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A STUDY OF THE EFFECTIVENESS OF VARIOUS  
METHODS OF MUSCULAR RELAXATION

A thesis presented in partial fulfilment  
of the requirements for the degree of Master of  
Arts in Psychology at Massey University.

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1979.

### ABSTRACT

This study was designed to compare the effectiveness of four different methods of skeletal muscle relaxation.

Twenty four male, undergraduate student volunteers were recruited for this study, the age range was 18 to 31 years.

The Experiment was conducted in two sections as time did not allow for the training of 24 Subjects concurrently. Section I was conducted over weeks one to eight inclusive and Section II was conducted over weeks nine to thirteen inclusive.

All Subjects received two pre-test sessions which involved the measuring and recording of the level of tension which was present in three muscle groups, the occipitofrontalis, the right sternocleidomastoid and the right biceps.

Muscle tension was measured using a Disa 3-channel Electromyogram, and recorded using a multichannel ultra-violet recorder.

The Subjects were assigned to training groups (four Subjects per group) on the basis of visual inspection of the records, those with the highest levels of tension recorded were assigned at random between the groups, similarly those with medium levels of tension and those with low levels of tension were assigned at random to the groups.

The training methods in Section I were, Progressive Relaxation, Jacobson (1938) and Control Group C. The training methods in Section II were, Muscle Relaxation, Wolpe (1969), Metronome Conditioned Relaxation, Brady (1973) and Control Group F.

When the training sessions were completed, each Subject received two post-test sessions, which were of the same format as the pre-test sessions.

The data recorded was then scored and converted into an integrated E.M.G. Analysis of the results indicated that in most cases there was little, if any reliability between scores on pre-test I and pre-test II thus further quantitative analysis of the data was not appropriate. Graphic representation was made of group means for comparison between pre-test II and post-test I.

It was expected that training in some of the methods would produce complete muscle relaxation, (or no tension as measured on the Electromyograph recordings.) The Subjects inability to achieve voluntary muscle relaxation may have been attributed to several factors in the design of the experiment. The Subjects were trained in a different room to the pre-test, post-test room. The recording from the muscle groups during pre-test, post-test sessions may well have interfered with the Subjects ability to relax. The stimuli presented to the Subjects during the testing sessions also appeared to contribute towards the Subjects inability to relax.

The Experimenter's observations of the Subjects during the latter stages of training indicated that the Subjects in Jacobson's Garmany's and Wolpe's methods all appeared to achieve some level of relaxation which was not reflected in the results recorded.

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## INTRODUCTION

Petersen (1972) reported that " Jacobson's (1938) method of progressive relaxation appears to be a slow process, but nevertheless, a highly successful and rewarding one."

One limitation of the study was the fact that it was reported :  
" at no time was the experimenter absolutely certain that the subject had obtained complete skeletal muscle relaxation." (S.M.R.)

An Electromyogram provided opportunity for a more thorough investigation of the level of relaxation Jacobson's method appeared to produce. It was expected that E.M.G. recordings would provide more objective data that Jacobson's method produced a deep level of S.M.R.

S.M.R. was used originally by the medical profession with no formal training in Psychology, such as Jacobson (1938) and Schultz (1959). Initially rest was prescribed as an adjunct to nervous hypertension, other nervous symptoms and also for post-operative treatment. Observation of patients showed that optimal resting or relaxation was not obtained this way, there was still skeletal movement. Thus the value of prescribing rest alone, may well be questioned. Jacobson (1938) lists the therapeutic use of progressive relaxation (p.419) using self report of patient, and therapists report of the success in alleviating 27 different physical and psychosomatic disorders.

Relaxation techniques of varying form have practical application today in the clinical setting either as part of a psychotherapeutic process, e.g. Wolpe's (1949 Systematic Desensitization or as a technique in itself.

The technique of S.M.R. is still being applied in the clinical setting when other techniques such as transcendental meditation and yoga have considerable predominance and acceptance in the community, and whose teachers and students claim outstanding effects, such as physical and psychological quiescence as a result of their respective methods. This may be due to the fact that new methods are often regarded with suspicion, and also the opportunity for therapists to learn the techniques may not be present.

Apart from the clinical applications of S.M.R. just mentioned it also has importance in psychophysiology.

Jacobson (1938) states his interest in relaxation was stimulated by research in 1908 at Harvard in the area of neuromuscular tension. By this time Sherrington was investigating the motor and sensory pathways of muscles. The importance of the physiology of the motor system can be seen when one considers the fact that all movement is brought about by contraction or tension in the skeletal musculature. ( Without this capacity for movement, the organism would be virtually defunct ).

Muscle tension may be unambiguously defined as motor unit firing. Electromyography makes it possible to record and measure the electrical activity associated with the firing of motor units.

The term "muscle tension" defined above must not be confused, as it often is in the literature, with the feel of normal healthy muscle tissue which is firm when palpated, as compared to the feel of the flaccid muscle of a paralysed person. In this study, tension refers to motor unit firing, that is, an increase in tension between the origin and insertion of the muscle. This tension may give rise to shortening of the muscle, or an isotonic contraction, this action results in displacement at the joint over which the muscle lies. On the other hand, if there is

external resistance, or an antagonistic muscle contracting to an equal degree, there will be no displacement at the joint, this is known as an isometric contraction. An isometric contraction may not always be observed through visual inspection, but with practise it becomes possible to identify quite small amounts of tension in a muscle by palpation of the area.

The use of the Electromyogram is the only possible method of ascertaining with any degree of confidence, that there is complete relaxation, or no tension present in a muscle.

Many experimenters claim to use a shortened version of Jacobson's method. An attempt was made to evaluate some of these other methods in this study.

Autogenic training, as set out by Luthe (1962) was considered but was discarded due to the fact that training took four to ten months.

The muscle relaxation described by Lazarus (1971) was not sufficiently definitive in stating length of time for training, and not detailed enough for this study.

Hypnosis and yoga were not used to obtain S.M.R. because the expertise to use these techniques was not available to the Experimenter, who felt it was necessary to remain the sole person to train all Subjects in this study.

Wolpe's (1969) method of relaxation as used as part of the process of systematic desensitization was felt to be an important method to evaluate as Wolpe (1969) states " The method of relaxation taught is essentially that of Jacobson (1938), but instruction is completed in the course of about six interviews, in marked contrast to Jacobson's very prolonged training schedules." ( p. 100 ) Wolpe admits his method is far shorter than Jacobson's, but doesn't point

out that his method is also a departure from Jacobson's in another very important aspect, that is that Wolpe instructs his subjects in the location of the tension they should feel. Jacobson, in contrast, requires his subjects to identify and locate the sensations of tension for themselves.

A method of Muscle Relaxation by Garmany (1952) was chosen because this method did in fact use the same principles as that of Jacobson's (1938) but also incorporated controlled breathing exercises in contrast to Jacobson who aimed to "free the respiration from voluntary influence." ( p. 60 )

The final method which was considered and decided suitable for evaluation in this study was that of Metronome Conditioned Relaxation, by Brady (1973). This method incorporated the use of a metronome constantly ticking at the rate of 60 beats per minute along with instruction to "relax and let-go of the muscles", this was pre-recorded on a cassette tape. The instruction and tone of this method appeared to be along the lines of that of a type of hypnotic inducement.

Of the four methods chosen for investigation, ( Jacobson, Wolpe, Garmany and Brady ), each one varies from the other in the way the subjects are taught to identify the sensation and location of tension in the muscles. Each one varies in the way the subjects are instructed to relax.

Each method varies in the number of skeletal muscles covered and the amount of time spent on each muscle group before moving on to the next one. This last point may be one of the most crucial factors to be given consideration when comparing the four methods. Jacobson (1938) most clearly allows for the method to be carried out at a pace suitable for each particular Subject. The Experimenter does not move on to a new muscle group until the subject

has had sufficient time and practice to correctly identify the sensation of tension present, and then to let this tension go, or to relax. In contrast to this method, Brady (1973) covers all the major muscle groups in the body in eight steps, allowing only a few minutes to tense, then relax each group of muscles in turn.

All four methods are similar in the respect that the subjects are required to practise relaxation on their own each day, and most important, that the respective authors all claim to achieve the same result, that is, S.M.R.

A large portion of evaluation of S.M.R. is in the area of its use as part of a process of Systematic Desensitization, Wolpe (1958). Mathews (1971) reports measures taken of the effectiveness of S.M.R. many of these used EKG recordings, but also used measures of heart rate, respiration rate and skin resistance, Mathews found contradictions in the results, in all cases it may well be questioned that there were insufficient training sessions to produce S.M.R. It could also be questioned, why such emphasis was placed on the other physiological measures such as heart and respiration rate and skin resistance when it has elsewhere been suggested that these do not vary systematically in any one individual, Duffy (1962).

Valins (1970) suggests that the effect of muscular relaxation in systematic desensitization is from self instruction or instruction from a prestigious person, which leads the Subject to believe, incorrectly, that their efforts were successful and that they are relaxed. This fact may well be taken into consideration in relation to the methods used in the present study, especially when considering the two shortest methods, Wolpe's (1969) and Brady's (1973) when the time taken in training falls considerably short of Jacobson's (1938) full length procedure. N.B.

Jacobson does refer to briefer methods of relaxation, these are not investigated in this study.

To some extent, the suggestion that Valins (1970) makes, that a subject may incorrectly believe he is relaxed cannot occur when using Jacobson's method due to the fact that the subject is required to locate the sensation of tension in the muscles then let this tension go, the subject has to do the work, while the Experimenter is there to guide the subject in the right direction, at the same time, the Experimenter checks that a muscle is relaxed by palpation of the area and passive movement if possible. E.M.G. recordings may be taken as a final check that the subject is in fact relaxing.

The previous study by Petersen (1972) gave the expectation that Jacobson's method was superior to the other methods investigated in the present study, mainly because of the thoroughness and detail of his technique, and also the requirement for the Subject to learn the technique with encouragement from the Experimenter, but without the element of suggestion.

It was also felt that Garmany's (1952) may possibly produce some S.M.R. in the Subjects as this method appeared more similar to Jacobson's (1938) than the other two methods chosen.

The purpose of this present study was to evaluate Jacobson's technique of S.M.R. in comparison to other techniques.

THE METHODS USED

METHOD APROGRESSIVE RELAXATIONE. JACOBSON (1938)

Table I lists the muscle groups, the order in which they were covered for training, and the mean number of sessions for all four Subjects, that instruction was given on each muscle group.

Jacobson (1938) explains the location of the various muscle groups, Gray (1973) was referred to for any additional information.

On arrival each Subject was asked to remove restrictive clothing and instructed to lie on their back on the table, with their arms by their sides and their legs uncrossed.

The Subjects were trained in the cultivation of muscle sense, that is, the ability to identify and locate the sensation of tension in a muscle.

TABLE 1

## MEAN NO. OF SESSIONS FOR INSTRUCTION PER MUSCLE GROUP

<u>Muscle Group</u>	<u>Mean No. of Sessions</u>	<u>Muscle Group</u>	<u>Mean No. of Sessions</u>
Left Biceps	4	Right Biceps	4
Left Triceps	3	Right Triceps	3
Left hand Flexors	2.25	Right hand Flexors	2.25
Left hand Extensors	2.5	Right hand Extensors	2
Left foot Flexors	2.25	Right foot Flexors	2
Left foot Extensors	2.5	Right foot Extensors	2.5
Left leg Flexors	3	Right leg Flexors	3
Left leg Extensors	2.25	Right leg Extensors	3
Left thigh Flexors	1.5	Right thigh Flexors	1.5
Left thigh Extensors	1.5	Right thigh Extensors	1.5
Abdominal Muscles	2	Respiratory Muscles	1.25
Erectores Spinae	1.5		
Left pectoral group	1.75	Right pectoral group	1.75
Left interscapular group	1.25	Right interscapular group	1.25
Elevators of shoulders	1.75		
Bending head to right	2.5	Bending head to left	2.5
Bending head forward	1	Bending head back	1
Holding head up stiffly	3.25		
Wrinkling the brow	2.5	Frowning	3
Closing eyelids tightly	1.25	Turning eyes left, Lightly closed lids	1.75
Lightly closed lids, Turning eyes right	1.75	Eyes looking up	1.75
Eyes looking down	1.5	Eyes stright forward	1.75
Smiling	1	Rounding lips to say "O"	1
Protruding the tongue	1	Retracting the tongue	1.25
Closing jaws tightly	1.25	Opening jaws	1
Counting one to ten	1.75	Swallowing	1
Imagining items	4		

To begin with, it was necessary to familiarise the Subject with the procedure of tensing a muscle group, this sensation was intensified by the Experimenter giving passive resistance with her hand. The first two sessions were spent wholly on the flexors of the left and right forearm and hand.

The verbal instruction given to the Subject initially was, " I want you to bend your left arm slowly and steadily at the elbow while I give resistance with my hand. I want you to tell me what sensations you feel." Some Subjects described a variety of sensations such as pressure from clothing, or the table the upper arm was resting on, or sensations from the joints and tendons. When the Subject correctly identified the sensation arising from the biceps muscle, the Experimenter pointed out that this was the sensation that would be called "tension". The Subject was required to repeat the exercise of flexing the forearm with the Experimenter giving resistance until he could correctly identify the sensation of tension. The Experimenter then gave the Subject the instruction, " This is doing ! What we want is simply the reverse of this, namely not doing ! " Jacobson (p49) The Subject was then instructed to let the tension go slowly, in degrees until no tension was perceived, this was defined as " going in the negative direction" or going in the opposite direction.

After the Subject gained experience of flexing the arm with resistance, he was then requested to flex the arm without resistance, for biceps muscle, and to extend or straighten the already bent arm for triceps muscle, he was to then locate the tension, then go in the opposite direction.

Finally the Subject was required to tense the muscle groups without moving the arm, ( an isometric contraction), then to go in the opposite direction. During early sessions considerable emphasis was placed on letting tension go a little at a time until a minimal amount of tension could be perceived.

With practice, the Subject learnt that it was not necessary to contract a muscle in order to progressively relax. The Subject was instructed at the beginning of a session to relax all the muscle groups previously covered, without first tensing them.

Jacobson (1938) states " From the outset the learner does everything for himself ..... which is entirely different from a suggestive procedure. " ( p 52 ) The Experimenter took care not to introduce the element of suggestion while training the Subjects in this procedure.

As the training sessions advanced, the Experimenter asked the Subject to tense various muscles already covered in previous sessions, and then correctly identify the location of this tension. This was to check that the Subject was in fact learning muscle sense, that is, the ability to detect any tension present in a muscle group, and that he was not merely guessing where the tension should be. Failure on the part of the Subject to correctly locate the tension was indication to the Experimenter that further practise was required, and that the initial instructions given in the first sessions should be repeated to the Subject. The Subject here is required to make a judgement on the presence or absence of tension, similar in nature to an Experiment in Psychophysics, and the Experimenter needs to check the reliability of the Subject's responses, to be confident that the Subject is responding appropriately.

Each Subject progressed at their own rate, no attempt was made to move onto a new muscle group unless the Subject appeared to obtain muscle sense and relaxation of the present muscle group. Some time was spent with all Subjects during later sessions on the relaxation of mental activities.

During each session, after the training in cultivation of muscle sense and relaxation of specific muscle groups, the Subject was given a period when he was instructed to relax, or in Jacobson's term; to " go in the negative direction ", that is to let any tension present in the muscle go. The Subject has been shown from the first session on that tension in a muscle is caused by the Subject voluntarily doing something, while relaxation is the reverse of this, " not doing " Jacobson ( p 49 ) or a negative. Each Subject given a minimum of ten minutes, usually twenty minutes, depending on the amount of time left in each session, for attempting complete relaxation.

As Jacobson pointed out, some Subjects may find unexpected noise outside the room or the presence of the Experimenter disturbing to relaxation, so all Subjects were instructed to use any such distraction " as a signal to relax all the further."

The Subject was also instructed that although brief attention may be needed on beginning relaxation, the aim was to minimize attention, and to make relaxation automatic.

Jacobson (1938) explains that it is possible to obtain S.M.R. without first cultivating muscle sense in a Subject. In this study, every attempt was made to cultivate muscle sense in Subjects trained in this method.

A written record was kept during every training session of all instructions given, muscles covered, relaxation, difficulties, observations and remarks, abbreviated notation was given where possible, using Jacobson's format ( p 48 ).

During the relaxing phase of every training session, the Experimenter checked the level of relaxation of the muscle groups while the Subject was instructed to carry on relaxing. The Experimenter became quite adept at distinguishing a muscle which was relaxed from a muscle which felt slightly tensed. The Experimenter also passively moved the limbs with one hand, while supporting the joint with the other, while the Subject was instructed to continue relaxing. If the Subject wasn't relaxing the limb being passively moved, some resistance could be felt, that is, the limb felt stiff when the Experimenter attempted to move it or the Subject sometimes moved the limb for the Experimenter. The Experimenter also made observations throughout the training sessions of the following objective tests of advancing relaxation which Jacobson ( p 61 ) lists ; observation of the regularity and force of respiration; visual observation of the flaccidity of the muscle group or region; the absence of movement or contraction including speech and winking of the closed eyes; the presence of a sudden involuntary start or jerk; increasingly slow responses to interruption, or failure to respond; the sleepy-eyed appearance of the individual who arises after successful relaxation; the vacuous appearance of the open eyes during relaxation with the facial muscles so relaxed that it is expressionless; the absence of stomach rumbling.

All the Subjects were questioned at the end of each session about any difficulties and the progress they felt they had made.

All the Subjects were requested to practise relaxing at home for at least one hour per day. They were instructed to relax only, and not to contract any muscle groups first.

Any Subjects who completed the procedure before the eighteenth session were given further exercises in the relaxation of mental activities, until all Subjects had completed eighteen training sessions.

METHOD BMUSCLE RELAXATIONGERMANY ( 1952 )

This Method allowed for Subjects to progress at their own rate, all Subjects were given the maximum training time within the context of this technique. The total number of sessions ranged between nine and thirteen.

At the beginning of training sessions each Subject was instructed to loosen any tight clothing and to lie on their back on the table with their arms at their sides and their legs uncrossed.

Like Jacobson, Garmany introduces the Subject to the method of localising tension in the muscles. The Subject was trained to distinguish the feeling of a stretched muscle or joint from the sensation of muscle contraction.

The Subject was instructed to flex the elbow while the Experimenter gave resistance to movement of the forearm. The Subject was asked to identify where he could feel the tension. Garmany does not give consideration to any agreement with the Subject that the sensation should be called tension the way Jacobson does.

The Subject was to repeat this exercise until he was able to isolate the sensation of tension from all other sensations present.

After repeating this exercise with the triceps muscles, the Subject was then instructed to repeat this exercise without resistance from the Experimenter. Garmany states that the Subject " should be taught how to focus his attention on the sensation which arises." The Subject was given exercises to help develop the faculty of focusing on the sensations of tension. The Subject was instructed to practise these exercises for not less than fifteen minutes twice a day.

In session II the Subject is taught to contract the muscles without displacing the limbs ( an isometric contraction ).

During this session the Subject was also instructed in the method of relaxed breathing.

The Subject was asked to allow air to pass in and out at a constant velocity as he breathed, this could be judged by the noise his breathing made. The Subject was also instructed to allow the intensity of the breathing to remain the same. For this exercise, four seconds were to be taken for inspiration and four seconds for expiration. The Subject was instructed to begin and end each session of relaxation with twelve complete respirations.

Session III involved the training of active relaxation, the Subject was instructed his brain was similar to a galvanometer for monitoring when his muscles were at rest. Instructions for relaxing were to be given in the form : "let it go", "let the limb fall limp" or "let it go heavy."

The Subject was to be reminded to check for tension during the session and that relaxation was to start from the position the limb was already in and to obtain an "absence of contraction" of that part.

Garmany introduces the term "active relaxation" here which is in contrast to Jacobson's (1938) technique which implies that relaxation is a passive phenomenon, "involving no effort."

Attention to correct breathing was emphasised during this session.

Sessions IV and V were spent giving further practise in tensing and relaxing the upper, then lower limbs. Garmany (1952) states that in a good patient, everything below the neck should be dealt with now, twice as many sessions may be required for some. Table II lists the order of muscle groups covered and the mean number of sessions taken for all Subjects on each muscle group.

Session VI was used to introduce a further breathing exercise, the Subject was instructed to inspire taking 4 seconds, hold for 4 seconds then expire taking 4 seconds then inspire again. This exercise was to be used in place of the previous breathing exercise at the beginning and end of each training period. During each training session attention should be given to even breathing of medium amplitude.

Session VII involved training of relaxation of occipito-frontralis muscle, muscles around the mouth and muscles of the eyes.

TABLE II

MUSCLE GROUPS PLUS MEAN NO. OF SESSIONS FOR EACH MUSCLE

<u>Muscle Group</u>	<u>Mean No. of sessions</u>	<u>Muscle Group</u>	<u>Mean No. of sessions</u>
Left biceps	1.75	Right biceps	1.75
Left triceps	1.75	Right triceps	1.75
Left leg flexion	2.25	Right leg flexion	2.25
Left leg extension	2.25	Right leg extension	2.25
Left foot flexion	2.25	Right foot flexion	2.25
Left foot extension	2.25	Right foot extension	2.25
Left hand flexion	1	Right hand flexion	1
Left hand extension	1	Right hand extension	1
Left SCM (neck)	1.25	Right SCM	1.25
Interscapular	1.25	Shoulder elevators	1.25
Left pectorals	1.25	Right pectorals	1.25
Left thigh flexion	1.25	Right thigh flexion	1.25
Left thigh extension	1.25	Right thigh extension	1.25
Raise eyebrows	1	Frown	1
Wrinkle nose	1	Smile	1
Purse lips	1	Cojugate deviation of eyes	1

Session VIII involved integration of relaxation learned for all the individual muscle groups. The Subject was instructed to allow his whole body to relax quickly even if a series of steps are still required for this. The Subject was instructed to use this technique during the course of everyday living.

Garmany's method of S.M.R. may be administered over eight to twelve sessions, depending on the progress of the Subject. One Subject in this study requested a further session to practise S.M.R., this was granted.

Emphasis was placed on the need for Subjects to check regularly for any tension present in the body in this method. Although Garmany (1952) like Jacobson (1938) emphasises the need for the Subject to be able to relax from any level of skeletal muscle tension present at a particular time.

METHOD DMUSCLE RELAXATIONWOLPE ( 1969 )

This method of relaxation was set out by Wolpe (1969) as part of Systematic Desensitization.

Wolpe states that his method of relaxation " is essentially that of Jacobson (1938) " but that it " is completed in the course of about six interviews " and that patients are required to practise at home for two fifteen minute sessions every day. In fact training in S.M.R. in this method must have been very brief, because in the course of these six interviews time must have been taken also to build up the anxiety hierarchy and then to present the anxiety producing stimuli from the hierarchy while the Subject relaxed.

The Subjects in this method were seated in a firm, supporting chair with arms. To begin, Wolpe instructed the Subject to grip the arm of the chair with one hand, and he was asked to notice " the qualitative difference between the sensations produced in his forearm and those in his hand." He was then told the sensation in his forearm was caused by muscle tension.

Wolpe expected the Subject to be able to notice the tension immediately. There was no opportunity for the Subject to query

the instructions given and it was assumed that the Subject had a knowledge of the names of the various muscle groups and also what his flexors and extensors were. The Subject was not given the opportunity to repeat the exercise and really familiarize himself with the sensation of tension.

The Experimenter then asked the Subject to bend his arm at the elbow against resistance from the Experimenter. The Subject was then required to straighten his arm against resistance from the Experimenter and to attend to the extensor muscles of that arm.

The Subject was then asked to let go gradually as the amount of force exerted against him was diminished, he was instructed to notice the decreasing sensations in the forearm and when the forearm comes to rest on the arm of the chair to go on letting go and to extend the activity that went on in the biceps while the forearm was coming down. The Subject was informed that it was the act of relaxing these additional fibres that would bring about the emotional effects required.

All the way through this method, the Subject was instructed in what he should be feeling. If the Experimenter was to carry out Wolpe's method faithfully, which the Experimenter did attempt to do here, there was no way to judge if in fact the Subject could feel the sensation of tension or not. Further instructions were to "go on letting go" and to "keep going further and further in the negative direction."

The Subject was then required to put his hands in his lap for a few minutes, he was then requested to report any new sensations

such as tingling, numbness or warmth.

Wolpe states "after a few minutes the therapist palpates the relaxing muscles", the assumption is made that the muscles are relaxed which may not necessarily be the case at all. Jacobson (1938) states that it may take up to 15 minutes to relax completely.

This method places emphasis on the emotional aspect when instructing the Subject, again highly suggestive of what he "should" be feeling e.g. the Subject is told that "from the emotional point of view, the most important muscles of the body are situated in and around the head."

This is in contrast to Jacobson (1938) who makes explicit statements that the Experimenter must make absolutely no reference to what the Subject should be feeling, the Subject must learn this for himself by repetition of all instructions by the Experimenter and by careful attention by the Subject to the sensations he feels. Table III lists the various muscle groups covered in this method, the order they were presented to the Subjects and the mean number of sessions any one muscle group was presented to each Subject.

Wolpe states that there is no set order for training the various muscle groups in relaxation. In this experiment the order used was the same that Wolpe actually lists.

Wolpe states that the Subject should be allowed enough time to relax all the muscles covered in each session, no actual time is mentioned but is assumed that an actual session would likely be around one hour and it must be remembered that relaxation must occupy only a portion of any one session.

TABLE III

MEAN NUMBER OF SESSIONS FOR INSTRUCTION FOR EACH MUSCLE GROUP

<u>Muscle Group</u>	<u>Mean No. of sessions</u>	<u>Muscle Group</u>	<u>Mean No. of sessions</u>
<u>SESSION I</u>			
Forearm flexors & extensors	1	Biceps	1
Triceps	1		
<u>SESSION II</u>			
Frontralis	1	Muscle around nose	1
Muscles around mouth pursing lips	1	Muscles around mouth Smile	1
<u>SESSION III</u>			
Masseters and temporales	1	Muscles of the tongue	1
Pharyngeal muscles	1	Muscles of the eyeball	1
Infrahyoid muscles	1		
<u>SESSION IV</u>			
Neck muscles	1	Shoulder muscles	1
Deltoids	1	Lateral neck muscles	1
Post-humeral & scapula-spinal	1	Pectorals	1
<u>SESSION V</u>			
Muscles of back	1	Muscles of abdomen	1
Muscles of thorax	1		
<u>SESSION VI</u>			
Flexordigitorum brevis	1	Calf muscles	1

TABLE III - MEAN NO. SESSIONS FOR INSTRUCTION FOR EACH MUSCLE GROUP - CONTINUED

<u>Muscle Group</u>	<u>Mean No. of sessions</u>	<u>Muscle Group</u>	<u>Mean No. of sessions</u>
Peronial and anterior tibial	1	Quadriceps femoris	1
Hamstrings	1	Adductors of the thigh	1
Abductors of the thigh	1		

Wolpe's method gives Subjects the suggestion of psychological relaxation with instructions such as "this relaxation 'beneath the surface' is the part that matters for producing the desired emotional effects", again Jacobson does not use any such form of suggestion in his method.

METHOD EMETRONOME CONDITIONED RELAXATIONJ. P. BRADY (1973)

Instructions for this method were recorded on one thirty minute cassette tape using the Experimenter's voice. The same cassette tape was played once during each session.

The following general instructions were given in session I before playing the tape "While using this tape it is essential to be in a comfortable position in which no effort is required to maintain posture."

"The tape consists of three sections. In the first ( six minutes) you are instructed to tense then relax eight major muscle groups of the body. Even if you feel that one muscle group has not been adequately relaxed when the tape moves on to the next, move along with it to the next group. There will be time later to concentrate on specific portions of the body that are slower to relax.

In the second section (six minutes) of the tape you will hear a metronome beating and suggestions to relax further are paced with its beat. In this section you are instructed to imagine you are floating on a large cloud that is drifting along in the sky. Most persons find that this facilitates further relaxation.

However you may substitute another scene if you find another more relaxing.

In the last section of the tape (eighteen minutes) you continue to hear the beats of the metronome. Periodically further suggestions to relax are paced with it. Most persons find it most relaxing to continue to think about the scene they used in section II - such as floating on a cloud or rocking in a hammock. Throughout the tape pay attention to the voice but in an easy, casual, accepting way. Rather than work at relaxing let relaxation happen to you.

When the tape is over and you are about to get up, I shall count from one to ten slowly and you are to gradually rouse yourself. Open your eyes slowly, gradually stretch and tense the muscles of your arms and legs and finally get up."

In session I the first six minutes of the tape was played to each Subject, then stopped and the Subject was asked if he could understand the instructions recorded. The Experimenter explained anything which was not clear to the Subject.

The Subjects were then instructed to lie down on the table and listen to, and carry out instructions on the tape.

Table IV lists the muscle groups covered, these were repeated in each of the six sessions.

TABLE IVMUSCLE GROUPS COVERED: METHOD E

<u>Muscle Group</u>	<u>Muscle Group</u>
Right hand, forearm and arm	Left hand, forearm and arm
Upper part of face - brow	Lower part of the face - mouth
Shoulders and neck	Upper part of the trunk
Abdominal wall	
Right foot, leg and thigh	Left foot, leg and thigh

The tape used in this method was made from a transcription of Brady's (1973) tape. When making the tape, the Experimenter made every effort to keep the tone of voice the same as that used by Brady, with the same intonation and at the same speed. The metronome was also set at the same pace of sixty beats per minute. The following is a transcription of Brady's tape;

Get into a comfortable position, be sure that your arms and legs especially, are perfectly comfortable.

Now you are going to relax eight major muscle groups in order, one group at a time. We will begin with the muscles of the right hand forearm and arm. Now tense the muscles of your right hand, forearm and arm, by making a fist and flexing the forearm on the arm, fine.

Now let these muscles slowly relax, slowly release the tension, go beyond zero point and relax then in a negative direction, letting them relax completely until the limb is completely limp, completely limp.

Now, tense the muscles of your left hand, forearm and arm in a similar manner. Now slowly release the tension in these muscles, again going beyond zero point, in a negative direction until this limb is completely relaxed, completely limp.

Now, focus your attention on the muscles around the upper part of the face found to produce tension in the brow, and at the same time, tense the muscles of the lower part of the face by drawing back the corners of the mouth.

Now, slowly relax all these muscles, let all the tension go, from these muscles of the face, relaxing these muscles completely.

Now, tense the muscles of the shoulders and neck, by throwing the shoulders back and at the same time touching your chin to your chest. Now again relax your shoulders, and let the head fall back, relaxing completely, letting go all the tension, letting these muscles become completely supple, completely relaxed.

Now take a very deep breath, in order to exercise the muscles of the upper part of the trunk. And now, slowly let the breath out relaxing the muscles as you do so, relaxing them completely as your breathing becomes slow and regular, let these muscles relax.

Now moving to the lower portion of the trunk, tense the muscles especially of the abdomen, make the abdominal wall hard and firm. Now relax these muscles, letting them go limp, relaxing beyond zero point, again in a negative direction, relaxing these muscles of the lower trunk completely. The abdominal wall becomes soft and may protrude slightly.

Now tense the muscles of the right foot, leg and thigh. Slowly relax these muscles letting them relax completely going beyond zero point in a negative direction until all the muscles of the left lower limb are completely relaxed, completely comfortable and so now all the muscles of the body are relaxed but as time goes by, you allow them to become more and more completely relaxed, more and more completely relaxed, letting all the muscles of the body go limp, relaxing completely.

If there is any tension remaining in any part of your body, now concentrate on these muscles, and relax them specially, focus your attention on them and let them relax completely until they reach the complete state of relaxation that's present in the rest of your body.

Relaxing completely, letting go of the tension that has accumulated during the day. Letting go and relaxing completely letting go and relaxing completely. - ( Metronome starts here )

Now, I am going to pace my instructions to relax, to the beat of the metronome, and so now, as you listen to my voice and hear the metronome, I want you to relax even more, to completely relax completely relax. You are to let the muscles go, let the muscles go. You are to let go and relax.

And so, as time goes by, you continue to fall into a deeper and deeper state of relaxation. All the muscles of the body going limp as you relax and let go, as you relax and let go.

The more and more you relax physically, the more and more deeply relaxed you become psychologically. You become completely calm and at ease, completely calm and at ease as you relax and let go, as you relax and let go.

As you continue to relax more and more, relax more and more, as you continue to relax, a pleasant, warm and heavy feeling comes over your body. A pleasant warm heavy feeling, you seem to be sinking deeper and deeper into a completely relaxed state. A completely relaxed state, as you relax, relax, as you relax and let go of the muscles, as you let go of the muscles, as you let go, let go.

Now as you continue to relax more and more, I want you to imagine the following scene : You're floating on a cloud in the sky, a large white billowy cloud, the cloud is drifting along, and you're drifting along with it, simply drifting along as you relax, drifting along as you relax and let go, as you relax and let go.

The weight of your body causes you to slowly sink into the substance of the cloud, you slowly sink down into the cloud, its a pleasant relaxing feeling, a pleasant relaxing feeling.

And so, as time goes by, you sink deeper and deeper into the cloud, deeper and deeper into the cloud, sinking down, down, down into the cloud, down, down, down, into the cloud.

As you sink into the cloud, you sink into a deeper and deeper state of relaxation. Accompanying this visible relaxation, is a psychological relaxation, a state of calm and tranquility, of calm and tranquility, as you sink deeper and deeper into a deeply relaxed state, you sink deeper and deeper into a deeply relaxed state, you become more and more completely calm and at ease, more and more completely calm and at ease, as you relax and let go, relax and let go.

As you listen idly to my voice and to the metronome, the metronome seems to be telling you to relax and let go, relax and let go. The beats of the metronome allow you to relax and let go, relax and let go. The sound of the metronome tells you to relax and let go, relax and let go. It enables you to relax and let go, relax and let go, and so you sink into a deeper and deeper state of relaxation, a pleasant state of relaxation. And your whole body feels pleasantly warm and heavy, pleasantly warm and heavy, as you sink deeper and deeper into a deeply relaxed state, deeper and deeper into a deeply relaxed state, deeper and deeper into a deeply relaxed state. All the muscles of the body completely relaxed and comfortable, completely relaxed and comfortable. As you relax and let go, relax and let go, the metronome tells you to relax and let go relax and let go. ( 49 beats )

The metronome tells you to relax and let go relax and let go,  
relax and let go, relax and let go, relax and let go.

You sink deeper and deeper into a deeply relaxed state as  
you relax and let go, relax and let go. The metronome tells  
you to relax and let go, relax and let go of the muscles, relax  
and let go. ( 170 beats )

The metronome tells you to relax and let go, relax and let go  
of the muscles, relax and let go, relax and let go, relax and  
let go. ( 286 beats )

The metronome continues to tell you to relax and let go, relax  
and let go of all the muscles of the body. Relax and let go,  
relax and let go, relax and let go, relax and let go.  
( 260 beats )

## METHODS C & F

### CONTROL GROUPS

Each training session for the control groups involved two different tasks, a time estimation task, and a vigilance type task. These tasks were chosen to give the Subjects a similar type of activity to that given to Subjects in the Experimental groups.

Much of the early part of each Experimental group session was involved with voluntary contraction of different muscle groups, sometimes with limb displacement, (isotonic contraction) and other times without limb displacement ( isometric contraction ).

This was a simple response movement to the Experimenters instruction, with the Subject being required to give his attention to the task.

The Subjects in the Control groups were given a variety of pre-instructed responses which involved voluntary muscle contraction, e.g. in the time estimation task, the Subject was to indicate the end of his estimation of the time which had elapsed with the prior instruction to flex a particular limb. When the Subject had done this, he was then instructed to "lower down and rest the limb." This was to give the Subject some motor activity ( muscle contraction), then the suggestion of relaxation and also the Subjects attention to the task, all of these variables were present in the Experimental groups.

The intention was to create a similar sort of atmosphere for the Subjects in the Control groups as for the Subjects in the Experimental groups. The interaction between the Experimenter and each Subject was an important factor in the Experimental groups. The nature of a great part of the interaction was more vague and intangible in terms of variables such as the demand characteristics, how the Subject perceives these, and how the Experimenter reacts to the Subjects perceptions. An attempt was made to try to maintain the same sorts of attitudes as for the Experimental groups in the way the criteria were presented, the atmosphere which was created and the time spent instructing the Subjects.

The Control groups C and F were given tasks carefully designed to appear bona fide experimental methods. The nature of the tasks were identical for both groups, the only difference being that the Subjects in group C were given a total of eighteen training sessions lasting over six weeks, to equate for training time for Groups A and B Subjects, and the Subjects in Group F were given a total of six training sessions lasting over three weeks, to equate for training time of the Subjects in Groups D and E.

Each Subject was instructed on arrival at the first training session ; "You will be trained in two different tasks, these are being carried out as an attempt to look at the kinds of problems faced in programming space travel and under water research, where it is not always possible to use ones hands to initiate the manipulation and adjustment of controls. Sometimes it is necessary to use foot or head movements as the hands need to be free for other manipulations."

The Subjects were also instructed that as space and underwater operations were often carried out in a supine position, so the present experiment would also be carried out with the Subject lying down. The Subjects were asked to lie on their back on the table with their hands by their sides and their legs uncrossed.

#### Task I : Time Estimation

For this, the Experimenter passively flexed the Subjects limb and instructed the Subject that when the Experimenter lowered the limb, this indicated the commencement of the time to be judged. ( See Appendix I for table of times estimated and the main muscles which contract to flex each limb.)

At the end of the time span being demonstrated the Experimenter said "finish". The Subject was then told he was to estimate that same length of time. The Subject was instructed that his estimation of the time commenced when the Experimenter lowered the Subject's limb, and when the Subject judged that the correct length of time had lapsed he was to flex the same limb again by himself.

The Experimenter timed this with a stop watch and marked on a record sheet whether the time estimated by the Subject was under, on time or over the standard time previously demonstrated by the Experimenter. The purpose of this task was not to collect quantitative data, so it was not necessary to keep a record of the actual time the Subject estimated.

Each Subject was given as many practice trials as necessary before starting trials proper to make sure he understood what was required of him.

The different limbs used, and the length of time to be estimated was pre determined and charted prior to each training session.

The Subject was instructed that it was obviously possible to count in between to estimate the time with greater accuracy but that this was not required in this task.

The time estimation task took approximately 20 minutes of each session. At the completion of this task the Subject was instructed to lie quietly and relax before commencing the next part of the experiment.

#### Task II : Vigilance Type Task

The Subjects were required to listen through headphones to pre-recorded bleeps on a tape. When the Subject detected that the bleep varied from the standard tone or bleep, this was the stimulus bleep, he was to indicate this to the Experimenter by flexing a particular limb, ( see Appendix II for limb flexed in each session ) and then returning the limb to its resting position until he could identify the next stimulus bleep.

This task was based on the type of vigilance task required of Subjects in the clock test Mackworth (1950). The vigilance stimuli varied in pitch between sessions in an attempt to keep up the motivation of the Subjects.

The Subject was required for this task to lie quietly with a minimal amount of attention to the tape, but nevertheless, some attention. It was hoped that this part of the training session would equate for the latter part of each training session for the Experimental group Subjects where they were required to relax but still attend to their level of S.M.R. to ensure that there was no

tension present. It was decided that this attention factor was an important part of the Experiment and should be taken into consideration in the Control groups, rather than instructing Subjects to do nothing, or to just relax.

The vigilance task took twenty minutes to present to the Subjects. A trial run was presented first to the Subject to familiarise him with the noise or standard bleep and the stimulus bleep. A check was also made that the volume was at a comfortable level on the headphones.

A series of six different cassette tapes were prepared in order to give the Subjects some variety in an otherwise monotonous task, see Table V, using a Hewlett Packard 3311A Function Generator.

Each tape varied either in the number of signals or bleeps per minute, or in the pitch of the bleeps, also the stimulus signal or bleep varied from the standard bleep either in pitch or duration, e.g. tape number one had a standard bleep at 900 Hz presented three times per minute. Interspersed throughout the tape and replacing the standard bleep was a stimulus bleep of 920 Hz, the Subject was required to identify and respond to this stimulus bleep by flexing the limb previously agreed upon.

The Experimenter kept a record sheet of the Subject's responses, and monitored these using a stop watch to check that the responses were correct. The Subjects were given feedback on whether they had improved or not since the previous session, which helped maintain the motivation of the Subjects so as to avoid any drop-outs due to the monotonous nature of the tasks, especially for the Subjects in Group C who underwent a total of eighteen training sessions.

TABLE V

VIGILANCE TYPE TASK FOR CONTROL GROUPS

<u>Tape No.</u>	1	2	3	4	5	6
No of signals per minute	3	6	4	4	6	4
Standard noise (Hz)	900	900	900 2sec duration	900	700	780
Stimulus signal (Hz)	920	920	900 3sec duration	920	680	800

These two tasks were designed to equate for the following variables which were considered to be important in the Experimental groups;

1. Time

It was considered necessary to equate for the maximum number of training sessions in Experimental groups in Section I.

2. Experimenter Interaction

The Experimenter maintained the same sort of attitudes for the Control groups as for the Experimental groups. All instructions were delivered in the same sort of tone and manner as for the Experimental groups.

3. Time spent on actual Instruction to Subjects

The time estimation and vigilance tasks were designed in such a way so as to try to give the Subjects a similar amount of time in actual instruction to that in the Experimental groups.

4. The Motor Activity Involved

The Subjects in Experimental group A and B were involved in a considerable amount of motor activity while learning the cultivation of muscle sense. So the Subjects in the Control groups C and F were required to respond in their tasks with a variety of pre-instructed limb and head movements.

5. Passive Movement of the Subjects Limbs

This was carried out quite frequently especially in Experimental groups A and B, to check that the Subject was in fact relaxing. This is why the Control group Subjects had their limbs or head

passively moved by the Experimenter to indicate the commencement of the time estimation task. This tactile contact was a very significant aspect of the interaction between the Experimenter and the Subject, which played an important role in establishing the rapport between the Experimenter and the Subject. Manipulation and palpation of another individual's limbs, head or torso is not an activity associated with formal interaction as a rule in New Zealand society except during medical consultation. Throughout this Experiment a professional manner was adopted, and a formal but reassuring approach was maintained, so that the Subjects would overcome any initial embarrassment as soon as possible.

#### 6. Discrimination Training

A substantial amount of time in each Experimental group training session involved the Subject attempting S.M.R. Although the act of relaxing is the reverse of the Subject "doing something" it is in fact "not doing". Jacobson (p 49 ), the Subject did not however just lie down and do nothing, he was expected to have a certain awareness of his level of relaxation. An attempt was made to equate for this type of activity in the Control groups with the introduction of the vigilance task which required some degree of attention by the Subject but at a lower level than in the time estimation task.

## METHOD

### SUBJECTS

Twenty four volunteer Subjects were recruited, all these Subjects were undergraduate students. The age range of the Subjects was 18 to 31 years.

In an attempt to keep the sample homogeneous, all the Subjects recruited were males as it has been suggested, Duffy (1962), that female Subjects are more inclined to fluctuate in temperament.

When volunteer Subjects were being called for this experiment the following statement was made "Male volunteers are required for an experiment which will involve the measurement of bodily activity from the arm, neck and forehead with training in certain tasks. Subjects will be required to be available for three-one-hour sessions each week for up to eight weeks."

No mention was made of the fact that the experiment was investigating the effectiveness of S.M.R. or that training in S.M.R. would be involved. This was to prevent Subjects forming preconceived ideas, especially regarding any thought that they may be learning a technique that had an advantageous outcome or gain for themselves, also the Subjects in the Control groups would not be given S.M.R. training.

The other most important reason why no mention was made that S.M.R. training was involved was, hopefully, to cut down the likelihood of recruiting the kind of volunteers who would present themselves purely to learn S.M.R. It was felt that knowledge that relaxation techniques were being applied might attract some individuals with emotional problems who were seeking some kind of remedy. As in the case of experimentation using vision, Subjects with normal sight had to be recruited, similarly in this experimental situation, Subjects who were readily trainable in relaxation had to be used, and for this reason the decision was made not to include any Subjects who were noticeably agitated or disturbed. The purpose of the experiment was to investigate the Subjects ability to relax under a variety of conditions and not specifically to provide a therapeutic remedy to any Subject who may have some emotional disturbance. The inclusion of Subjects in this category may confound the results by causing difficulty in carrying out the instructions in the close situation of the Experimenter and Subject. The Experimenter was

aware of the fact that it was still possible to have included Subjects in the sample who may have had an emotional problem which was not overtly obvious at the initial interview. This did happen when it was noticed in the pre-testing sessions that one Subject was highly agitated, did not seem to be able to lie quietly, even though he was requested to do so. This Subject sweated profusely throughout the pre-test sessions, and talked incessantly. It was decided that it was necessary for this Subject to be placed in the Control group as one of the two experimental methods being used in this section ( Method E ) was very loaded with hypnotic suggestion and again it may be possible that any one of the Subjects may respond to this method in an unforeseen manner, it was decided preferable not to include a Subject whom it was felt may be prone to react undesirably.

It was wise to proceed with caution in such instances, as the Experimenter was not experienced in the methods of bringing Subjects out of hypnotic trances, even though some instruction was given as a safeguard.

All prospective Subjects were interviewed individually by the Experimenter. Volunteers with any previous experiences of yoga, transcendental meditation, relaxation techniques or any related procedures were not used for this study because their prior experience may influence the dependant variable.

One volunteer who presented himself in a highly agitated state was not included in the sample for the experiment as Jacobson (1938) suggests that it may take longer for neurotics to learn S.M.R.

In the initial interview of prospective Subjects the Experimenter

got each Subject to agree to the fact that they couldn't be told all of what was going on, but that there would be a debriefing at the conclusion of the experiment when any questions they had would be answered. It was important to get the Subjects agreement on this, so that when they asked any question during sessions, they were referred back to their initial agreement. Each Subject was also requested not to compare notes with anyone else until the experiment was completed.

During the interview the Subjects were informed that in the first and final weeks of the Experiment, recordings would be taken of bodily activity via surface electrodes which would be taped to their forehead, neck and upper right arm and that an earth strap would be attached to their right ankle. Subjects were requested to dress appropriately to allow access to these areas.

All the Subjects were assured that the purpose of the experiment was to make recordings and that the procedure would not be unpleasant for them. The Subjects were informed that the intervening sessions would involve some form of training.

A timetable was drawn up out of lists of times during the day Subjects would be available. During the first and final week all Subjects were required for two - fifty minute test sessions in each week. Each Subject was required to come at the same time of the day for these sessions, the time of the day varied for individual Subjects this was to hold constant any fluctuations in diurnal rhythms. According to Duffy (1962) these may alter the internal state of the Subject and thus influence the measures being taken.

A separate timetable was drawn up for the intervening weeks, during which time all Subjects in Section I were required for

three fifty minute sessions each week and all Subjects in Section II were required for three forty minute sessions each week. An attempt was made to spread each Subjects sessions over the week from Monday to Friday so that no Subject was timetabled for training sessions on three consecutive days in any week.

### APPARATUS

EMG activity was monitored by a Disa Type 14A30 3-channel Electromyograph, the sensitivity level was kept constant throughout all testing sessions at 20uv per division. The Disa was calibrated with a preset signal of 30 mV. (Noise factor of  $7.5 \text{ uv} \pm 1.5 \text{ uv}$ ).

EMG activity was recorded with an S.E. 3006 multichannel U.V. recorder, ( sample Electronics N.Z. Ltd. ) using Agfa Oscilloscript recording paper run at a constant speed of 10 inches ( 250 mm ) per minute, for every testing session giving a permanent record of EMG activity.

A portable cassette recorder was used to play the tapes for the Subjects in the control groups, headphones adjusted to a suitable level for each Subject were also used.

The same cassette recorder was also used to play the tape on M.C.R. for the Subjects in Experimental Group E, the speaker was used for this Group due to the fact that this gave a clearer reproduction than the headphones for playing back this particular tape.

### PROCEDURE

The Experiment was divided into two sections simply because there was not sufficient working hours during the week for the Experimenter alone to train 24 Subjects concurrently.

Section I, run over weeks 1 to 8 inclusive, Subject numbers 1 to 12 were trained and tested. When Section I was completed, Subject numbers 13 to 24 in Section II were trained and tested over the following 5 weeks.

In the first week of both Sections I and II, all Subjects came in for two pre-test sessions. Two pre-test sessions were given to each Subject with the hope of establishing some reliability in the results.

The procedure for each pre-test and post-test session was the same, sessions were conducted in a room set up with the E.M.G. equipment. The room was kept at a constant temperature of 15°C, controlled by a thermostat on the heater.

Each Subject was met on arrival, reminded that the session would last 50 minutes, and requested to use the bathroom if necessary.

The Subject was asked to give the skin area over right biceps a thorough wash with warm water and soap. This was to help remove fatty deposits on the surface of the skin.

The Subject was then requested to remove his footwear and lie in the supine position on the bed ready for the electrodes to be applied for recording.

The muscle groups from which measurements were recorded were; the right biceps, the right sternocleidomastoid (S.C.M.) and the frontal belly of occipitofrontalis ( frontalis ), Grey (1973). Standard lead placements were used as set out by Davis(1952).

Pilot work done by the Experimenter on Subjects, some with partial training in S.M.R. others with no training at all, indicated that most Subjects could obtain voluntary muscle relaxation for a considerable portion of time on the muscles of the arms, hands and lower legs. The Subjects were not able to voluntarily relax the muscles of the S.C.M. or frontals.

Consideration had to be given to the choice of muscles to be used on the following grounds;

The muscles chosen had to have a skin surface over them which was quick and easy to prepare as each pre-test and post-test session lasted only a total of 50 minutes. In this time, the skin had to be prepared, electrodes and earth applied, the equipment and electrodes plugged in then checked, the presentation of various stimuli which were then recorded, the unplugging and removal of the electrodes and earth strap, the cleaning up of the Subjects skin where the electrodes were placed, the cleaning of the equipment, and the preparation for the next Subject. The first stage of preparing the skin and taping on the electrodes had to be completed in the first fifteen minutes to allow sufficient time for the remainder of the procedure. This did not make any allowance for any Subject who happened to arrive late for their appointment. All Subjects were urged to be on time for all their appointments.

The time factor ruled out the possibility of using the muscles of the hand for recording from as the pilot work showed that it took too long to prepare the skin on the hand and to obtain a sufficiently low resistance level between the two electrode sites in a short time. The biceps muscle was readily accessible and the skin surface did not take too long to prepare if this was done carefully. This muscle group was also chosen for its easy manoeverability of underlying joints.

Recording from the lower leg muscles was decided against due to the possible difficulty of access to this area. Extra time would also have had to have been taken to shave the hairs off the area of the leg in the case of most of the Subjects. As it was, permission was obtained from any Subject with a beard to shave a very small portion of his neck area over S.C.M. This was also necessary for a few arms which had a hairy growth too. The removal of hairs allowed proper contact to be made between the electrode and the skin surface.

The frontralis muscle was chosen as both Garmany (1952) and Wolpe (1969) claim that many headaches are a result of prolonged tension in this muscle. Also the skin over frontralis was very quick to prepare and did not need much rubbing with electrode paste and pumice to lower the resistance to an acceptable level.

Measures from the frontralis muscle also seemed appropriate as it is a muscle often used in related studies on biofeedback techniques for relaxation training, Kinsman et al (1975).

The S.C.M. muscle in the neck was chosen because pilot work indicated that it was not possible to obtain voluntary muscle relaxation of this muscle without training, also the skin over

this region was quick to prepare.

The Experimenter then prepared the skin surface for placement of surface electrodes according to the technique described by Venables and Martin (1967) with the following modifications; The skin was swabbed with 100% alcohol. A piece of soft pumice was used to remove the horny layer of skin ( rather than a dentists burr) and to rub in the highly conductive electrode paste. Small flat silver surface electrodes 1cm by 0.5cm were placed on the appropriate skin area, and taped down firmly with electricians tape. The muscle groups under study were the right biceps, right sternocleidomastoid and frontalis muscle.

Care was taken not to rub too hard thereby abrading the skin, in general, if a slight erythema appeared, it was indication that the skin preparation was sufficient.

The resistance of the skin was then checked. If the resistance was not  $\leq$  to 10,000 ohms, further preparation was carried out by again rubbing more electrode paste into the area with pumice.

The right ankle was firmly swabbed with alcohol and electrode paste was then applied to the area before placing a lead earth strap, 5cm wide, around the ankle. This earth strap was held in close contact with the skin by tying a cloth firmly around it.

When the electrodes had been applied the Experimenter checked that the Subject was lying comfortably with his arms at his sides and his legs uncrossed. The Subject was given the following instruction: "I want you to relax while you lie there. I am going to look at basal data on you, so just lie back without

talking and relax for the next while until I tell you that I have finished."

The calibration and noise level were then checked on the Electromyogram before the leads from the three pairs of electrodes and the earth strap were plugged in.

The Experimenter then commenced to take recordings of the Subjects level of atonia. As it was considered possible that even untrained Subjects could obtain some degree of voluntary S.M.R. in a resting state with physiological and psychological calm, additional stimulus criteria were introduced and measured to enable further comparison between the Subjects before and after training sessions.

The stimuli introduced and measures recorded ( all three muscle groups throughout ) while the Subject attempted to relax were :

1. Relaxing for two minutes

During this time the Experimenter kept as quiet and still as possible so as not to distract the Subject.

The Subject's pulse rate was then taken and a record kept of this.

2. Relaxing for one minute

3. Loud noise

The Experimenter moved to the head of the bed where an empty cake tin 24cm by 10cm was kept on the floor. The Experimenter instructed the Subject to keep on relaxing. The cake tin was quietly picked up and held at a height of 90cm off the floor

and then dropped in such a way so that its base would land squarely on the ground.

The presentation of this stimulus caused a startle response in the Subjects so four minutes elapsed before the presentation of the next stimulus to give the Subject a chance to settle down.

#### 4. Scratching skin over biceps muscle

The skin over the biceps muscle and 1.5cm to the lateral side of the pair of electrodes was scratched lightly with a piece of 1.5cm diameter wire. The end of the wire in contact with the Subject's skin had been smoothed off. The wire was lightly scratched down the arm for a length of 15cm then back again. The purpose of scratching the surface of the skin over the biceps muscle was to elicit a stretch reflex action such as Clarke (1966) demonstrated by scratching the skin over the large muscle groups in the upper leg producing the patellar tendon jerk.

#### 5. Scratching skin over frontalis muscle

The same piece of wire was used to scratch the surface of the skin over the frontalis muscle 1.5cm below the taped on electrodes and for a distance of 8cm horizontally across the brow and back. This was expected to produce an increase in the amount of muscle tension already present.

#### 6. Passive movement of the arm

The Subject was given the following instruction : "I am going to bend your arm at the elbow and then straighten it. I want you to keep on relaxing and do not try to help me move your arm."

The Experimenter then placed his left hand over the ventral aspect of the Subject's right elbow joint to stabilize it and to stop any movement of the upper arm. Using the right hand, the Experimenter picked up the Subject's right hand and wrist and flexed it slowly onto the Subject's upper arm until an angle of  $90^{\circ}$  was reached. The Experimenter then lowered the arm at the same speed until it reached its normal resting position.

#### 7. Passive flexion of the head

The Experimenter stood at the head of the bed. The Subject was given the following instruction : "I am going to move your head slowly from side to side, I want you to keep on relaxing and don't try to help me."

The Experimenter then grasped each side of the Subject's head with the palms of the hands. The Subject's head was then lifted approximately 20cm off the bed and slowly flexed towards the right shoulder then towards the left shoulder. The Subject's head was then returned to its normal resting position.

#### 8. Passive rotation of the head

The same instruction was given to the Subject as for stimulus number 7 but this time the Experimenter rotated the Subject's head to the right, then to the left, then back to the normal resting position. Rotation of the head was obtained by moving the head so that the Subject's face was looking firstly over his right shoulder, then returned so he was looking straight in front, then it was rotated so he was looking over his left shoulder, then it was returned to the straight ahead position, then it was lowered back to its normal resting position.

At this stage in Pre-test 2 and Post-test 2 stimulus number 3, the loud noise, was presented here instead of straight after recording of relaxing for one minute. This was done to hopefully prevent the Subject from expecting its occurrence.

#### 9. Digit Span backwards

The following instruction was given to the Subject: "I am going to say some numbers, when I have finished I want you to say them at the same speed, but backwards." The numbers ( Table VI ) were read out at the rate of one digit per second. Table VI also gives the alternate list of digits used for Pre-test 2 and Post-test 2.

#### 10. Strobe light

This stimulus was a strobe light set at a height of 176cm off the ground, centered over the Subject's chest, with the light directed at the Subject's face. The strobe setting was at 12 flashes per second for 60 seconds. The flash intensity was set at 16 on the dial, which was not too bright to cause any undue discomfort to the Subject.

The Subject was instructed to keep his eyes open, but not to look directly at the light.

#### 11. Relaxing for one minute

The room was kept as quiet as possible while the Subject was instructed to relax.

A final calibration check was carried out in order to allow a comparison with the calibration at the beginning of the session.

TABLE VISTIMULUS ITEM 9 : DIGITS BACKWARDS

<u>Pre-Test 1 and Post-Test 1</u>	<u>Pre-Test 2 and Post-Test 2</u>
71928	72649
913749	256974
6493174	7395826
8365982	1364932
4859625	5847694
27469271	68352974

At the termination of the EMG recording of the presentation of the stimuli the electrodes were removed and the skin area was swabbed with alcohol. The earth strap was removed and the Subject was requested to clean the electrode paste off his ankle with soap and water.

The Experimenter then checked with the Subject that he knew the correct day and time for his next session.

All the electrodes were then thoroughly washed with warm soapy water and swabbed dry with alcohol.

Assignment of Subjects to groups was made on the basis of visual inspection of the results from pre-test sessions 1 and 2. The total recording time from each session was twelve minutes, 10 ft ( 3.048cm ) of recording paper.

The Subjects were matched as closely as possible so that the three Subjects with the highest overall amplitude of tension recorded were assigned at random between the three groups in Section I. The same was done with the three Subjects with the lowest overall amplitude of tension in recordings.

The remaining six Subjects whose amplitude of tension in recordings fell inbetween the highest and lowest categories were also assigned at random to one of three groups, so that there was a total of four Subjects in each group.

Consideration was also given during visual inspection of the records to any gross change in amplitude of the recorded tension during presentation of the following stimuli :

3: loud noise; 6: passive movement of right arm; 9: digit span backwards.

These three items were looked at in particular as they appeared to produce the largest variation in response between Subjects.

The three methods used on the groups of Subjects in Section I ( one method for each group ) were :

Method A : Progressive Relaxation.	Jacobson (1938)	Group A
Method B : Muscle Relaxation.	Garmany (1952)	Group B
Method C : Control Group		Group C

The Subjects in Section II were assigned to groups by visual inspection of the records in the same manner as for the Subjects in Section I. The three methods used in this section were :

Method D : Muscle Relaxation	Wolpe (1969)	Group D
Method E : Metranome Conditioned Relaxation	Brady ( 1973)	Group E
Method F : Control Group		Group F

Table VII gives a summary of the design of the Experiment.

The training sessions for all Subjects ( Section I and II ) were held in a different room situated in a quiet part of the building to ensure a minimum of extraneous noise. During all the training sessions, all the Subjects, with the exception of those in Experimental Group D, lay on a surface of three flat writing tables joined together and covered with a double thickness wool blanket. This surface was of sufficient width and length to allow reasonable movement of the Subjects' limbs, while still being supported by the tables surface.

The Subjects in Experimental Group D sat on a chair with a firm supporting back and with arm rests during all training sessions.

TABLE VII

DESIGN OF EXPERIMENTSECTION IWEEKS 1 - 8 INCLUSIVE

<u>Number of Subjects</u>	<u>No of Pre-test sessions</u>	<u>Assignment to Groups</u>	<u>Group</u>	<u>No of Subjects</u>	<u>No of Training Sessions</u>	<u>No of Post-test Sessions</u>
12	2		Exp.A	4	18	2
			Exp.B	4	9, 11, 11, 13	2
			Control C	4	18	2

SECTION IIWEEKS 9 - 13 INCLUSIVE

<u>Number of Subjects</u>	<u>No of Pre-test sessions</u>	<u>Assignment to Groups</u>	<u>Group</u>	<u>No of Subjects</u>	<u>No of Training Sessions</u>	<u>No of Post-test Sessions</u>
12	2		Exp.D	4	6	2
			Exp.E	4	6	2
			Control F	4	6	2

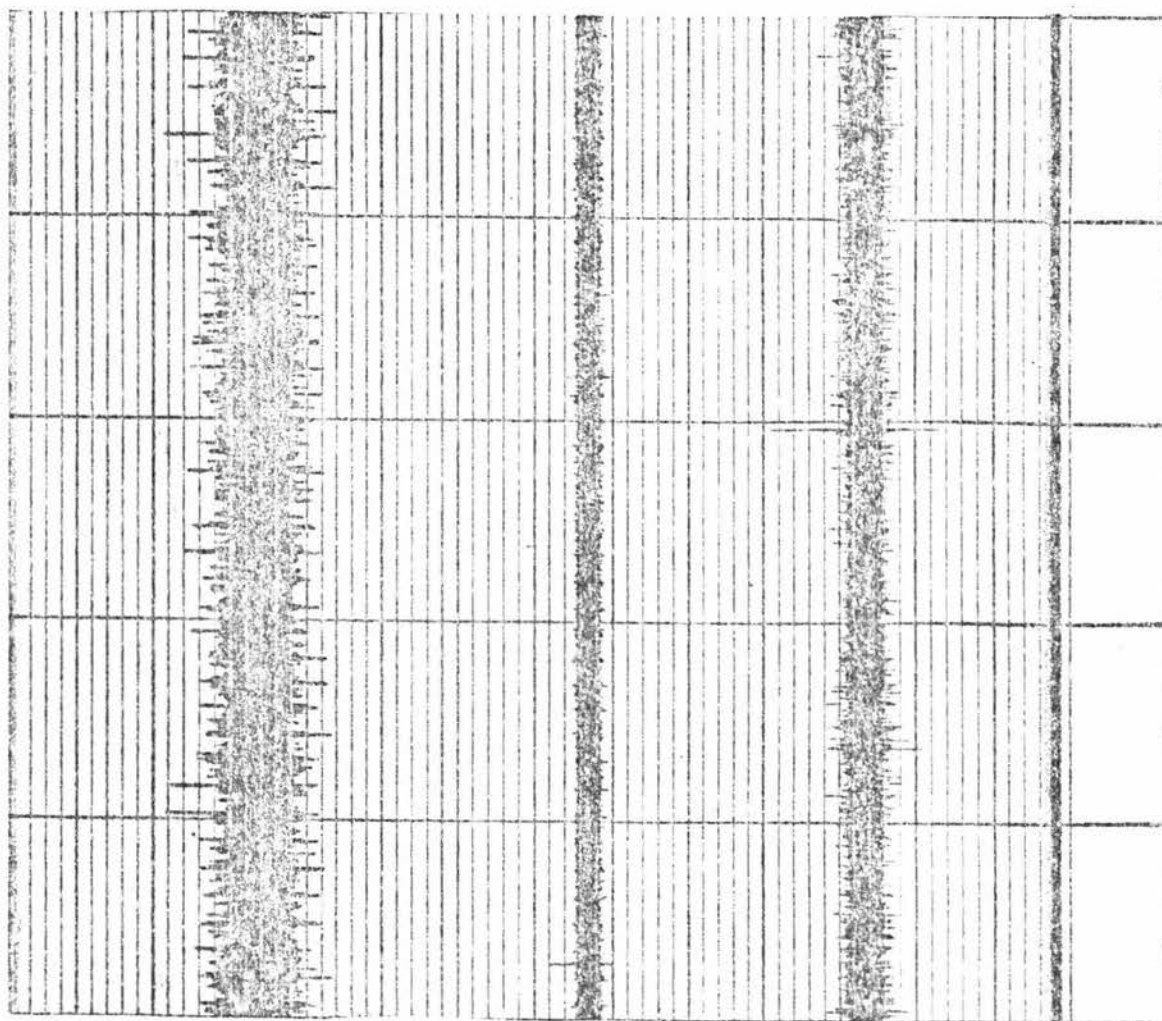
When the training sessions had been completed for all the Subjects in Section I, these Subjects were all given two post-test sessions which were conducted in the same room and of the same format as for pre-test 1 and 2. At the conclusion of post-test 2 the Experimenter answered any questions the Subjects had relating to the Experiment.

The same procedure of post-testing was carried out for Subjects in Section II after the training sessions were completed.

Figure 1 : Sample of E.M.G. recording from Subject 2,  
Group A, post-test 2.

- A : Relaxation one
  - B : Loud Noise
  - C : Passive Movement of Arm
  - D : Relaxation three
- Horizontally one centimeter equals 20 u.v.  
Paper speed = 10 inches per minute

A

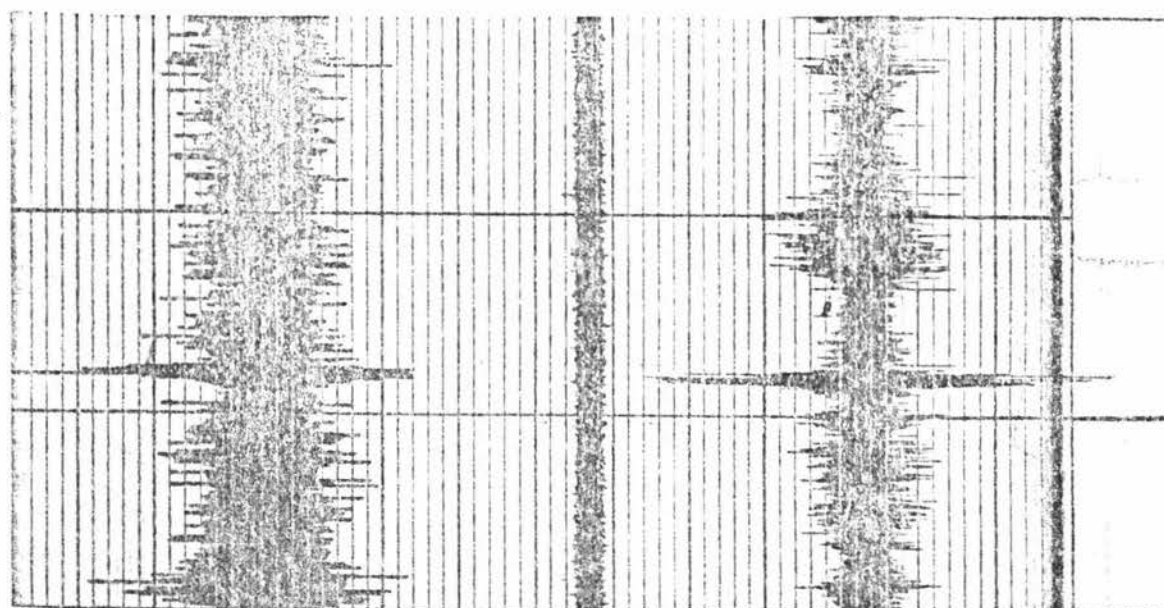


S.C.M.

Biceps

Frontralis

B



S.C.M.

Biceps

Frontralis

C

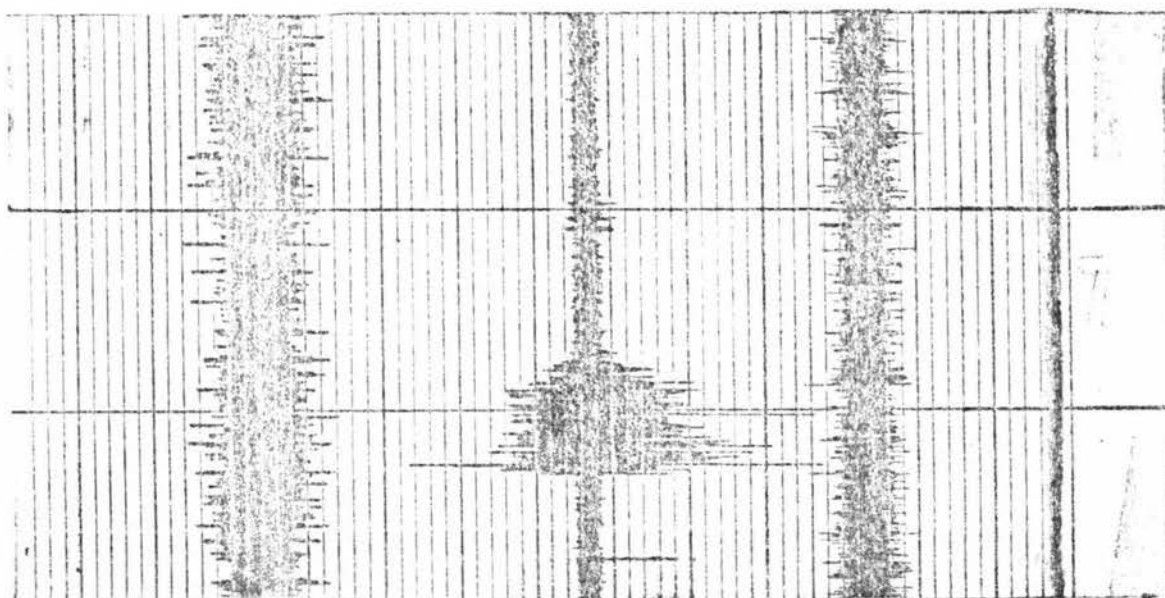


S.C.M.

Biceps

Frontralis

D



S.C.M.

Biceps

Frontralis

## RESULTS

It was expected that the Subjects in Experimental group A, and possibly the other Experimental groups would be able to maintain complete atonia in all three muscle groups being measured for a good proportion of the time while the Subjects were requested to relax in the post-test sessions.

The results showed that this was not so. Most Subjects were able to completely relax the right biceps muscle on demand some of the time prior to any training.

At no time before or after training was any Subject able to obtain complete relaxation from SCM or frontalis muscles.

It was expected that the type of results obtained would allow for a ratio comparison of the percentage of time the Subject was able to relax in each condition as compared with the percentage of time there was some tension present in each muscle group. Inspection of the results showed this was an inappropriate method as no Subject could obtain complete S.M.R. in two of the muscle groups from which EMG recordings were taken. ( see figure 1 for a typical sample of the EMG recordings obtained.)

A method of obtaining an integrated EMG was chosen as described by Shaw (1963). Manual scoring by this method was a lengthy process, it was not practical in the time available to score the total length of records from each Subject. Consideration was given to all the stimulus conditions which were recorded in the pre and post - test sessions and the following items were

chosen as the most appropriate to score out of all the results obtained :

1. Relaxation, the first 30 seconds
2. Relaxation, the first 30 seconds
3. Loud noise, the first 12 seconds
6. Passive movement of the arm, the first 12 seconds
9. Digits backwards, the first 6 seconds and the last 6 seconds
11. Relaxation, the first 30 seconds

Each of the above six conditions were scored from each pre-test and post-test session.

It was important to score at least a portion of each of the recordings of relaxation, as the prime purpose of the experiment was to compare the effectiveness of the four methods of S.M.R. Out of the stimuli presented those chosen for scoring were the stimuli which appeared on visual inspection to produce the most noticeable differences in the amplitude of tension for some of the Subjects.

The loud noise appeared to produce a short burst of increased tension for some Subjects, where as for others, the increase in the amplitude of tension lasted longer, e.g. up to 4 seconds. A similar trend in recordings of passive movement of the arm was obtained. The digits backwards appeared to have the effect for most Subjects of producing a gradual increase in the amplitude of the tension ( especially in biceps muscle ) from the presentation of the first digit to the final digit.

The last recording of relaxation indicated an increased level of tension for some Subjects, as compared to relaxation 1 and 2 in any one session.

It was not possible to score the results of SCM pre-test 1 and 2 from Section I ( Subjects 1 to 12 ) as the galvanometer on the SEL recorder was not functioning properly on that channel and the trace was too faint to measure.

The integrated EMG from each condition is presented in Appendix III.

The reliability was checked between pre-test 1 and pre-test 2 for each stimulus condition. The correlation for these are shown in Table VIII. There was consistency between pre-test 1 and 2 scores from SCM on all items except relaxation 3, it was noted that this was only for Subjects in Section 2 as there was no score obtained from SCM in Section 1.

The only high correlation from biceps muscle was for items 6 and 9, passive movement and digits backwards. The only high correlation from frontralis muscle was for item 3, loud noise.

There should have been a high correlation between pre-test 1 and 2 for all items over all three muscle groups, as this was not the case, further quantatative analysis of the data was not appropriate.

Figure 2 shows graps of means of groups for pre-test 2 and post-test 1 for a comparison between methods A, B and C on frontralis and biceps muscles.

Methods A and B have been chosen for graphic illustration as they were expected to produce the greatest decrease in amplitude of tension of all the methods. As can be seen in the graphs there is a greater decrease in amplitude of tension over a larger number of items in post-test 1 than for Control group C which is the kind of result that was expected.

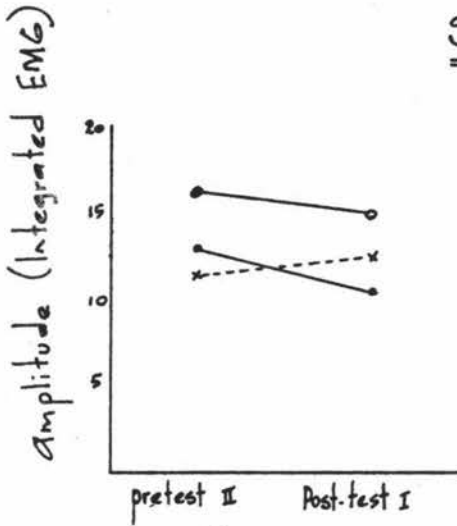
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1. Relaxation 1	0.422	-0.060	0.861
2. Relaxation 2	0.108	0.247	0.807
3. Loud Noise	0.715	0.398	0.955
6. Passive movement	0.338	0.831	0.833
9. Digits backwards	0.525	0.950	0.944
11. Relaxation 3	0.189	0.145	0.557

TABLE VIII : CORRELATION OF SCORES FOR ITEMS BETWEEN PRE-TESTS 1 AND 2

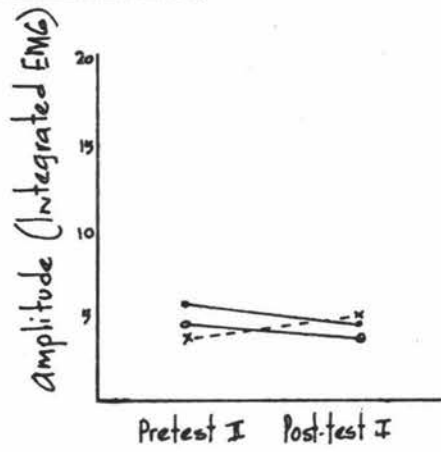
Figure 2 : Group A, B and C means for pre-test II and post-test I.

KEY  
 Jacobson —●—  
 Garmany —○—  
 Control I x---x

## SECTION I

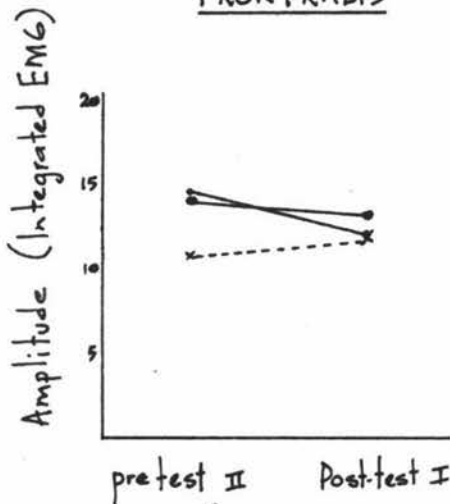


FRONTALIS

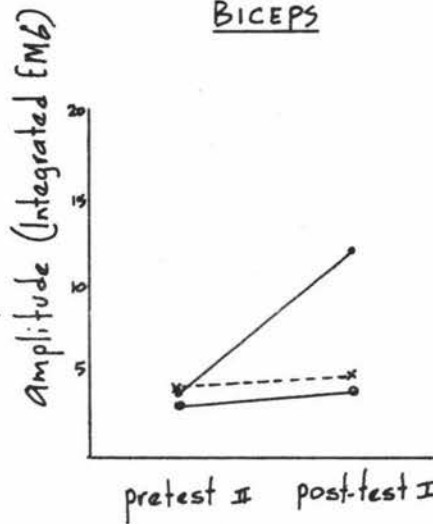


BICEPS

RELAXATION I

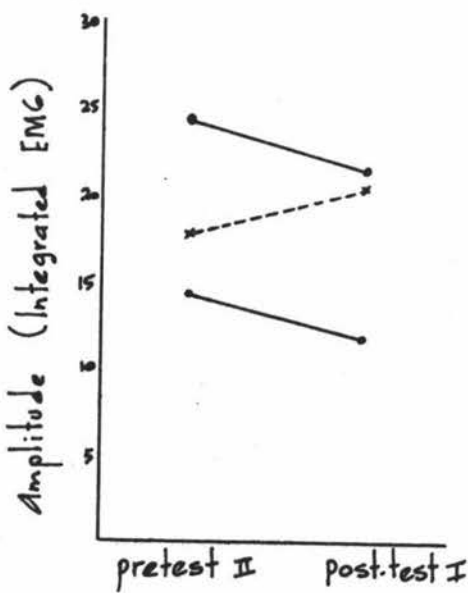


FRONTALIS

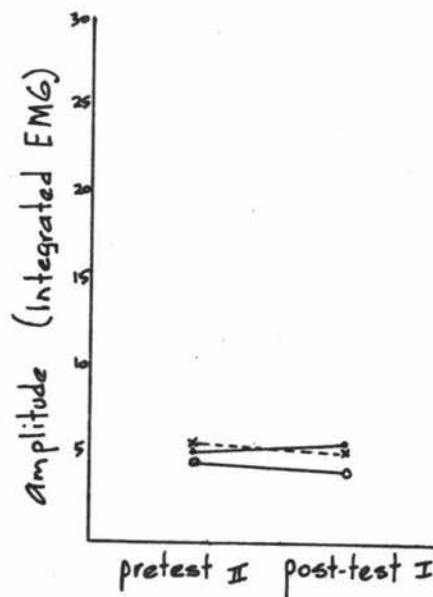


BICEPS

RELAXATION II

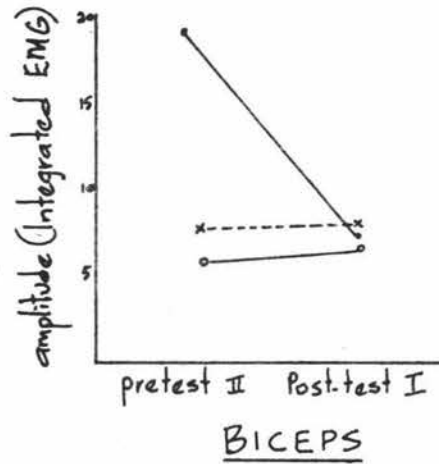
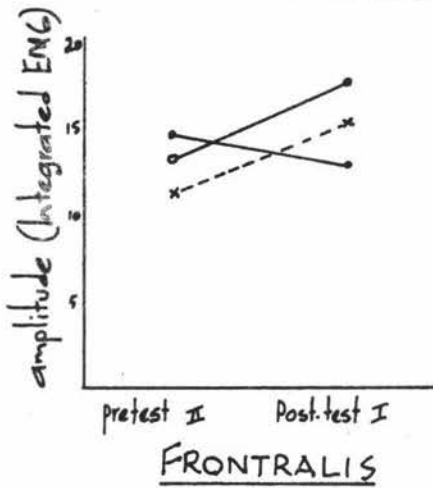


FRONTALIS

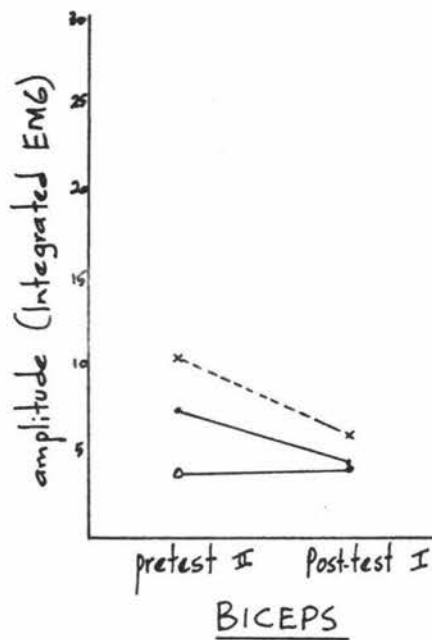
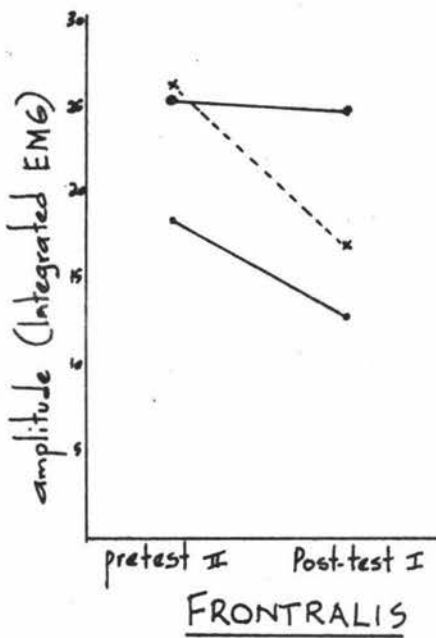


BICEPS

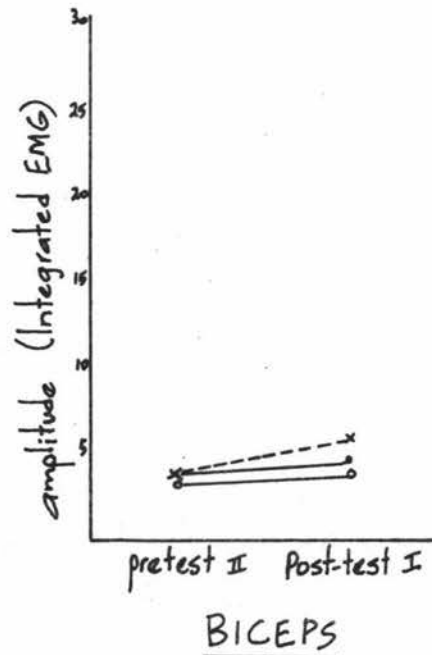
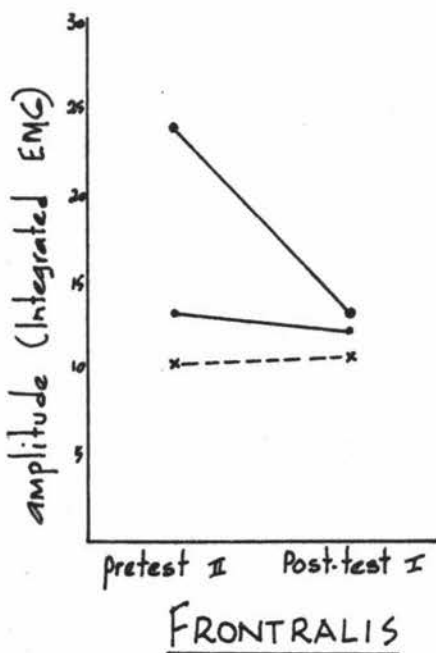
LOUD NOISE

SECTION I cont.

PASSIVE MOVEMENT  
OF ARM



DIGITS BACKWARDS



RELAXATION III

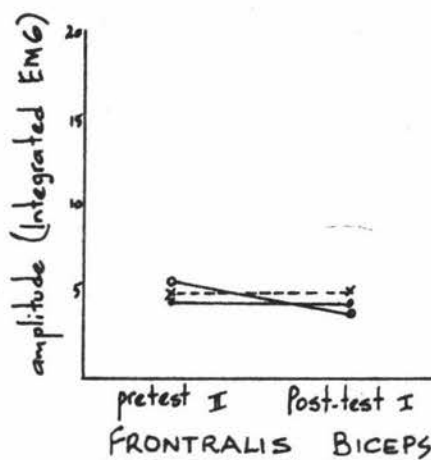
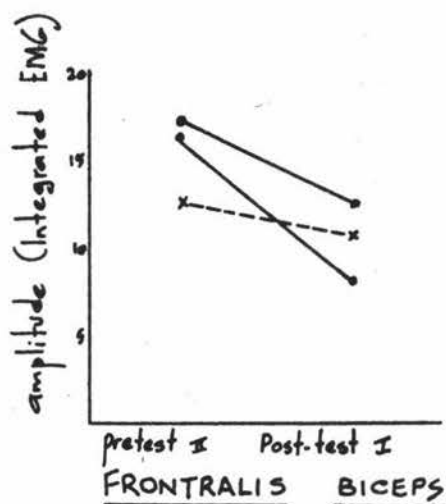
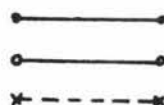
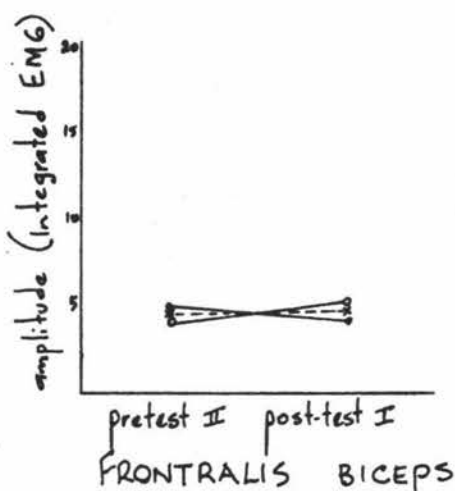
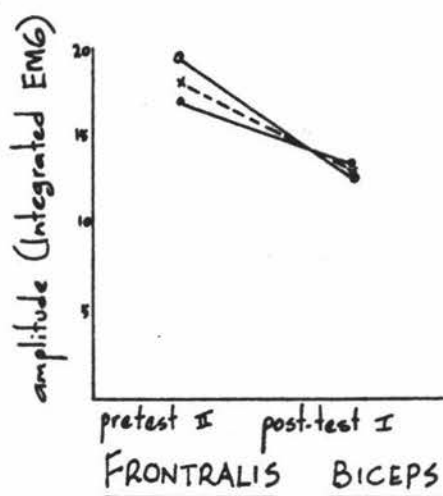
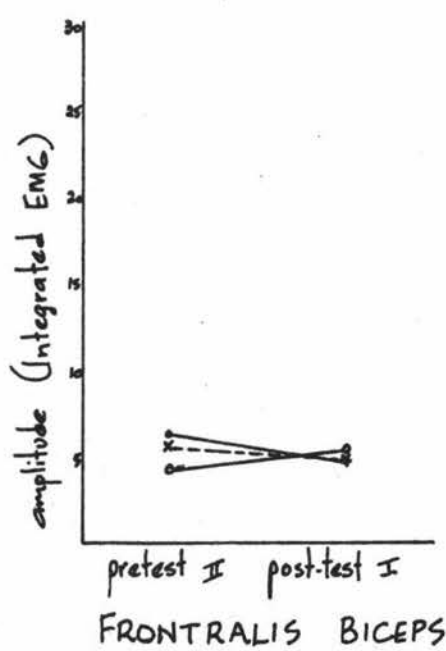
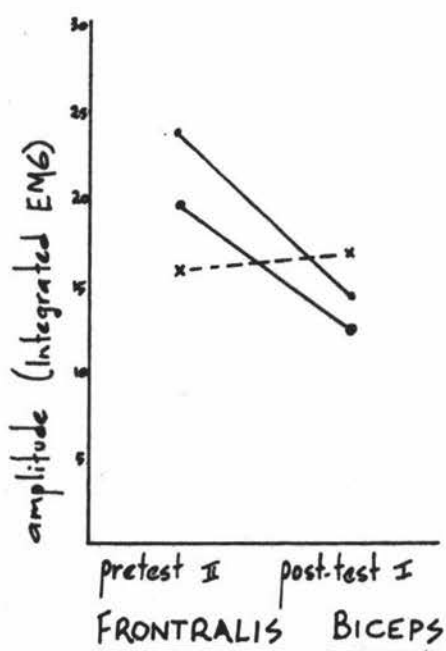
SECTION II

KEY

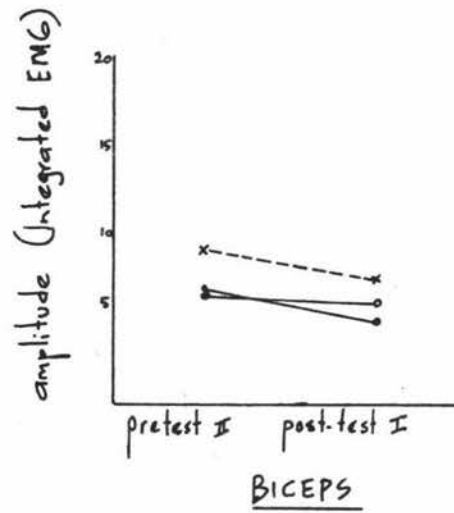
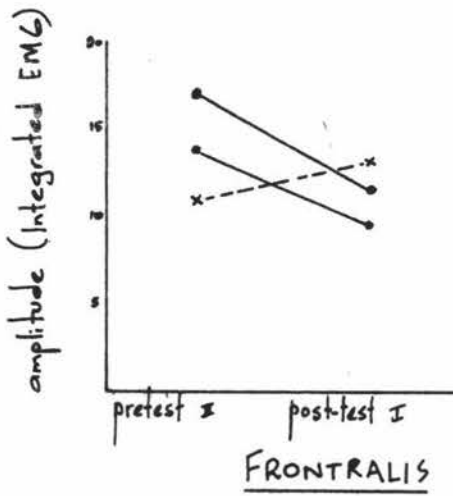
Nolpe

Brady

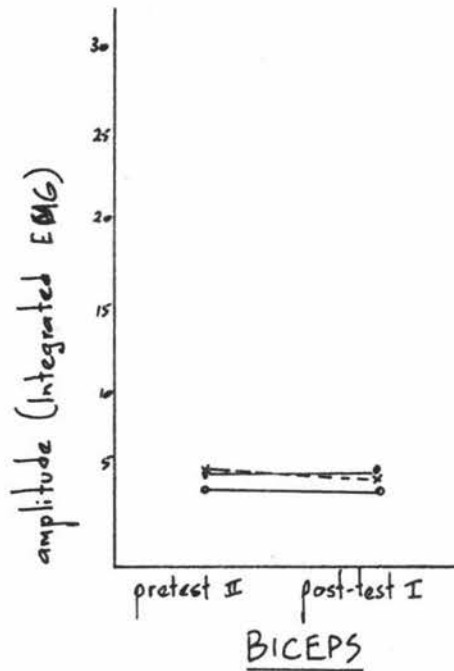
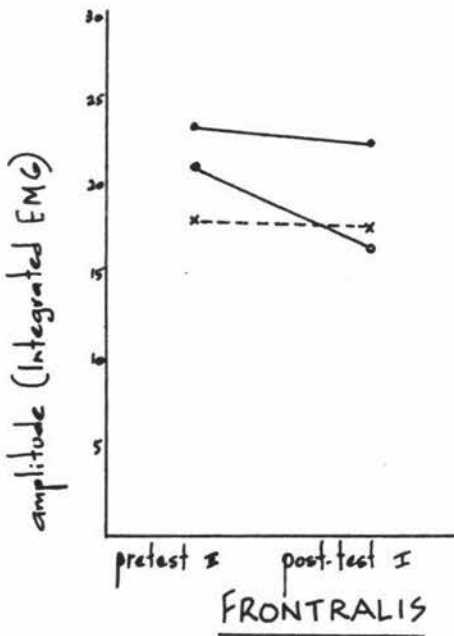
Control II

RELAXATION IRELAXATION IILOUD NOISE

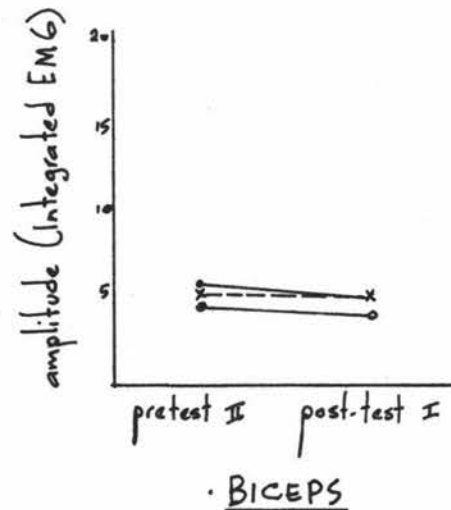
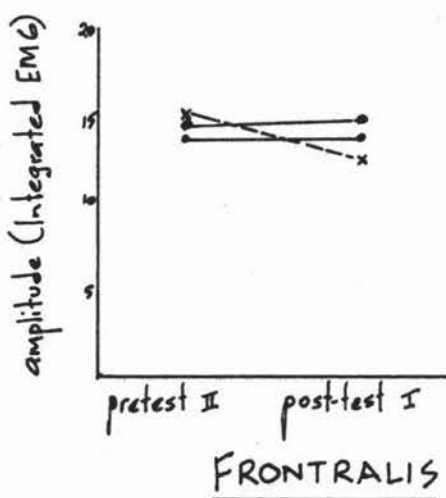
## SECTION II Cont.



PASSIVE MOVEMENT  
OF ARM



DIGITS BACKWARDS



RELAXATION III

### DISCUSSION

Training in four different methods of S.M.R. was undertaken in order to compare their effectiveness in terms of the Subjects ability to carry out relaxation under a variety of conditions as measured on the Electromyogram. The results obtained were not as expected, this led to problems in the time taken for scoring the data and more important, the limitations on the implications which could be drawn using the results from the EMG recordings. Nevertheless, the Experimenter also had kept comprehensive notes on the progress of the Subjects throughout the training procedures and the information from these records should not be discounted when evaluating the methods used.

The EMG results do not show a consistent reduction in the level of tension in the post-test situation as compared with the pre-test results, let alone complete muscle relaxation which was expected for at least some of the time.

The failure of the Subjects to obtain complete S.M.R. in any of the groups may be attributed to a number of factors. The Subjects in Experimental groups A and B had undergone from nine to eighteen training sessions, by this time the demand characteristics of the Experiment had become obvious to the Subjects even though the Experimenter had attempted to keep a low profile on this aspect. Three of the Subjects commented after completion of the Experiment that they had become really worried that they might not be able to relax in the post-test recording sessions. This was obviously an undersirable state and may in fact have caused some of the other Subjects to worry even though they didn't mention this fact.

This may have been overcome if the Subjects had been given all their training sessions in the room that the pre-tests and post-tests had been carried out in and if the electrodes had been applied to the Subjects in all the training sessions, also the equipment switched on and running. Although this would have been ideal, it would not have been possible in the present Experiment because many Subjects were only available for 50 minutes, between lectures, and to carry out the above suggestions in the training sessions would have required each training session to last longer than the 50 minute limit of time available from some Subjects.

Another very important aspect which all the Subjects reported either during the pos-test sessions or when questioned after all the sessions were completed, was that they were all anticipating the dropping of the tin ( item 3, loud noise ) in each post-test session from the moment the electrodes were plugged into the electromyogram.

Some Subjects commented that even after the stimulus item 3 had been presented, they were expecting something further to happen that would cause them to get a fright. Obviously as this stimulus upset all of the Subjects, and its effects lasted over the whole of the post-test session, it should not have been included as one of the stimuli. In pilot work the Experimenter had difficulty in finding stimuli which would elicit and increase in the level of tension being recorded from the muscles of the Subjects, and the presentation of a sudden loud noise did not produce a response of the same magnitude as it did with the Subjects in the present experiment. Again it was possible that the Subjects in the Experiment became too aware of the demand characteristics present in the situation during the training sessions.

Four Subjects mentioned that they were worried about the digit span backwards and had tried to memorise the numbers used.

It would seem apparent then that recordings of the Subjects attempting to relax would have been sufficient for this study without the introduction of additional stimulus items.

Any future study of this kind would need to compare any differences which may arise through attaching electrodes to the Subject for every training session, this practice in itself may cause problems due to irritation of the skin and possible discomfort caused by continual preparation of the skin's surface for electrode placement.

Apart from these inadequacies in the design of the Experiment some further consideration should be given to the numbers of training sessions given for Jacobson's method. Other students in the department receiving the same number of training sessions in Jacobson's method produced similar results when tested, measures were taken from the same muscle groups as in this Experiment. It is possible that further training sessions may produce complete S.M.R.

Observations by the Experimenter during the training sessions indicated that Subjects trained in methods A, B and D all achieved some level of S.M.R. especially those in methods A and B. This was judged by palpation of the various muscle groups and by passive movement of the head and limbs. Initially, all Subjects tensed their limbs when the Experimenter carried out any manipulation, even though the Subject was instructed to carry on relaxing.

As the sessions went on, the Experimenter became more adept at picking up even minute amounts of tension on palpation of a muscle group.

The major problems encountered during training sessions were the Subjects discomfort from lying on the hard table. Subjects in the Experimental groups ceased to complain about this after the first three to four sessions as relaxation improved as compared with the Subjects in the two Control groups C and F, who all complained of discomfort right through to the final training session.

Subjects in Experimental group D, who received their training sitting in a chair, did not have enough support and sometimes had the unpleasant experience of their head suddenly flopping forward causing them to jump.

All the Subjects in Experimental group A and three in group B reported a feeling of weightlessness in their arms and legs as sessions progressed, some Subjects reported that they could not even feel their arms or legs for some of the time. One Subject in group A found this sensation extremely distressing and kept shaking his hands during the first ten sessions, the Experimenter reassured him that this was not anything to become anxious about.

The other main problem was keeping the Subject motivated over all the sessions, three Subjects in methods A and B reported great enthusiasm during early sessions but became impatient and restless during later sessions. They reported that they wanted to get on with relaxation without having to learn muscle sense. Jacobson (1938) mentions that training in muscle sense does not necessarily make relaxation any easier, but for the purpose of the present study, the Experimenter wished to carry out every aspect of the method Jacobson describes.

The motivational aspects did not appear to be a problem for the Subjects in Section II probably because they received only a total of six training sessions each.

Observations of Subjects in Experimental group E ( metranome conditioned relaxation ) seemed to indicate that the Subjects went into a light sleep during the latter half of the playing the tape. Two of the Subjects snored occasionally during the sessions, all of the Subjects were observed to twitch quite frequently, sometimes just in one leg or hand or arm, and sometimes their whole body would twitch quite violently causing the Subject to open his eyes and look around. Sometimes the Subjects would report being aware of these sensations.

All the Subjects in the experimental groups reported that they felt good after a training session. The Subjects in Experimental groups A, B and D reported that during relaxation they were not aware of specific thoughts on anything, occasionally some Subjects reported that they were aware of having vague thoughts, but that they didn't last long and they didn't really attend to them.

The Subjects in Experimental group E gave the most enthusiastic reports on the success of the method which they were taught but observation of the Experimenter indicated that the method was the least successful in obtaining voluntary relaxation. Method A was the most thorough in training and the Experimenter's observations indicated that this method seemed to be more successful in producing S.M.R. than the other methods, but that method B may produce similar results with further training sessions.

To summarize this Experiment could only be considered a pilot study, and modifications to the design would be required before any further study commenced.

APPENDIX ITIME ESTIMATION TASK FOR TRAINING SESSIONSCONTROL GROUPS C AND F

<u>SESSION I</u> <u>Muscle Group</u>	<u>Time</u> <u>(seconds)</u>	<u>SESSION II</u> <u>Muscle Group</u>	<u>Time</u> <u>(seconds)</u>
Left biceps	30	Left head flexion	20
Right biceps	15	Right head flexion	30
Left biceps	15	Right head rotation	15
Right biceps	20	Left head rotation	20
Left hand extensors	45	Left hand extensors	15
Right hand extensors	15	Right hand extensors	45
Right hand extensors	45	Left hand extensors	45
Left hand extensors	15	Right hand extensors	15
Head flexion to right	20	Left knee flexors	30
Head flexion to left	20	Right knee flexors	20
<u>SESSION III</u> <u>Muscle Group</u>	<u>Time</u> <u>(seconds)</u>	<u>SESSION IV</u> <u>Muscle Group</u>	<u>Time</u> <u>(seconds)</u>
Left biceps	30	Left biceps	20
Right biceps	15	Right biceps	30
Right biceps	20	Right biceps	15
Left biceps	15	Left biceps	15
Right hand extensors	30	Left hand extensors	20
Left hand extensors	20	Right hand extensors	60
Left knee flexors	15	Right hand extensors	30
Right thigh flexors	20	Left head rotation	10
Right knee flexors	15	Left hand extensors	15
Left thigh flexors	15	Right head rotation	5

<u>SESSION V</u>		<u>SESSION VI</u>	
<u>Muscle Group</u>	<u>Time (seconds)</u>	<u>Muscle Group</u>	<u>Time (seconds)</u>
Right head rotation	10	Right thumb abduction	15
Left head rotation	15	Right thumb abduction	60
Left head rotation	5	Right thumb abduction	10
Right head rotation	15	Right thumb abduction	5
Right arm abduction	30	Right thumb abduction	20
Left arm abduction	10	Left little finger extension	30
Left arm abduction	20	Left little finger extension	10
Right arm abduction	10	Left little finger extension	60
Right thigh flexion	10	Left little finger extension	5
Left thigh flexion	10	Left little finger extension	15
<u>SESSION VII</u>		<u>SESSION VIII</u>	
<u>Muscle Group</u>	<u>Time (seconds)</u>	<u>Muscle Group</u>	<u>Time (seconds)</u>
Left foot extensors	20	Left knee flexors	20
Right foot extensors	30	Right knee flexors	30
Right index finger	10	Right knee flexors	15
Left index finger	15	Left knee flexors	45
Left index finger	10	Left index finger	10
Right index finger	15	Right index finger	15
Left foot extension	5	Right index finger	5
Right foot extension	30	Left index finger	15
Right foot extension	20	Left index finger	5
Left foot extension	30	Right index finger	20

<u>SESSION IX</u>		<u>SESSION X</u>	
<u>Muscle Group</u>	<u>Time (seconds)</u>	<u>Muscle Group</u>	<u>Time (seconds)</u>
Left index finger	20	Left biceps	20
Left index finger	10	Right biceps	30
Left thumb abduction	60	Right biceps	15
Left thumb abduction	20	Left biceps	15
Right thumb abduction	30	Left hand extensors	20
Right thumb abduction	60	Right hand extensors	60
Right index finger	10	Right hand extensors	30
Right index finger	10	Left hand extensors	15
		Left head rotation	10
		Right head rotation	5
<u>SESSION XI</u>		<u>SESSION XII</u>	
<u>Muscle Group</u>	<u>Time (seconds)</u>	<u>Muscle Group</u>	<u>Time (seconds)</u>
Left biceps	30	Right head rotation	15
Right biceps	20	Left head rotation	5
Right biceps	15	Left head rotation	15
Left biceps	20	Right head rotation	10
Right hand extensors	30	Right hand extensors	60
Left hand extensors	15	Left hand extensors	15
Left knee flexion	15	Left hand extensors	60
Right knee flexion	30	Right hand extensors	15
Right knee flexion	15	Right arm abduction	10
Left knee flexion	20	Left arm abduction	15

<u>SESSION XIII</u>		<u>SESSION XIV</u>	
<u>Muscle Group</u>	<u>Time (seconds)</u>	<u>Muscle Group</u>	<u>Time (seconds)</u>
Left index finger	20	Left head flexion	20
Left index finger	10	Right head flexion	30
Left index finger	30	Right head flexion	15
Left index finger	5	Left head flexion	20
Left index finger	15	Left hand extensors	15
Right index finger	15	Right hand extensors	60
Right index finger	5	Left foot extensors	60
Right index finger	30	Right foot extensors	15
Right index finger	10	Right foot extensors	30
Right index finger	20	Left foot extnsors	20
<u>SESSION XV</u>		<u>SESSION XVI</u>	
<u>Muscle Group</u>	<u>Time (seconds)</u>	<u>Muscle Group</u>	<u>Time (seconds)</u>
Right head rotation	10	Left thigh flexion	15
Left head rotation	15	Right thigh flexion	10
Left head rotation	5	Right thigh flexion	30
Right head rotation	15	Left thigh flexion	30
Right arm abduction	30	Left elbow flexion	10
Left arm abduction	10	Right elbow flexion	15
Left arm abduction	20	Right elbow flexion	20
Right arm abduction	10	Left elbow flexion	15
Right thigh flexion	10	Left hand extension	15
Left thigh flexion	10	Right hand extension	10

<u>SESSION XVII</u>		<u>SESSION XVIII</u>	
<u>Muscle Group</u>	<u>Time</u> <u>(seconds)</u>	<u>Muscle Group</u>	<u>Time</u> <u>(seconds)</u>
Left index finger	30	Right thumb abduction	15
Left index finger	15	Right thumb abduction	60
Left index finger	20	Right thumb abduction	10
Left index finger	5	Right thumb abduction	5
Left index finger	10	Right thumb abduction	20
Right little finger	30	Left little finger	30
Right little finger	15	Left little finger	10
Right little finger	20	Left little finger	60
Right little finger	5	Left little finger	5
Right little finger	10	Left little finger	15

APPENDIX II

<u>Session No</u>	<u>Tape No</u>	<u>Limb Flexion or Extension</u>
1 $\neq$	2	Left arm
2	2	Right arm
3	3	Left forearm
4	3	Right forearm
5	4	Left arm
6 $\neq$	4	Right arm
7 $\neq$	5	Left index finger (extension)
8	5	Right index finger(extension)
9	2	Right arm
10	5	Left arm
11	6	Left index finger
12 $\neq$	6	Left forearm
13	3	Left thigh
14 $\neq$	3	Right thigh
15 $\neq$	1	Right arm
16	1	Left arm
17	4	Right leg
18	1	Left leg

VIGILANCE TASK : ORDER OF TAPES USED AND LIMB USED FOR GROUP C.

ORDER OF TAPES USED AND LIMB USED FOR GROUP F IS

MARKED WITH  $\neq$

APPENDIX IIIINTEGRATED E. M. G.

1. Relaxation one
2. Relaxation two
3. Loud noise
4. Passive movement of arm
5. Digits backwards
6. Relaxation three

RELAXATION ONE

<u>Subject</u>	<u>Pre-test 1</u>			<u>Pre-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	12.558	5.244	0.000	12.190	6.302	0.000
2	16.882	4.876	0.000	16.974	9.154	0.000
3	7.682	2.806	0.000	8.924	4.968	0.000
4	14.582	3.450	0.000	12.604	2.760	0.000
5	10.534	2.300	0.000	13.248	2.530	0.000
6	51.382	4.232	0.000	24.058	2.760	0.000
7	10.580	3.082	0.000	9.890	3.266	0.000
8	19.274	3.100	0.000	16.928	7.820	0.000
9	10.350	3.220	0.000	12.466	3.680	0.000
10	17.710	22.126	0.000	11.638	3.864	0.000
11	11.132	4.278	0.000	10.672	3.450	0.000
12	11.868	6.578	0.000	9.936	4.048	0.000
13	15.456	5.750	22.862	9.752	4.968	21.804
14	17.618	9.292	14.628	26.174	3.772	16.146
15	19.596	4.922	8.648	14.306	5.014	11.776
16	16.928	5.014	60.030	16.974	4.830	58.788
17	11.132	4.186	11.316	9.062	4.186	47.932
18	12.650	3.128	27.600	34.500	4.048	14.628
19	10.488	3.956	7.268	14.076	10.074	9.614
20	11.362	3.956	9.614	11.270	3.818	11.868
21	9.660	9.062	23.598	11.362	4.232	28.980
22	15.916	13.800	19.734	9.108	5.290	21.482
23	14.352	5.382	11.454	16.284	5.382	13.892
24	16.330	4.324	18.538	14.904	4.922	21.160

<u>Subject</u>	<u>Post-test 1</u>			<u>Post-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	7.820	5.1520	18.722	10.994	5.244	8.878
2	15.364	4.5540	13.984	13.984	3.864	16.192
3	8.050	3.7260	10.304	7.590	3.174	9.936
4	10.166	4.0940	8.970	9.522	4.140	14.628
5	15.778	3.4040	17.434	5.658	3.174	11.500
6	14.812	3.7260	18.032	17.940	4.048	16.882
7	10.718	3.6800	19.596	9.292	4.048	16.560
8	17.526	4.1400	13.110	16.882	3.358	9.752
9	9.660	4.5540	7.130	9.798	3.542	40.112
10	11.362	3.8640	11.822	11.638	4.554	14.904
11	12.696	5.1980	19.136	12.328	4.922	20.562
12	15.088	4.3700	14.812	12.420	5.520	14.168
13	9.522	5.0140	25.484	8.878	4.830	21.344
14	6.808	3.5880	17.158	7.728	3.220	15.042
15	9.614	4.5080	16.974	9.844	4.048	13.248
16	6.348	4.9680	13.662	15.456	3.404	14.904
17	7.866	4.1860	35.098	8.050	3.128	12.236
18	22.724	3.5880	9.936	25.530	3.404	13.708
19	11.592	4.8300	12.604	15.548	3.450	10.626
20	7.958	3.9100	13.892	9.844	3.818	10.764
21	10.764	4.4620	23.460	11.684	3.450	23.460
22	11.638	4.5540	24.196	12.236	11.960	23.828
23	11.822	5.6580	20.746	12.190	4.370	15.778
24	9.384	5.3820	24.564	9.108	4.094	20.976

RELAXATION TWO

<u>Subject</u>	<u>Pre-test 1</u>			<u>Pre-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	14.076	6.164	0.000	15.364	5.3820	0.000
2	21.804	4.278	0.000	17.526	4.4620	0.000
3	6.900	9.016	0.000	9.016	2.9440	0.000
4	11.454	3.588	0.000	15.042	2.7600	0.000
5	13.110	2.484	0.000	10.856	2.4840	0.000
6	38.640	3.864	0.000	15.134	3.0360	0.000
7	11.500	3.404	0.000	11.500	3.3580	0.000
8	15.410	3.128	0.000	18.032	3.1740	0.000
9	4.140	4.140	0.000	7.130	3.6800	0.000
10	15.778	4.968	0.000	11.408	4.8300	0.000
11	26.772	4.278	0.000	11.822	3.4960	0.000
12	12.650	6.256	0.000	11.960	4.0940	0.000
13	12.052	5.566	23.690	13.938	5.0600	21.988
14	21.160	5.244	16.008	23.184	4.5080	16.560
15	28.290	3.726	14.490	14.030	5.1060	13.340
16	20.792	7.360	40.848	17.204	5.2900	59.754
17	6.854	5.290	10.856	9.844	4.0020	57.822
18	12.236	2.990	28.060	41.584	4.2320	21.620
19	11.316	3.818	8.372	13.800	4.2780	11.500
20	8.832	4.094	11.132	14.214	3.7720	14.306
21	10.580	9.890	17.066	9.844	4.0940	27.048
22	19.274	12.328	21.114	13.984	4.5540	22.816
23	10.580	5.060	12.696	19.090	5.3820	24.702
24	15.962	4.370	19.274	29.302	5.2900	20.194

<u>Subject</u>	<u>Post-test 1</u>			<u>Post-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	11.040	5.152	19.090	11.040	5.382	11.040
2	17.664	4.600	18.860	13.064	4.324	17.526
3	8.326	3.450	9.660	8.510	3.220	9.246
4	9.384	4.600	10.580	9.016	4.232	18.676
5	14.352	3.634	13.846	13.800	3.496	14.030
6	8.004	4.002	14.260	7.682	3.956	16.836
7	11.362	4.140	15.824	9.200	4.002	16.560
8	16.100	4.048	15.502	16.192	3.358	9.798
9	9.798	4.554	6.946	9.522	3.450	20.838
10	14.858	4.002	11.776	12.650	5.106	10.672
11	11.730	4.094	18.998	14.950	5.290	21.482
12	10.304	6.440	12.098	13.478	11.730	13.248
13	9.568	5.014	23.368	9.062	4.646	28.428
14	6.486	3.358	14.812	7.590	3.358	15.686
15	9.660	4.362	16.928	9.430	4.232	12.696
16	28.336	5.520	14.352	14.674	4.416	24.978
17	10.074	10.166	11.362	6.992	2.944	12.788
18	25.162	3.220	10.718	26.220	3.496	12.788
19	8.004	3.726	12.052	9.246	3.772	12.466
20	8.234	3.956	13.018	10.074	4.094	12.190
21	9.660	4.784	26.818	9.890	4.140	26.266
22	19.550	4.968	24.012	14.720	4.554	22.816
23	13.524	5.382	21.482	10.258	4.508	17.204
24	9.384	5.474	25.116	12.144	4.094	22.908

LOUD NOISE

<u>Subject</u>	<u>Pre-test 1</u>			<u>Pre-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	31.786	5.757	0.000	20.838	8.372	0.000
2	22.954	4.554	0.000	14.720	4.324	0.000
3	14.766	5.244	0.000	10.074	5.244	0.000
4	16.100	3.220	0.000	11.316	3.174	0.000
5	14.766	6.164	0.000	14.674	3.358	0.000
6	52.900	12.236	0.000	41.952	7.544	0.000
7	17.940	4.048	0.000	14.030	4.186	0.000
8	34.500	3.542	0.000	25.162	3.680	0.000
9	18.584	6.578	0.000	14.352	10.350	0.000
10	35.650	6.394	0.000	24.656	4.002	0.000
11	23.414	4.600	0.000	12.328	3.450	0.000
12	11.454	5.934	0.000	19.872	4.830	0.000
13	24.886	6.394	30.820	23.690	6.716	31.740
14	15.502	3.956	11.086	27.692	5.750	24.058
15	32.660	4.554	18.216	21.298	5.060	14.122
16	6.808	5.980	39.974	22.678	8.004	45.264
17	7.084	3.956	23.874	18.584	3.634	27.646
18	40.296	3.220	30.590	32.430	6.164	35.926
19	11.868	9.154	15.180	13.110	5.612	11.454
20	11.454	3.910	9.660	12.558	3.864	13.662
21	12.282	9.430	20.148	11.730	4.140	25.714
22	15.042	13.616	25.852	17.434	7.544	25.024
23	20.884	7.406	25.484	15.502	5.520	27.370
24	28.244	5.014	36.018	18.216	5.520	24.702

<u>Subject</u>	<u>Post-test 1</u>			<u>Post-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	28.336	6.9460	20.240	10.672	6.0720	15.272
2	20.884	4.6920	18.906	20.056	7.4520	27.830
3	7.774	5.6120	10.442	7.590	3.6800	13.156
4	11.316	4.6460	13.662	10.120	3.8640	12.374
5	14.812	4.6920	20.976	15.180	3.9560	21.574
6	40.204	3.9560	38.502	26.542	4.0940	11.500
7	17.894	4.1400	20.148	16.100	6.4860	18.768
8	11.960	3.4960	12.742	9.890	3.3120	9.936
9	11.316	5.6120	8.832	16.100	5.2900	16.422
10	31.096	4.5540	15.548	19.734	5.4280	15.410
11	14.858	7.1300	21.344	17.020	8.1420	22.632
12	24.702	4.0020	28.106	45.724	4.6000	15.916
13	13.478	4.9220	21.896	20.286	5.1980	34.914
14	10.534	4.1860	19.550	10.534	4.6000	17.894
15	16.422	5.2900	18.446	14.720	6.3940	17.848
16	16.514	5.6120	19.734	12.834	6.3940	40.112
17	8.050	7.7280	12.696	10.028	3.1740	19.964
18	17.710	3.2200	12.650	23.046	4.0480	17.302
19	12.466	5.4280	12.696	12.512	5.7040	12.650
20	11.040	3.9100	15.916	11.408	4.6460	13.346
21	16.698	4.8300	29.532	10.166	7.4520	31.188
22	18.630	5.0140	25.070	16.652	6.8540	25.392
23	18.446	5.2440	62.146	23.552	5.0600	39.100
24	13.018	6.3480	27.738	11.454	4.0940	22.540

PASSIVE MOVEMENT OF ARM

<u>Subject</u>	<u>Pre-test 1</u>			<u>Pre-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	14.168	5.888	0.000	19.596	10.304	0.000
2	19.872	25.208	0.000	17.112	42.136	0.000
3	5.704	5.704	0.000	10.902	13.110	0.000
4	11.454	10.764	0.000	10.534	11.638	0.000
5	8.878	12.144	0.000	8.188	7.314	0.000
6	36.570	4.370	0.000	20.424	3.542	0.000
7	11.822	4.554	0.000	11.500	5.612	0.000
8	10.672	6.210	0.000	13.524	6.164	0.000
9	10.442	8.004	0.000	11.776	6.118	0.000
10	12.144	6.440	0.000	13.432	5.198	0.000
11	8.464	13.754	0.000	9.154	14.720	0.000
12	11.270	6.256	0.000	9.706	5.612	0.000
13	9.633	7.314	31.096	10.902	5.244	25.484
14	15.824	4.094	9.430	18.998	4.370	18.814
15	16.744	6.394	21.068	13.708	8.970	9.982
16	13.578	8.060	39.882	11.270	8.510	42.918
17	7.590	6.302	6.992	11.500	9.016	36.156
18	10.948	3.128	19.550	32.614	7.912	13.662
19	9.154	9.154	9.936	9.752	4.324	10.212
20	10.626	5.290	10.212	13.386	5.244	11.914
21	9.890	11.316	27.232	10.902	12.098	28.566
22	15.456	8.234	21.804	14.950	10.672	22.034
23	19.274	13.524	27.324	11.408	7.314	16.468
24	16.054	5.612	18.400	5.750	5.750	19.918

<u>Subject</u>	<u>Post-test 1</u>			<u>Post-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	15.134	5.566	14.766	8.326	4.876	10.258
2	17.250	10.304	12.374	18.998	14.490	18.124
3	7.590	4.324	6.716	7.038	4.186	10.074
4	10.534	8.832	11.316	10.120	4.738	10.902
5	8.280	8.234	9.476	8.096	15.134	13.478
6	39.652	6.210	19.412	33.580	12.834	17.158
7	11.546	7.452	14.490	9.844	4.278	18.308
8	9.660	4.600	10.212	13.570	3.956	8.464
9	28.106	8.050	6.808	10.718	5.060	14.536
10	11.546	6.026	10.672	16.100	5.474	11.270
11	10.350	7.958	17.066	14.674	11.270	21.850
12	11.316	10.074	11.638	12.650	5.980	17.618
13	11.040	5.014	14.260	10.350	6.900	24.610
14	8.694	4.094	8.694	9.246	3.818	9.430
15	9.384	6.118	15.916	9.108	7.222	13.892
16	10.166	4.462	29.394	11.178	5.612	26.312
17	9.246	4.692	12.788	8.004	5.934	12.880
18	20.148	3.818	11.592	29.440	4.922	12.650
19	8.878	10.212	12.190	10.396	5.888	12.604
20	9.430	4.968	12.052	9.890	4.784	11.684
21	11.454	9.108	17.756	12.374	6.486	27.278
22	18.492	6.164	22.172	14.950	9.614	21.850
23	12.052	6.946	19.550	16.376	5.658	18.768
24	9.982	6.348	18.124	10.350	6.716	19.274

DIGITS BACKWARDS

<u>Subject</u>	<u>Pre-test 1</u>			<u>Pre-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	18.170	7.268	0.000	19.596	11.408	0.000
2	29.394	16.652	0.000	24.150	11.132	0.000
3	11.040	4.324	0.000	14.996	3.404	0.000
4	31.050	3.726	0.000	14.260	2.760	0.000
5	27.646	4.830	0.000	19.780	2.622	0.000
6	30.774	4.094	0.000	30.268	3.772	0.000
7	21.436	5.106	0.000	20.194	3.634	0.000
8	17.158	5.980	0.000	31.326	5.474	0.000
9	13.524	3.910	0.000	11.868	3.864	0.000
10	41.814	4.554	0.000	41.400	4.646	0.000
11	24.058	30.130	0.000	32.660	29.210	0.000
12	23.690	5.612	0.000	18.124	3.450	0.000
13	22.218	5.474	24.564	16.008	5.474	28.014
14	22.172	6.486	24.656	22.034	4.140	18.814
15	38.640	7.130	25.438	31.050	5.336	21.942
16	36.018	10.074	62.146	25.852	6.532	62.192
17	18.952	4.876	17.434	21.344	4.784	36.800
18	11.684	3.450	40.756	34.776	3.956	26.450
19	11.270	3.818	14.306	16.790	4.186	10.304
20	16.790	5.014	15.824	13.110	4.094	20.378
21	11.178	7.774	36.662	18.998	6.762	37.996
22	13.616	5.520	23.874	16.974	4.692	25.392
23	15.410	8.142	26.220	12.972	5.842	18.262
24	23.874	4.600	27.094	23.460	4.922	25.530

<u>Subject</u>	<u>Post-test 1</u>			<u>Post-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	10.672	4.8300	25.714	10.534	3.9100	22.356
2	21.114	4.5540	30.498	23.552	5.1060	47.242
3	8.234	3.7720	7.820	12.328	4.6000	14.122
4	10.258	4.0940	11.454	9.982	4.0020	12.788
5	8.280	3.6340	18.630	19.964	4.2320	13.478
6	41.768	3.8180	16.790	43.746	4.0480	28.428
7	21.022	4.3700	19.596	16.974	3.9100	20.654
8	25.714	4.0940	17.894	13.570	3.5420	12.696
9	11.638	4.5540	17.894	16.974	4.7380	15.548
10	29.118	4.5540	11.362	39.100	4.9680	16.054
11	11.454	9.4300	19.182	10.102	5.5660	28.750
12	15.042	4.1860	15.594	19.458	4.3700	27.922
13	13.110	5.0600	19.826	15.916	4.5540	26.174
14	20.516	6.8080	13.984	21.804	7.1760	13.892
15	20.378	5.4280	33.902	18.584	4.8300	13.800
16	37.444	5.4740	59.294	23.736	6.7160	50.002
17	8.234	3.9100	35.788	20.470	4.1860	32.292
18	28.198	3.2200	14.444	32.890	3.6800	15.916
19	16.974	4.8760	14.950	15.594	4.0480	12.696
20	12.052	5.9800	17.894	11.868	3.9560	15.548
21	10.258	5.2900	36.570	17.572	7.6360	33.810
22	24.748	4.7840	27.232	20.286	4.6000	28.934
23	16.054	5.4740	44.850	11.776	4.6920	39.054
24	17.940	5.3360	21.436	25.438	4.5080	26.036

RELAXATION THREE

<u>Subject</u>	<u>Pre-test 1</u>			<u>Pre-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	19.734	5.428	0.000	16.652	4.5540	0.000
2	13.635	6.302	0.000	10.994	4.1860	0.000
3	5.934	3.864	0.000	9.200	2.7600	0.000
4	10.028	3.450	0.000	15.134	2.7600	0.000
5	20.286	2.346	0.000	18.538	2.4380	0.000
6	23.276	4.600	0.000	49.312	3.6800	0.000
7	13.156	3.680	0.000	10.258	3.2660	0.000
8	12.972	3.680	0.000	15.870	3.3580	0.000
9	10.580	3.450	0.000	9.844	3.8640	0.000
10	27.922	4.554	0.000	10.304	3.4500	0.000
11	37.030	4.554	0.000	9.246	3.4500	0.000
12	12.006	11.270	0.000	10.626	3.2200	0.000
13	11.508	5.428	34.408	10.995	5.1520	21.896
14	24.840	4.922	18.768	16.560	4.2780	15.594
15	23.414	4.140	11.132	12.972	9.5220	10.350
16	12.282	6.992	52.072	14.766	4.0940	25.116
17	6.348	4.876	6.900	9.338	4.4160	62.974
18	8.648	3.312	30.314	27.002	3.8180	13.386
19	9.016	3.818	9.476	10.948	4.1400	8.832
20	13.478	4.140	12.052	11.960	3.9560	11.730
21	9.154	9.660	18.032	9.706	5.5660	16.330
22	18.400	4.554	24.150	13.248	4.5540	25.438
23	13.110	5.382	17.572	18.170	5.4280	11.316
24	20.940	4.600	26.956	18.860	4.8300	34.730

<u>Subject</u>	<u>Post-test 1</u>			<u>Post-test 2</u>		
	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>	<u>Frontralis</u>	<u>Biceps</u>	<u>S.C.M.</u>
1	19.780	5.5200	37.812	16.284	5.1060	30.636
2	12.926	4.5540	35.834	10.488	4.3240	28.198
3	6.440	3.7720	5.612	5.474	3.1280	7.820
4	9.752	4.1400	12.834	10.626	3.8180	10.304
5	6.118	3.5420	7.866	13.202	3.4040	13.478
6	20.792	4.0940	15.548	9.062	4.0020	15.640
7	13.892	4.1400	15.456	9.890	4.0020	15.134
8	11.224	4.3240	16.422	12.604	3.3580	11.086
9	9.430	4.7380	7.636	10.488	5.0140	9.200
10	10.994	3.8640	9.384	9.200	5.0140	11.822
11	10.994	4.4620	17.066	12.236	5.8420	21.620
12	10.764	9.4300	13.064	12.420	4.6000	15.088
13	9.016	4.8760	13.064	9.200	4.6000	13.800
14	8.188	3.6800	11.408	8.050	3.6800	11.316
15	9.338	6.6240	16.974	9.936	4.2780	12.098
16	28.796	4.4160	14.260	13.248	3.4500	12.834
17	9.522	3.6800	44.942	10.166	3.0820	20.194
18	32.338	3.2660	12.788	25.852	3.6800	13.570
19	9.476	4.5540	13.892	10.074	4.0940	11.638
20	7.682	3.8640	12.328	9.246	4.2780	11.960
21	7.774	5.0140	29.394	9.200	4.2780	47.794
22	11.086	4.2780	25.070	12.972	4.2780	23.782
23	20.378	5.4740	24.196	14.674	4.6460	15.640
24	9.890	5.4740	27.048	13.984	3.8640	24.334

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