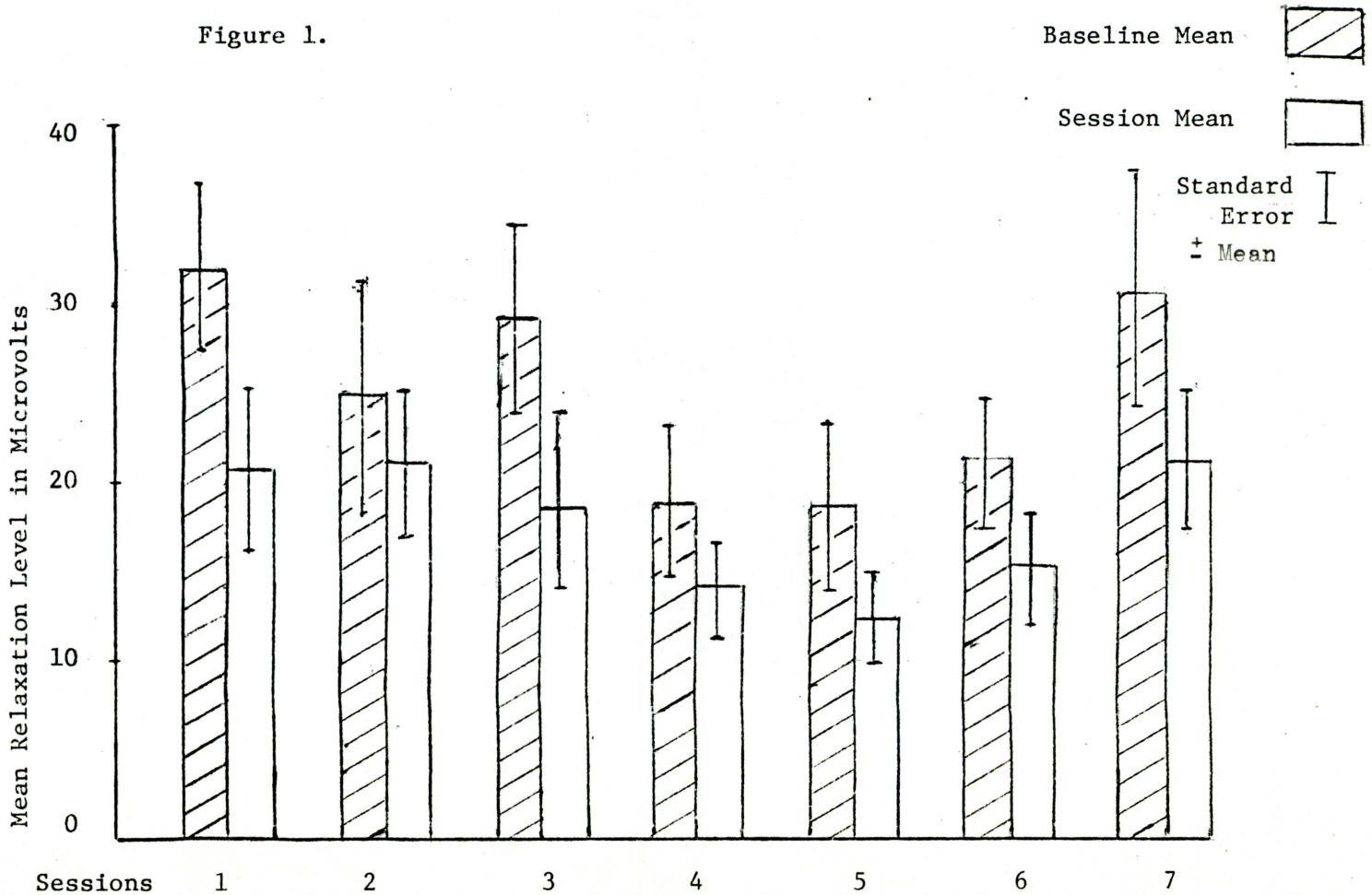

Figure 1 - Mean Relaxation Levels for all Sessions for Fourteen Subjects

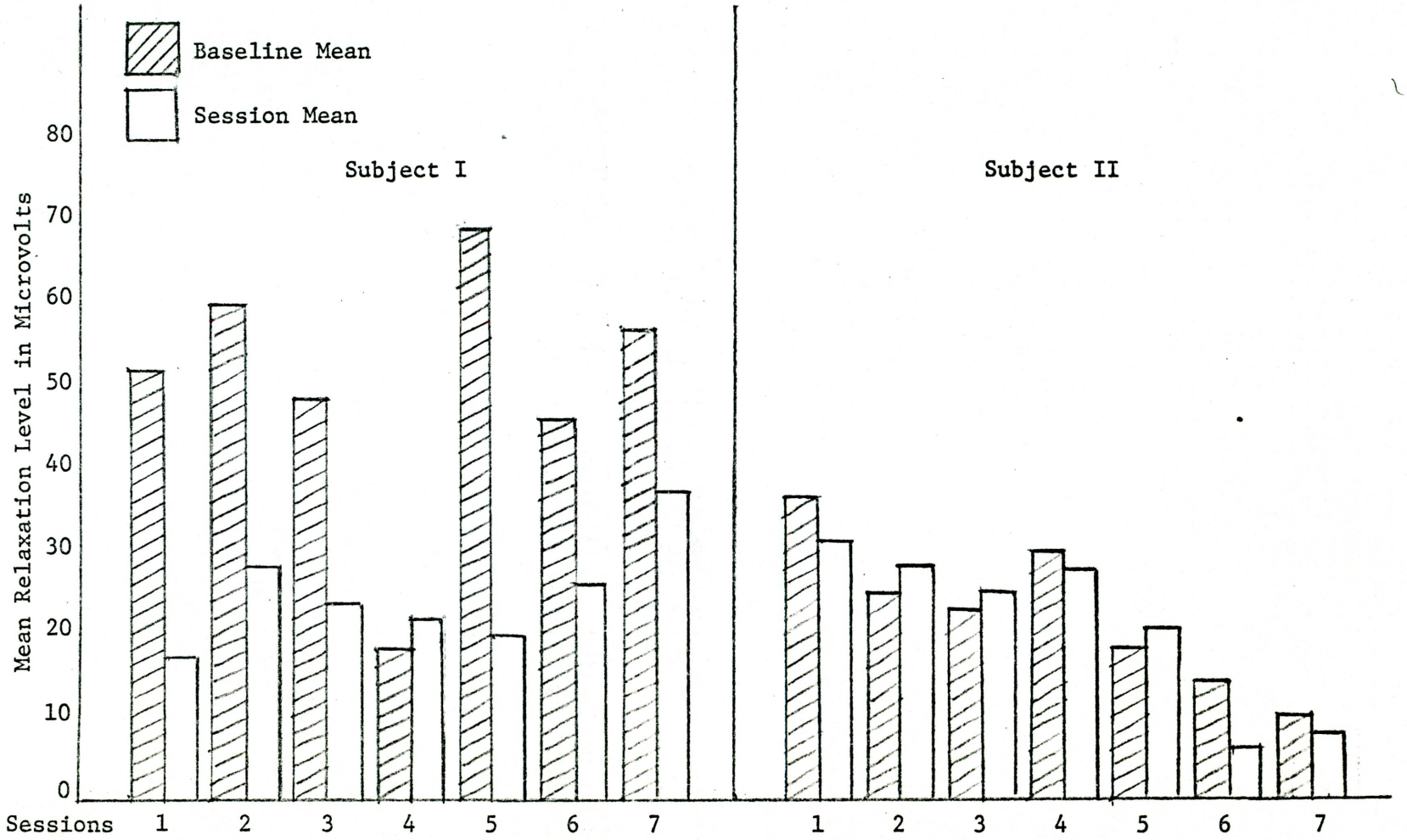

Figure 2 - Mean Relaxation Levels of All Sessions for Subjects I and II

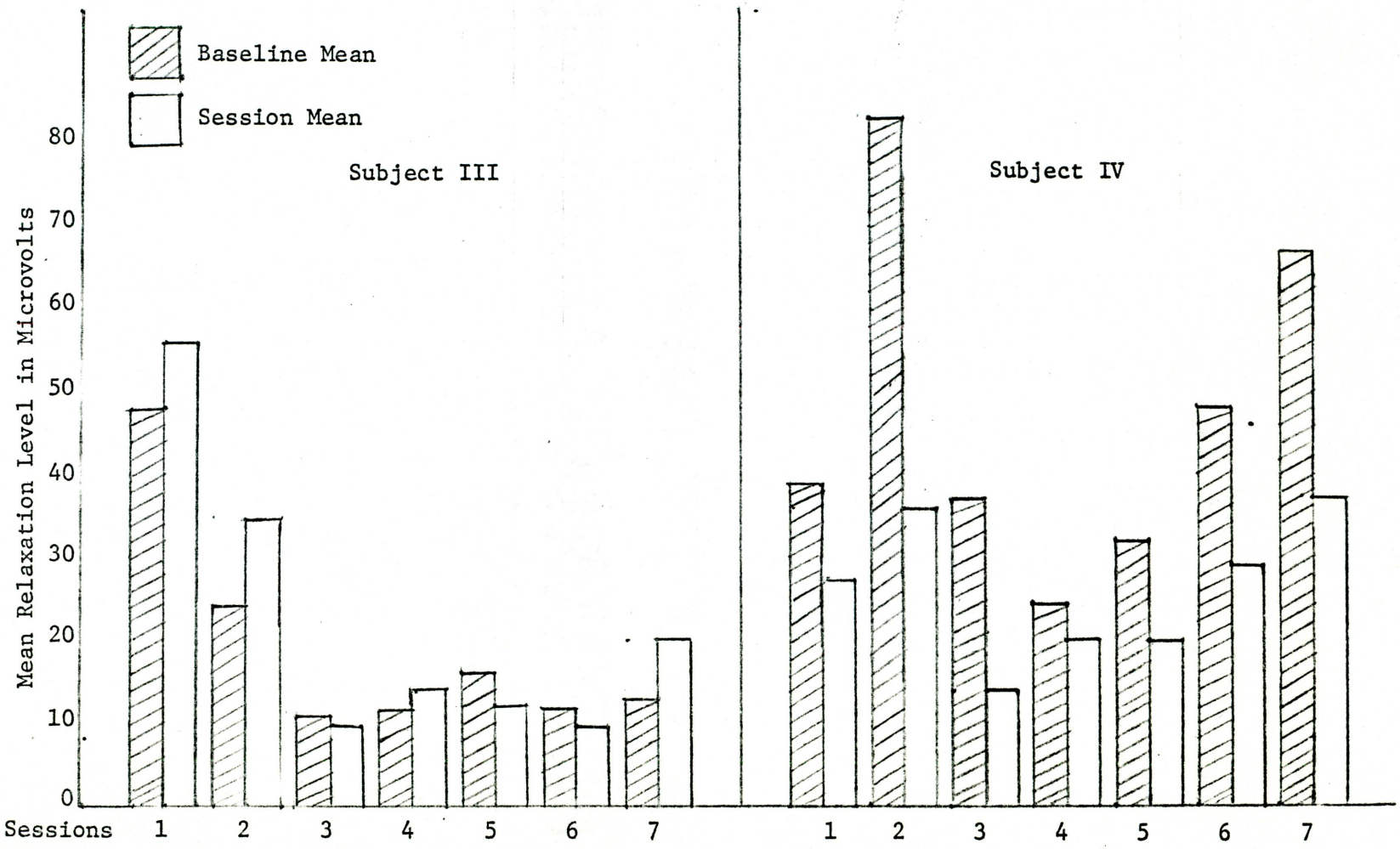

Figure 3 - Mean Relaxation Levels of all Sessions for Subjects III and IV

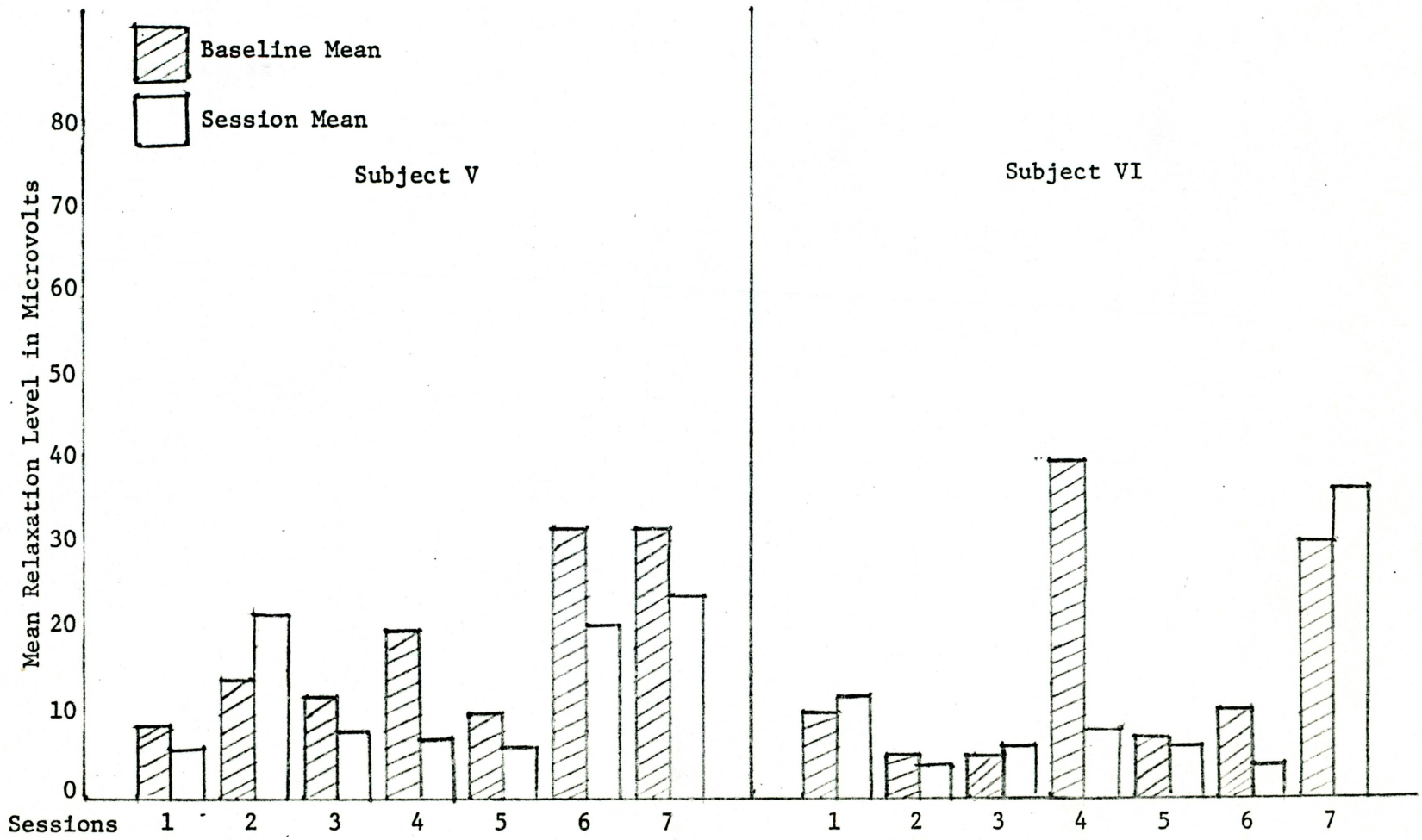

Figure 4 - Mean Relaxation Levels of all Sessions for Subjects V and VI

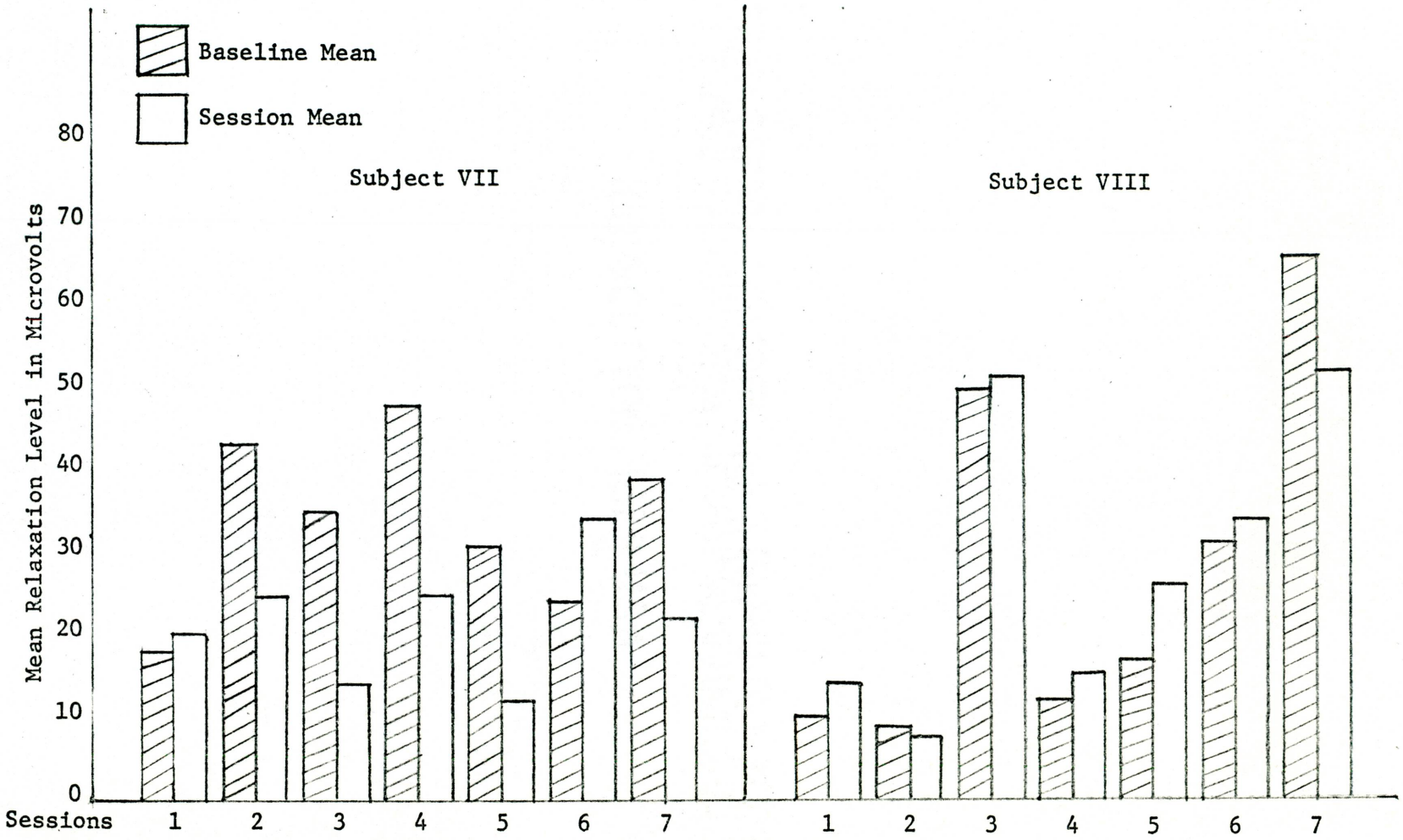

Figure 5 - Mean Relaxation levels of all Sessions for Subjects VII and VIII

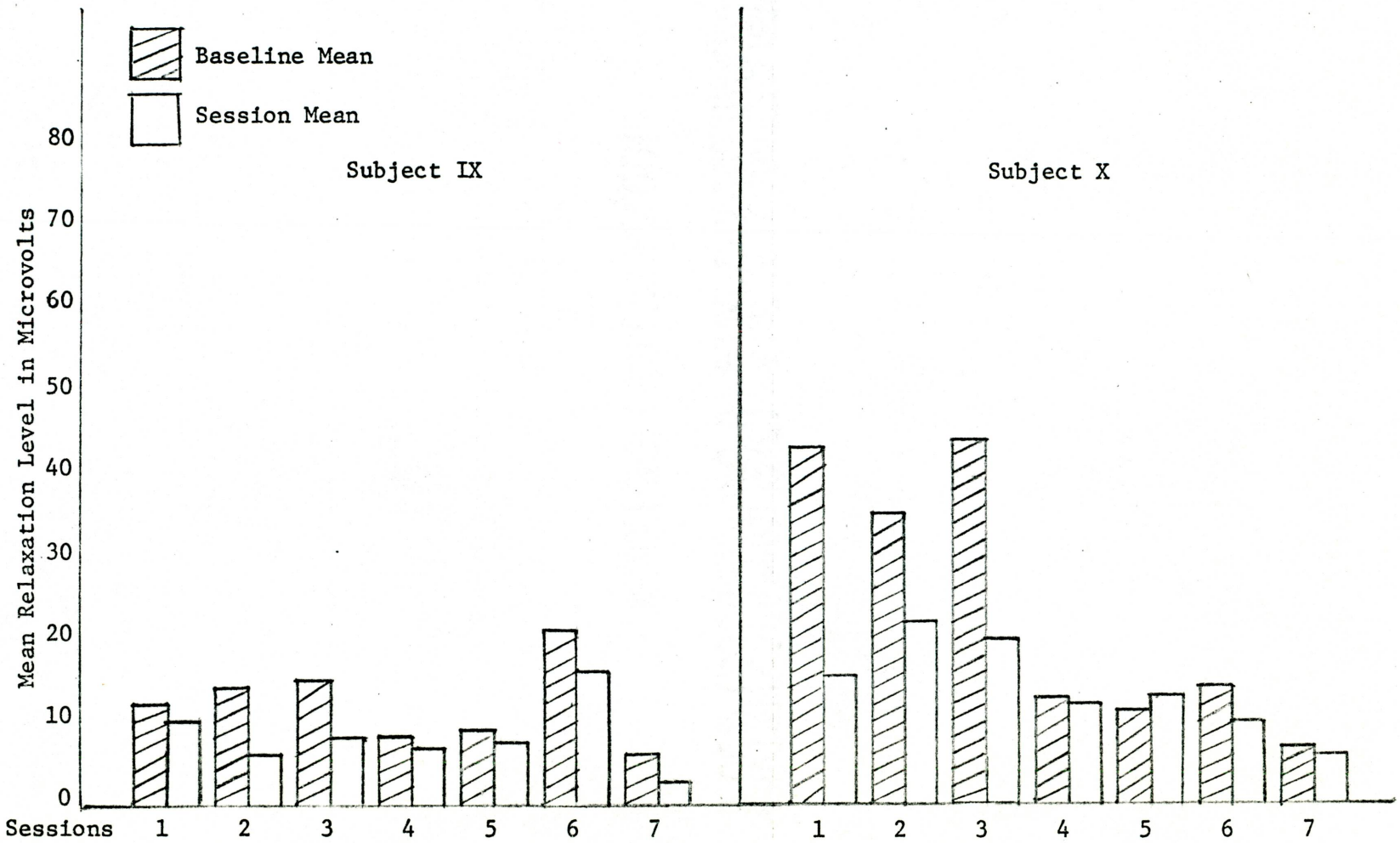

Figure 6 - Mean Relaxation Levels for All Sessions for Subjects IX and X

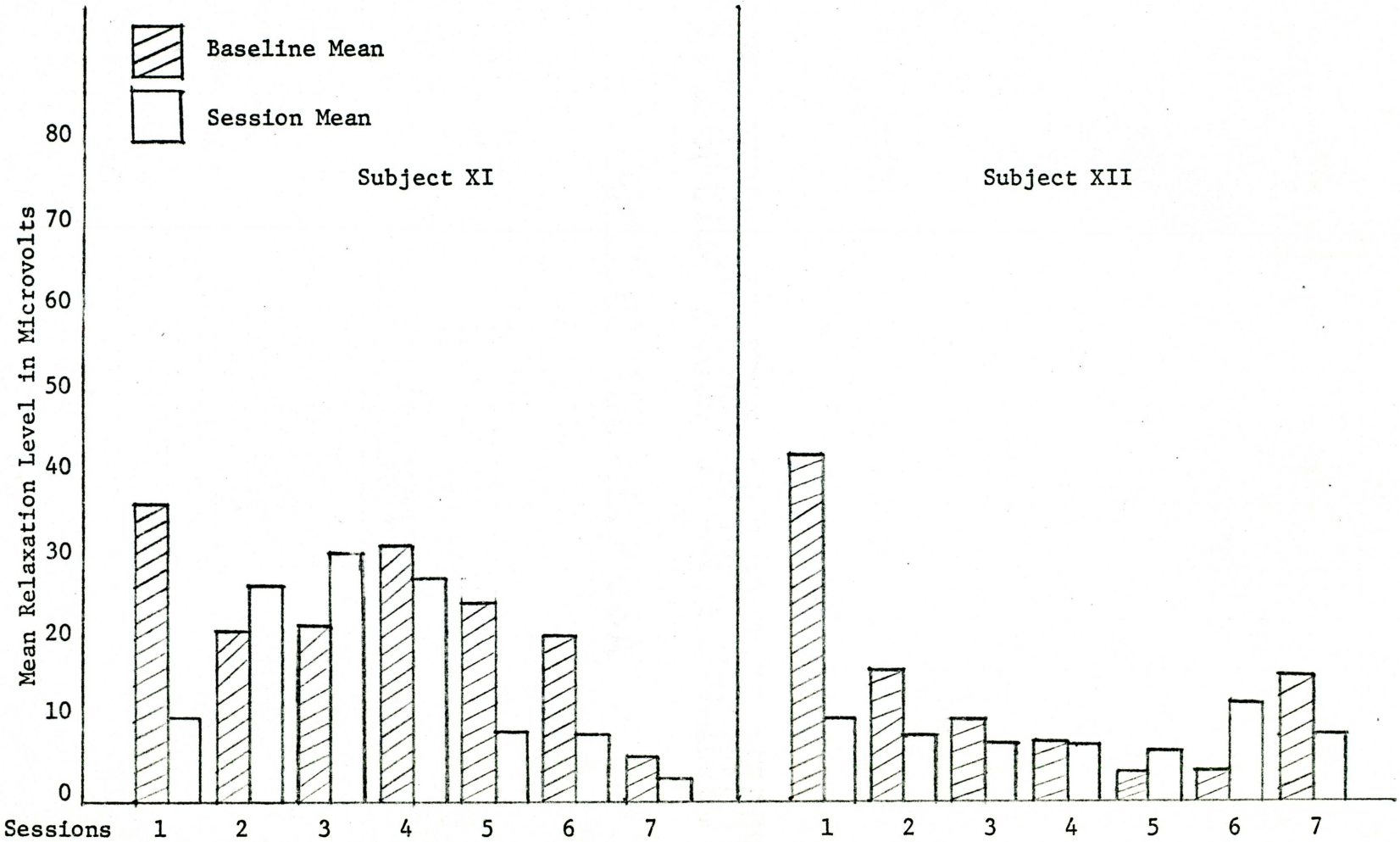

Figure 7 - Mean Relaxation Levels for All Sessions for Subjects XI and XII

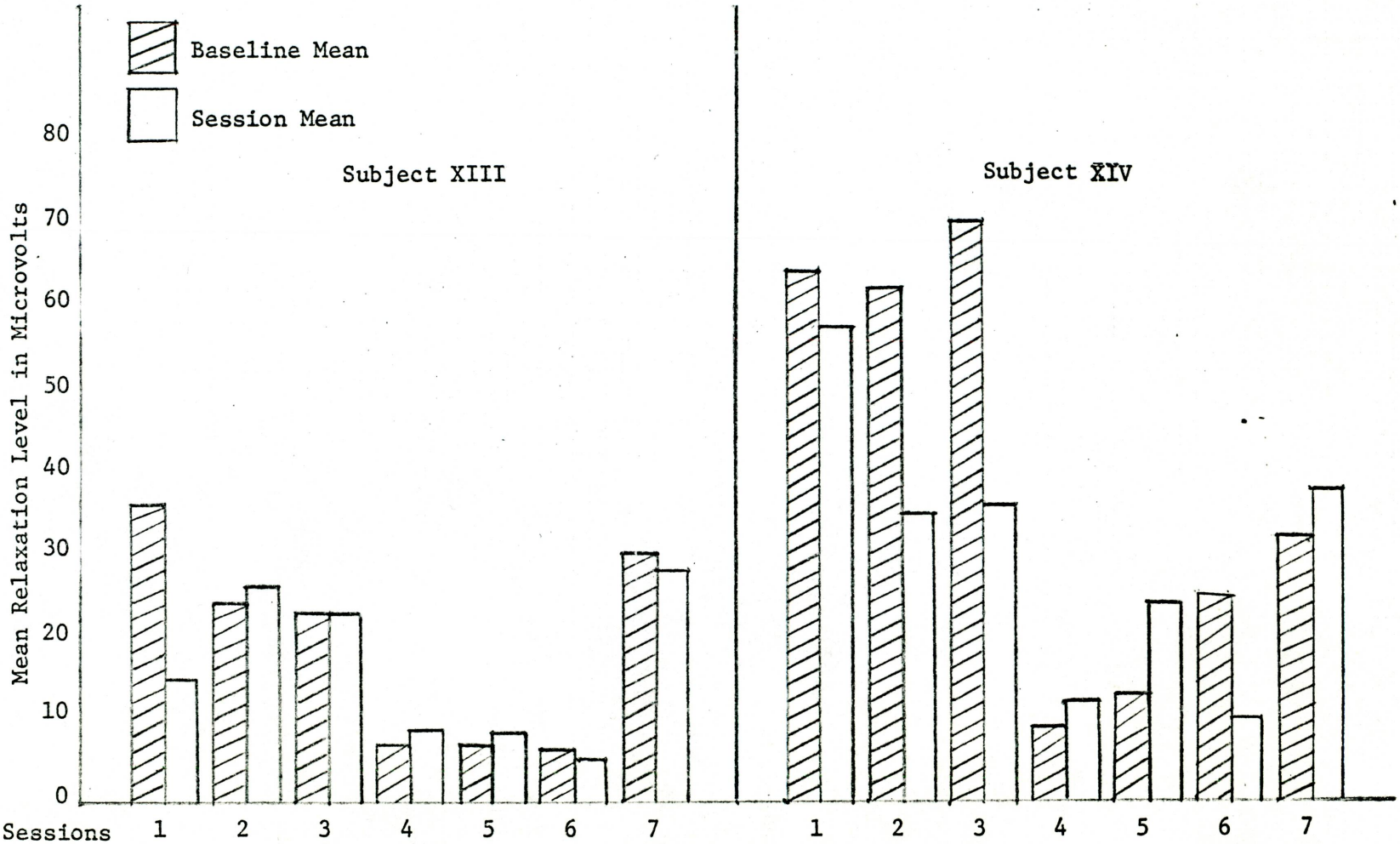

Figure 8 - Mean Relaxation Levels for All Sessions for Subjects XIII and XIV

LOMA LINDA UNIVERSITY

Graduate School

THE USE OF E.M.G. BIOFEEDBACK TO PROMOTE RELAXATION AND RELIEF OF CHRONIC LOW BACK PAIN

by

Esther Fashina and Dorothy Holm

An Abstract of a Thesis

in Partial Fulfillment of the Requirements

for the Degree Master of Science

in the Field of Nursing

May 1974

ABSTRACT

The purpose of this exploratory study was to determine if relaxation instruction and electromyographic (E.M.G.) feedback would reduce chronic low back pain. A secondary aim was to determine if the locus of control variable as defined by Rotter would influence the results obtained.

Fourteen non-hospitalized subjects with chronic low back pain, meeting the criteria of this study became the sample group. The training program consisted of six 30-minute sessions during which the subjects were taught relaxation with the use of a feedback electromyograph and relaxation instructions. After an interval of two weeks, a seventh session was conducted to evaluate if the relaxation learned could be maintained without frequent training sessions. The subjects also practiced relaxation twice daily at home between training sessions. A daily record of analgesics, sedatives and muscle relaxants taken three days before, during and two weeks after the training sessions was kept by the subjects.

In a preliminary orientation session, demographic data was collected, principles of relaxation and biofeedback were discussed and the subjects completed Rotter's Internal-External Scale questionnaire. According to their scores they were ranked and dichotomized into two groups, those having greater internal locus of control and those having greater external locus of control. Seven subjects fell into each category.

Data was analyzed and conclusions drawn on the basis of changes in the average pain scores, the changes in the amount of medication required and the decreases in the E.M.G. microvolt levels. A t-test showed a

significant difference between baseline pain recordings and those of the week before the sixth session. There was also a significant difference between the baseline record and the average of the week before the seventh session. A decrease in the amount of medication required was noted. No attempt was made to analyze this variable statistically because of the limited number of subjects who took medication with any degree of consistency. The difference in the E.M.G. microvolt levels between the beginning of the first relaxation session and the mean of the sixth session was significant at the .02 level. The difference was less when the first session was compared with the seventh session, P = .13).

T-tests indicated no significant difference between the two locus of control groups in their ability to relax, reduce the intensity of their pain and pain medications required, and to retain what they have learned for two weeks after the end of the training period.

Subjective responses indicated that eight subjects felt that the program improved their ability to sleep. Ten subjects reported that they were able to increase their activity levels, and/or maintain a sitting or standing position with less discomfort. Results from responses to the questionnaire at the end of the sixth session indicated that thirteen of the fourteen subjects felt that they had experienced some decline in the intensity of their low back pain. Seven noted that they felt a marked improvement.

There are limitations on the interpretation of the findings of this exploratory study which should be emphasized. Some of these limitations are as follows: The instructions for relaxation and the autogenic phrases read by the researchers were rated by the subjects as more helpful than the E.M.G. visual and audiofeedback. It is possible that the recumbent position of the subjects during the training sessions might have reduced

their ability to see the E.M.G. microvolt dial, thereby reducing the effectiveness of the visual feedback signal. The researchers related to all subjects in a supportive way. Since no control group was used in the exploratory study, the Hawthorne effect cannot be excluded as an explanation for relief of pain, reduction in medication used, or increases in relaxation. Two researchers administered the training program, each used the same protocol and followed specific subjects throughout the entire session. However, because of small subgroup numbers no attempt was made to evaluate the effect of the differences in the individuality of the researchers on respective subjects. Other intervening variables that were apparent but impossible to control were: pain from other sources; interfering emotional concerns; concomitant therapy and the possibility that the presenting low back pain problem was due to an acute episode of the existing chronic back pain.