THE EFFECTS OF AUDITORY SUBLIMINAL STIMULI ON STRENGTH AND RELATIVE ENDURANCE OF MALE ATHLETES

by

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August, 1983

A Thesis Submitted to
The Faculty of Graduate Studies and Research
In Partial Fulfillment of the Requirements
For the Degree of Master of Arts (Education)

SUBLIMINAL SUGGESTION AND PHYSICAL PERFORMANCE

ABSTRACT

The effects of auditory subliminal stimulation on muscular performance was examined using a double-blind procedure. Seventeen English-speaking, right-hand dominant male athletes with no hearing impairments were assigned in counterbalanced order to each of three experimental conditions: A positive and negative treatment condition in which the subject received a subliminal message in an attempt to improve or reduce performance respectively, and a control condition in which no subliminal suggestion was issued. Each subject's speech detection threshold, minus five decibels, was calculated and used as the intensity level for the auditory subliminal message. Initial and treatment strength scores were obtained from an isometric maximum voluntary contraction (MVC) of the elbow flexors. A relative isometric muscular endurance (RIME) score was calculated as the length of time the subject could maintain a load equivalent to 30% of his MVC. A repeated measures analysis through multivariate procedures revealed no significant differences ($p > .05$) in MVC and RIME scores across the three conditions. The results were interpreted as evidence that subliminal audio-conditioning is not an effective means of altering isometric strength and endurance performance of the elbow flexors.

RESUME

Cette étude a été menée dans le but de déterminer l'effet d'un stimulant subliminal auditif sur la force et l'endurance musculaire isométrique. Dix-sept athlètes males sans trouble auditif ont été soumis par ordre contre-balancé à chacune des trois conditions expérimentales suivantes: des messages subliminaux positifs et négatifs cherchant à améliorer ou à reduire leurs rendements, et une condition de contrôle sans message subliminal. L'intensité du stimulant subliminal fut établi pour chaque sujet en soustrayant cinq décibels de son seuil de reconnaissance auditif. Les mesures de force initiale et de traitement furent obtenues à partir de contraction volontaire isométrique maximale (CVM) des fléchisseurs du coude. Une mesure d'endurance musculaire isométrique relative (EMIR) fut calculée comme étant la période où le sujet pouvait maintenir une resistance equivalente à 30% de son CVM. Une analyse de conditions-répétées à travers des procédures multivariées n'a révélé aucune différence significative ($p > .05$) entre les conditions expérimentales pour les mesures de CVM et EMIR. Les résultats furent interprétés comme une indication que le conditionnement par message subliminal auditif n'est pas une méthode efficace pour influencer la performance de force et d'endurance isométrique des fléchisseurs du coude.

ACKNOWLEDGMENTS

It would be difficult to write a thesis of this exploratory nature without the active cooperation of numerous individuals. To this end, the author wishes to recognize the efforts of those who were instrumental in the completion of this investigation.

First and foremost, my gratitude is extended to my advisor, Dr. D. Q. Marisi, for having "sparked" in me an avid interest for psychology of motor performance. His profound knowledge, coupled with a most friendly nature, has made the completion of this thesis a most pleasant and educationally fulfilling personal experience.

Special thanks are extended to Dr. L. Vroomen and his technicians of the DATAC lab for their assistance in the design of the testing apparatus. To Dr. F. Rudmin of the McGill University School of Human Communications Disorders for his technical expertise in the field of acoustics and, to Dr. S. Rapagna for providing his statistical expertise in MANOVA procedures.

Furthermore, the cooperation and effort made by all the subjects of the CIOR in the collection of data over the several weeks of testing was greatly appreciated. I would also like to thank my friends John, Lorna and Mike for having provided moral support.

Finally, the author wishes to share this accomplishment with his parents who have taught him the virtue of an honest hard day's work.

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CHAPTER I

INTRODUCTION

One of the most widely accepted principles of human behavior is that a motivated condition is essential not only for learning, but also for effective performance in motor skills. Numerous motivating techniques have been applied in both experimental and practical settings and empirical evidence has clearly demonstrated that verbal encouragement is one technique which has been extensively employed to improve performance (Gerdes, 1958; Nelson, 1962; Strong, 1963). More specifically, this technique has been found to be a significant factor in increasing strength and endurance scores in physical fitness testing (Barber, 1966; Kroll, 1970). It is for this reason that educators in general, and physical educators and coaches in particular, devote considerable effort towards motivating students and athletes using verbal encouragement.

1.1 Scope of the Study

The phenomena of subliminal perception continues to be a widely researched and controversial topic in psychology. The contention that stimuli below the threshold of awareness can be retrieved without having consciously identified their meaning is central to signal detectability theory. Reviews of literature by Dixon (1971) and Silverman (1976) present a substantial amount of research evidence which firmly supports the view that registration of perceptual stimulation beyond conscious awareness does occur.

One of the problems that characterizes research in this area is that the term subliminal perception may be a misnomer because it implies that there are absolute thresholds that determine whether or not a stimuli will be registered. However, such a position is in contradiction with current opinions about the processing of perceptual inputs (Dixon, 1971; Aurell, 1979). Proponents of signal detection theory suggest that the relation between intensity of stimulation and registration within awareness occurs in a probabilistic manner as opposed to all or none mode. This explanation of stimuli reception has been termed multistate sensory and decision systems (Green, 1964; Green & Swets, 1966; Massaro, 1975). In addition, Erderly (1974) suggested that:

> The proceedings...which suggested that the perception of external events: attitudes, values, expectencies, needs, and psychodynamic defenses all impinge upon perception. (p.1)

It is for this reason, therefore, that many investigators are now applying signal detection analysis to demonstrate when registration of a subliminal stimulus occurs which is unaffected by biases such as threshold and response criterion (Winnick, Luria & Zukor, 1967; Thierman, 1967; Weintraub & Fidell, 1979).

The credibility of many psychological theories hinge to some extent upon the degree to which it is biologically tenable. Evidence for the basis of perception without awareness has been demonstrated in three lines of research. First, investigators have demonstrated that a stimulus of which the subject is unaware, because of anaesthetic or

surgical blocking, can nevertheless produce an effect on the nervous system (Fuster, 1958; Libet, Alberts, Wright & Feinstein, 1967). Secondly, the detection by EEG of the brain's average evoked response (AER), to a subliminal stimulus has been a direct means of measurement of unconscious mental and cognitive processes (Shevrin & Smith, 1971; Sachein, Parker & Rubin, 1977). A third group of experiments are those involving sleep studies which have shown that sleeping subjects can make complex discriminations among repetitive emotionally important auditory stimuli (Osward, Taylor & Treesman, 1960; Berger, 1965, Lasagna & Lasagna, 1973).

Once the intital controversy as to the existence of subliminal perception had been demonstrated, more research was directed towards determining its behavioral effects. This view was noted in a statement by Bevan (1964):

> That the topic has come of age is indicated by several facts. Experiments are no longer simply directed toward establishing subliminal perception as an empirical phenomenon but incline more toward examining its influence upon a variety of behavioral events. (p. 84)

In terms of behavior modification, perhaps the most significant of the demonstrable effects of subliminal stimulation involves Helson's (1958) adaption level theory. This theory hypothesizes that the organism acts as a system that pools all sensory inputs that serve as internal norms or standards which become reference values for subsequent judgments. Many studies have shown subliminal stimulation to be effective in influencing anchor judgments in the areas of size judgments (Boardman & Goldstone, 1962; Kennett, 1962; Farne, 1963); tone judgments (Bevan &

Pritchard, 1963); intensity of shock (Black & Bevan, 1960); body boundary (Fisher, 1975; 1976); and judgments with regard to amount of hunger (Byrne, 1969; Spence & Ehrenberg, 1964). However, similar studies have reported nonsignificant results with regard to value-norm-anchor judgments (Champion & Turner, 1959; Chun & Sarbin, 1968; Murch, 1968; Hovsepian & Quatman, 1978).

Recent studies investigating the potential influence of subliminal effects on modification of behavior have been equivocal. For example, investigations of the effects of subliminal messages on the modification of attitudes toward alcoholism (Hart, 1973) and for the treatment of obesity (Becker, 1976; Silverman, Martin, Ungaro & Mendelsohn, 1978) have supported the hypothesis that subliminal stimulation can affect attitudes and hence alter behavior. However, no support was found for these claims in terms of altering cigarette smoking behavior (Glover, 1979) or affecting consumer buying power (George & Jennings, 1975).

Silverman (1976) has reviewed numerous clinical experiments that were performed in the last two decades dealing with the effects of subliminal stimulation on psychopathic behavior. These experiments involved presenting psychopathic subjects with a specific pictorial and/or verbal wish-related stimulus at a subliminal level and comparing its effects with those of subliminal stimuli having neutral or different psychodynamic content. Many investigators supported the contention that subliminal stimulation can alter behavior and may be of therapeutic value (Lee & Typer, 1980).

Several studies have suggested that the appearance of subliminal effects was related to both situational and/or individual difference factors. For example, subliminal effects are more likely to be found when subjects are in a state of relaxed passivity (Fisher & Paul, 1959; Fiss, 1966; Key, 1973); attention is unselective or broadened (Murch, 1969); and, cognitions are intuitive, global, symbolic and free of logical constraints (Gordon, 1967).

The suggestion that emotion and motivation appear to play a significant part in subliminal perception has been investigated extensively in studies of perceptual defence (Brown, 1961; Dixon, 1971). The basic assumption of this proposition is that recognition thresholds depend upon the emotional connotations and the ease or difficulty with which one is able to perceive a subliminal stimuli depends upon the meaning or personal significance of the stimuli (Ericksen, 1954). The interaction between the level of motivation of the subject and the emotional content and connotations of the subliminal stimulus have been shown in various paradigms and is known as the subception effect (Lazarus & McCleary, 1961).

Once the validity of subliminal perception was established as an empirical phenomenon, the ethical consideration became the issue due to the fact that a person's behavior could be influenced without their conscious awareness. The commercial exploitation of the principle of subliminal perception has been clearly demonstrated (Key, 1973; 1976; 1980). Despite the reassurance that no one can be made to do something

personally unacceptable and that the subliminal stimulus can only act as a reminder for an existing desire (Byrne, 1959), the Canadian Radio Television Commission (CRTC) has amended its regulation forbidding the use of "any advertising material that makes use of any subliminal device" (Key, 1976, p. 212).

1.2 Significance of the Study

The contention that a person's level of motivation can be altered without his awareness through subliminal messages, should make evident the implications in physical education and sport psychology. For example, an athletic facility could create an environment that would subliminally promote a more positive psychological atmosphere conducive for athletic training and performance. As well, subliminal messages could be used in assisting the coach in altering an athlete's level of arousal or, offer the general population the psychological impetus towards engaging in physical activity.

Behavioral engineers, Becker and Romberg (Secret Voices, 1980) have claimed that they are providing subliminal "pep talks" to the Montreal Canadians and other professional teams. They insist that subliminal audio-conditioning is especially useful in promoting optimal performance. However, the validity of such a statement lacks scientific verification. Therefore, it is necessary to subject these contentions to scientific experimentation.

1. 3 Statement of the Problem

Theoretical documentation has clearly demonstrated that supraliminal stimulation such as verbal encouragement can improve performance and empirical evidence has suggested that registration of perceptual stimulation beyond conscious awareness does occur. Therefore, because there exists a relative dearth of literature pertaining to the effects of subliminal stimulation as a means of behavior modification and, since a search of the literature has revealed no studies focusing on subliminal effects on physical performance, it would seem that a study of this nature is warranted.

Thus, the general purpose of the study is to investigate the effect of auditory subliminal stimuli on the ability to perform a physical task involving muscular strength and endurance.

The specific hypotheses to be treated in the study are:

1.3.1 There will be no significant differences in maximal voluntary contraction (MVC) of the elbow flexors under pre and posttreatment conditions of positive, negative and no subliminal messages.

1.3.2 There will be no significant differences in relative isometric muscular endurance (RIME) scores of the elbow flexors under conditions of positive, negative and no subliminal messages.

1.4 Definitions and Abbreviations

1.4.1 Maximal Voluntary Contraction (MVC): The mean of the subject's best two of three static muscular contractions of the elbow flexors of the dominant arm, recorded and measured in grams by the static muscular force apparatus.

1.4.2 Relative Isometric Muscular Endurance (RIME): The length of time that a subject is able to apply a static contraction of the elbow flexors to a resistance equivalent to 30 ± 5% of his initial MVC.

1.4.3 Speech Detection Threshold (SDT): The lowest hearing intensity, expressed in decibels (db), at which the subject correctly detects 50% of the spondee digits presented.

1.4.4 Subliminal Stimuli: The auditory message that was played throughout the positive and negative subliminal stimuli conditions at an intensity level equivalent to the subject's predetermined SDT minus five db.

1.5 Delimitations and Limitations of the Study

Since the subjects employed in the study were volunteer, physically active athletes who basically had an interest in physical performance, inferences must be confined to the representative population. Further, the type and nature of the motor task used in the study cannot be considered representative of all motor tasks.

Individual differences such as language could possibly effect the perception of the subliminal message, therefore, only subjects whose mother tongue was English were used in this study to control for this possible extraneous variable. There also existed the possibility that differences in arousal level might have negated potential effects of the subliminal stimulus. However, it was assumed that there was a relatively even distribution of high and low aroused subjects in the sample. As well, the repeated measures design in which each subject acted as his own control, served to reduce the statistical effect of potential artifacts .

Specifically, the limiting factors of the study may be noted as follows:

1.5.1 Only male athletes of the Confédération Interalliée d'Officiers de Reserve (CIOR), ranging in age from 18 to 23 years, were used as subjects in the study.

1.5.2 The words chosen for the composition of the subliminal message were selected from ratings by non experimental subjects as to the effect these words might have on their level of arousal while performing a motor task similar to that used in the study.

1.6.3 The activity level, rest habits and daily patterns of the subjects were not rigidly controlled. However, all subjects were asked to adhere to a list of preexperimental instructions in an attempt to standardize procedures and minimize the potential influence of any extraneous variables.

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this study was to investigate the effect of auditory subliminal stimuli on an athlete's ability to perform a physical task involving static muscular strength and endurance. The literature relating to the present study has been reviewed under the following headings: (2.1) Subliminal Perception; and, (2.2) Behavioral Effects.

2.1 Subliminal Perception

The assumption that we process information without being aware of it, is an accepted fact (Aurell, 1979). However, the mechanisms by which this subconscious perceptual processing takes place remains nothing more than controversial theoretical postulates. One of the oldest problems to engage the attention of those interested in the possibilities of perception without awareness, is whether stimuli too weak or too brief to be consciously perceived can affect the percept. Werner (1956) stated that:

> There is good reason to believe that responses determined by stimuli of which the recipient is unaware may shed light upon preconscious stages of the perceptual process. ...to deny it has preconscious stages is to reduce perception to the level of photography. (p.352)

Many of the earlier studies in subliminal perception employed various biofeedback apparatus to determine whether or not a stimulus below the threshold of awareness could register at a preconscious

stage. Baker (1938), for example, used a pupilometer to investigate pupillary responses to a subthreshold auditory stimuli. After having determined each subject's (n = 16) awareness threshold to a tone of 1000 HZ using the descending method of limits technique, he then compared three pupillary responses to a subthreshold and suprathreshold auditory stimuli. The results indicated that pupillary responses could be consistently conditioned with a subthreshold stimuli which could persist for as long as two years. As well, the responses conditioned to suprathreshold sounds were established with much greater difficulty and were less stable. Data supporting these findings have been added by Metzner & Baker (1939). A failure to replicate Baker's results, however, has been reported by Wedell, Taylor & Skolnick (1943) and Hilgard, Miller & Ohlson (1941).

A study using an electromyograph (EMG) to detect motor responses to auditory stimuli above and below threshold was reported by Davis (1950). Recordings were made of the action potentials in several different muscle groups for 27 subjects in response to a tone of 1000 HZ. The tone was presented below a previously determined threshold using the ascending method of limits. The results indicated that increases in muscle tension occurred to stimulus intensities that the subject did not report hearing.

Wilcott (1953) investigated changes in galvanic skin resistance (GSR) of 10 subjects using four separate frequency intensities below the absolute threshold. The method of descending limits was used to

determine the intensity level for frequencies of 200, 2000 and 13,000 HZ and a thermal noise. Before each attempt at subthreshold conditioning, the subject's GSR was conditioned to a sound of 20 decibels (db) above the subthreshold level to be used for comparative purposes. The results indicated no changes in GSR for any of the subjects at all frequencies.

Empirical evidence supporting the notion that recognition of a visual stimuli presented below the threshold of awareness using a tachistoscope could elicit greater GSR has been demonstrated by Newall & Sears (1933), Baker (1937), McGinnes (1949) and Lazarus & McCleary (1951). McGinnes (1949) also found that subjects reacted with a skin resistance of significantly greater magnitude during the prerecognition presentation of emotionally toned words than they did before recognizing neutral words. Based on these results, he suggested that the subconscious not only could detect stimuli too faint to be perceived but that it also had the ability to discriminate without awareness.

One theoretical concept to explain the phenomenon of discrimination without awareness was postulated by Lazarus & McCleary (1951). The findings of their investigation indicated that shock conditioned nonsense syllables could evoke significant GSRs even when presented too briefly for conscious recognition. They termed this effect "subception" which they defined as; "a process by which some kind of discrimination is made when the subject is unable to make a correct conscious discrimination." (p.113).

The subception effect has been demonstrated in a number of experimental investigations which have shown that skin resistance could be evoked at exposure times below the verbal recognition threshold (Taylor, 1953; Lowenfeld, Rubenfeld & Guthrie, 1956; Dixon, 1958; Wall & Guthrie, 1949; Dixon & Harder, 1961; Worthington, 1961; Block & Reiser, 1962). Failure to replicate such findings has been reported by Bricker & Chapanis (1953); Murdock (1954); Voor (1956); and Naylor & Lawshe (1958).

This hypothesis has been the object of considerable dispute as alternative explanations of the empirical findings not dependent on the unconscious had been postulated. Howes (1954) presented an account of the subception effect based upon a statistical model of discrimination. Studies by Ericksen (1956) and Dulaney & Ericksen (1959) revealed that this effect could be formulated as a partial correlation between the GSR and the stimulus. More recently, Chun & Sarbin (1968a, 1968b) have suggested that the subception effect can be accounted for by methodological flaws which would permit verbal response effects to influence the GSR.

To counter this later argument O'Grady (1977) subliminally stimulated 24 subjects with neutral and emotionally charged pictures at three tachistoscope exposure levels and instructed the subjects not to respond verbally. The results of this study supported the subception hypothesis as GSR measures for the emotionally charged stimuli were significantly larger than the neutral stimuli for all exposure times.

The contention that recognition thresholds depend upon the emotional connotation of a stimuli was termed perceptual defence by Postman & Bruner (1948) to account for variations in the recognition thresholds for tachistoscopically presented words. Later, when studies by Blum (1954 & 1955) indicated that the perception of a stimuli may not only be inhibited as a function of the input's emotionality but also enhanced, the term perceptual vigilance was introduced to explain the latter phenomenon. A basic assumption underlying the theory of defence concerns the ability of the human organism to detect the presence of anxiety-arousing stimuli at an unconscious level of awareness (Ericksen, 1954).

Kleinman (1957) investigated whether perceptual defence against anxiety evoking verbal stimuli was observable in auditory perceptual thresholds. Subjects (n = 22) were randomly presented two lists of words, one critical and the other neutral, at nine db below their previously determined speech reception threshold. The threshold for each stimulus word was determined by the ascending method of limits where the intensity was increased by three db increments. The results, which were found to be consistent with the perceptual defence theory, indicated a significant difference between the threshold for the critical and neutral words.

Studies using tachistoscopic presentation of subliminal emotional stimuli have reported similar results (Matthews & Wertheimer, 1958; Minard, 1965; Bootzin & Natsoulas, 1965). Nevertheless, the criticisms

of the perceptual defence experiments have been numerous and directed at both methodology (Ericksen, 1954; McConnel, Cutler & McNeil, 1958; Klein, 1959) and interpretation (Lusack, 1954; Putsell, 1957).

Goldstein (1962), using a stimuli absent experimental group, showed that a response bias against calling anxiety-arousing words is quite sufficient to produce a significant perceptual defence effect, even when no verbal stimuli were being presented. Other experiments which have yielded no evidence for perceptual defence that could not be explained in terms of a response bias, include Goldiamond & Hawkins (1958), MacIntosh (1961), Zazonc (1962), and Goldstein et al. (1962).

In order to eliminate the response bias in experiments measuring signal detection performance, Swets (1964) proposed the use of the signal detection theory. The main advantage of this theory is that it provides information on two parameters of the subject's behavior for detecting a stimuli: A pure measure of sensory sensitivity and a measure of the subject bias or criterion for making a particular response (Tanner & Swets, 1954; Swets, Tanner & Birdsall, 1961; Green & Swets, 1966).

Two experiments by Hardy and Legge (1968) that have applied the principles of signal detection to the problem of perceptual defence are of particular relevance. In the first, visual awareness thresholds for either a neutral word or rectangle were measured for 16 subjects during concurrent subliminal auditory stimulation with emotional and neutral words. In the second experiment, the converse paradigm was

used, in that the same subject had to detect the presence of a faint neutral auditory stimulus while watching a translucent screen upon which emotional or neutral words were projected for three second intervals at subliminal intensities. The results for both experiments indicated that visual and auditory thresholds for neutral stimuli were significantly raised by the subliminally presented stimuli in the other modality. Furthermore, having measured performance using the parameters of the signal detection theory they were able to show that the changes in threshold were genuinely sensory in origin and not attributable to a bias in the decision process.

Similar results have been obtained by Williams (1980) who demonstrated that nonemotional words are not responded to as quickly nor as accurately as emotional words. In addition, Srivastava and Dwivedi (1980) found significantly higher perceptual defence behavior for subliminal auditory display of taboo words than the visual display. Further evidence for perceptual defence uncontaminated by response bias has been demonstrated by Broadbent & Gregory (1967) and Dorfman (1967).

Another line of research which supported the perceptual defence theory were those examining changes in alpha rhythm thresholds, for recognition of emotional and neutral subliminal words, as measured by an electroencephalogram (EEG) (Dixon & Lear, 1963, 1964; Barrett & Herd, 1964; Dixon, 1966; Emrich & Heinemann, 1966). The results from these studies demonstrated that awareness thresholds for emotional words were significantly less than the neutral words. Furthermore, since the subjects did not overtly respond to the stimuli, these results were strictly sensory in origin.

In an experiment conducted by Dixon (1956), subjects were asked to write down the first word that comes to mind everytime they received a supraliminal visual signal which was preceded by a subliminal auditory presentation of emotional and neutral words. The results indicated that galvanic skin responses recorded were significantly higher for the emotional versus the neutral stimulus words. More importantly though, when the subjects were asked a week later to match their responses against the stimulus words, they succeeded in doing so correctly significantly more often than could be attributed to chance. The implication of these results suggest that the subliminal verbal stimulus increases the probability of the subject responding with an associated word.

Spence and Holland (1962) tested the hypothesis that the number of associations evoked by a stimulus of which the recipient is unaware would exceed that elicited by the same stimulus above the awareness threshold. Three groups of subjects had to learn and recall a list of words which included a number of associates to the word cheese. The groups differed only in their preliminary treatment in that one was presented the subliminal stimulation with the word cheese, another was shown the same word supraliminally, while the third control group had no prior presentation of the critical word. In the subsequent recall task, subjects in the subliminal group produced significantly more cheese associates than did either of the other two groups. Spence & Holland interpreted these findings to suggest that the meaning of a stimulus can be registered without awareness and can subsequently influence recall.

While the main conclusion from these experiments, that auditory and visual words presented below awareness threshold may facilitate related responses, is consistent with the data from many other experiments (Werner, 1956; Dixon, 1958; Bach, 1959; Arey, 1960; Spence, 1961; Pine, 1961; Spence & Bressler, 1962; Spence & Ehrenberg, 1964; Worthington & Dixon, 1964; Gordon, 1967), it has been seriously challenged by many investigators who failed to produce similar results in replication studies (Ericksen, 1960; Fuhrer & Ericksen, 1960; Banréte-Fuchs, 1967; George & Jennings, 1972a). Furthermore, Neisser (1967) suggested that subliminal perception effects may be mediated by "demand characteristics on the part of the experimenter. Other studies which lend support to the experimenter-bias hypothesis include Rosenthal (1963), Barber & Rushton (1975) and Barber (1977). The results of these investigations have strongly suggested the use of a double-blind design in research of subliminal perception.

The length of time for which stimulation below the awareness threshold might have an effect has, in fact, a long history which has been extensively reviewed by Fisher (1960). Many studies developed as a result of an investigation conducted by Poetzl (1960) in 1917 found that a subliminal stimulus received during normal waking consciousness can affect subsequent dream experiences. In addition, Poetzl suggested that if supraliminal stimuli are not attended to, they would behave like subliminal stimuli.

This Poetzl effect has been variously obtained with other types of dreamlike or fantasylike materials, including daydreams (Fisher, 1954; Shevrin & Luborski, 1958; Goldstein & Barthol, 1960; Kaley, 1970), free associations (Allers & Teler, 1960; Hilgard, 1962; Haber & Erdelyi, 1967; Shevrin & Fisher, 1967) and imagery (Fisher, 1957; Fisher & Paul, 1959; Fiss, Goldberg & Klein, 1963; Eagle, Wolitzky & Klein, 1966; Giddan, 1967; Henley & Dixon, 1974; Mykel & Daves, 1979).

In a replication of the study of Henley & Dixon (1974), Mykel & Daves (1979) randomly distributed 32 right-handed college students into two experimental groups. One group received subliminal words to the right ear and music to the left ear or vice versa, and two control groups received only music to one ear. Categorization and ranking of imagery reported showed that emergence was greater with words to the right ear than with no words. The same effects were produced in a second experiment where the music was eliminated and the subject only received subliminal words to the right ear or no words. Some investigators have interpreted the results from these experiments as reminiscence (Giddan, 1967), partial cues (Goldberg & Fiss, 1959; Wiender & Schuller, 1960) or methodological artifacts (Johnson & Ericksen, 1961; Neisser, 1967).

One of the factors related to the maximum recovery of subliminal effects appears to be that the subject must be in a state of relaxed passivity. Fisher & Paul (1959) found that subliminal registration is maximized by making the subject occupy a supine position in darkness.

Similarly, Fiss (1961) has shown that relaxation brought about by instructions and confirmed by GSR monitoring, facilitates emergence of previous stimulus material. Pine (1964) has suggested that:

> The freeing of thought from adaptive demands and the freeing of perception from a barrage of stimulus inputs makes possible the greater emergence of preconscious and unconscious contents into awareness. (p.219)

Several studies have also suggested that certain individual differences are related to the appearance and strength of subliminal effects. For instance, Allison (1963) found that when subjects were encouraged to think in analytic, logical, and organized modes, subliminal effects were not found. On the other hand, when the same subjects were encouraged to think globally, intuitively, and freely, subliminal effects were demonstrated. These findings have been supported by studies of brain hemisphere conducted by Sackeim, Parker & Ruben (1977) and Charman (1979).

2.1.1 Summary

The esults and conclusions of the literature relating to the effects of subliminal stimuli on the perceptual process are inconsistent and justifyingly controversial. The ability to perceive visual and auditory stimuli below the threshold of awareness has been demonstrated using various biofeedback techniques, such as the pupilometer (Becker, 1938; Metzner & Baker, 1939), EMG (Davis, 1960), GSR (McGinnies 1949) and, EEG (Dixon, 1962). Failure to replicate similar results has been reported by Wedell et al. (1940) and Hilgard et al. (1941).

Assuming the validity of the data supporting the hypothesis that registration of stimuli below the threhold of awareness does occur, studies have since focused on our ability to discriminate and evoke related responses to subliminal stimuli. The underlying concern of these two lines of research was whether the meaning of subliminally presented words or pictures could be assessed.

Investigations in perceptual defence (Postman & Bruner, 1948; Blum, 1954,1955) and subception (McGinnes, 1949; Lazarus & McCleary, 1951) have provided empirical evidence that the discrimination of the emotional connotation of subliminal words does occur. This phenomenon has been demonstrated in changes of GSR (Worthington, 1961; Block & Reiser, 1962), visual (Mathews & Wertheimer, 1958; Minard, 1965) and auditory thresholds (Kleinman, 1957). Alternative explanations presented for similar effects have been accounted for as statistical artifacts (Howes, 1954; Ericksen, 1956) or response bias (MacIntosh, 1961; Goldstein, 1962; Zazonc, 1962). Studies eliminating the response bias through the use of the signal detection theory parameters (Dorfman, 1967; Broadbent & Gregory, 1967; Hardy & Legge, 1968; Williams, 1980) and employing greater methodological controls (Lear, 1963, 1964; Dixon, 1966), have provided further evidence for the perceptual defence hypothesis as a sensory phenomenon.

Research supporting the contention that auditory and visual words presented below awareness may facilitate subsequent related responses (Dixon, 1956; Spence & Holland, 1962; Worthington & Dixon, 1964;

Gordon, 1967) has been seriously challenged by many investigators who failed to produce similar results (Ericksen, 1960; George & Jennings, 1972). Other investigators (Neisser, 1967; Barber & Rushton, 1975) have attributed these effects to experimenter-bias. It would appear that based on the latter challenge, more research in this area is warranted using double-blind designs before conclusive inferences can be made.

The suggestion that the effects of stimulation of which an individual is unaware may persist over time has recently been demonstrated in various paradigms including daydreams (Kaley, 1970), free associations (Shevrin & Fisher, 1967) and imagery (Henley & Dixon, 1974; Mykel & Daves, 1979). Different interpretations of results have been postulated as a reminiscence effect (Giddon, 1967) or partial cue hypothesis (Wiener & Schiller, 1960). Thus, as Dixon (1971) has stated:

> If the Poetzl effect is, indeed, a valid phenomenon, then, like that of perceptual defence, it constitutes sufficient evidence for the reality of discrimination without awareness. Of perhaps greatest importance, however, is the demonstration, first, of preconscious stages in the perceptual process and, second, that since the effects of stimulation of which an individual is unaware may persist over time, awareness cannot be regarded as a necessary condition for all aspects of the learning process. (p. 152)

Several studies have suggested that both situational (Paul, 1959; Fiss, 1966; Murch, 1969) and/or individual differences factors (Allison, 1963; Gordon, 1967) are related to the appearance and strength of subliminal effects.

2.2 Behavioral Effects

Psychological research has generated a large body of empirical evidence supporting the contention that individuals can respond to stimuli presented below the threshold of awareness. The fact that more research is now directed towards determining its behavioral effects lends additional support for the subliminal perception phenomenon (Bevan, 1964).

Helson (1947) demonstrated that stimulus judgments are related to and dependent upon the combined effects of those antecedent stimuli to which the subject has adapted. In short, the adaptation-level theory hypothesizes that the organism acts as a system that pools all sensory inputs that serve as internal norms or standard which become reference values for subsequent judgments.

Bevan and Pritchard (1963) conducted three experiments, using a total of 144 subjects, to compare the effects of subliminally presented tones upon judgments of loudness with previously determined intensities of supraliminal tones. Their results clearly indicated that judgments of loudness could be raised by introducing a tone below the auditory threshold. These findings are similar to a more recent study conducted by Zenhausen and Hansen (1974).

Similar findings have shown subliminal stimulation to be effective in influencing anchor judgments in the area of size (Boardman & Goldstone, 1962; Kennett, 1962; Farne, 1963), length (Trimble & Ericksen, 1966), intensity of shock (Black & Bevan, 1960; Goldstone et al., 1962)

and, body boundary (Fisher, 1975, 1976). Nonsignificant results, however, have been reported with regard to value-norm-anchor judgments by Champion & Turner (1959), Murch (1968) and Hovsepian & Quatman (1978).

In a more recent study, Borgeat, Chabot & Chalout (1981) examined the influence of auditory subliminal messages on the level of activation. Subjects (n = 20) were randomly presented either activating or deactivating subliminal messages. Activation changes were estimated through variations in the scores at the Mood Adjective Check List which measured six factors; alertness, nonchalance, concentration, relaxation, aggression and anxiety. The results showed statistically significant differences for four of the six factors examined. It was, therefore, concluded that auditory subliminal stimuli can alter levels of activation.

In a study conducted by Byrne (1959), subjects (n = 105) were subliminally presented the word "beef" every seven seconds using a tachistoscope during the course of watching a film. Following this treatment the subjects rated themselves for hunger and were then encouraged to choose one from an assortment of different sandwiches. The results showed that while the subliminal stimulus had a significant effect upon subsequent hunger ratings, it did not affect choice behavior. These findings are consistent with experiments from Smith, Spence & Klein (1959), Goldstein & Davis (1961) and Spence & Ehrenberg (1964).

The contention that subliminally presented messages may operate directly upon the subject's overt response behavior has been suggested by the results from a study by Zuckerman (1960). Subjects (n = 36) were sequentially assigned to three experimental conditions and were required to write stories around supraliminally presented pictures using Thematic Appreciation Test (TAT) cards. Unknown to the subjects these cards were superimposed with a subliminal message to write more, don't write or a blank slide. The results indicated that the subliminal message produced the desired effect to a degree of statistical significance. In a second replication experiment where 18 new subjects had been presented the same messages supraliminally, no significant differences were found among the conditions. Commenting on these findings, Dixon (1971) speculated that:

> This is an interesting example of the way in which a subliminal stimulus can by-pass processes of conscious intent, and of the fact that it may be impossible to resist instructions which are not consciously experienced. (p. 177)

Similar investigations which have demonstrated that subliminal pictures or words can affect overt choice behavior have been found by Schiffs (1961), Worthington (1964) and Worthington & Dixon, (1964).

George and Jennings (1975) examined the effect of subliminal stimuli on consumer buying power. Tachistoscopic presentation of the words "Hershey's Chocolate" were presented to a group of 18 experimental subjects below a forced-choice detection threshold. A blank slide was displayed to a similar control group while viewing

a film. In a highly controlled buying situation, neither group purchased Hershey's products. Although the experimental group bought more comparable chocolate products than the control group, the results were nonsignificant. Further evidence against subliminal messages affecting consumer behavior has been reported by Defleur & Petranoff (1959) and Hawkins (1970).

Silverman (1976) reviewed over 40 studies that reported demonstrating the clinical treatment of psychopathic behavior using a technique termed subliminal psychodynamic activation (Silverman, Ross, Adler & Lustig, 1978b). These experimental studies involve the subliminal presentation of a specific pictoral and/or verbal wish-related stimuli and comparing its effects with those subliminal stimuli having neutral or different psychodynamic content.

This paradigm has been successfully employed with "normal" subjects in the behavioral treatment of smokers (Palmetier & Bornstein, 1980), obesity (Silverman, Martin & Ungaro, 1978a), improving academic performance (Parker, 1982; Ariam & Siller, 1982) and dart-throwing accuracy (Silverman et al., 1978a). Failure to replicate similar results has been reported by Greenberg (1977), Heilbrum (1980) and Haspel & Harris (1982).

Investigating whether subliminal perception could be used as a means for altering smoking behavior, Glover (1979) randomly assigned 72 female smokers to two conditions. A treatment group viewed three films with subliminally inserted words over a two week period, and a

group viewed the same films without the subliminal stimulation. The dependent variable was the average number of cigarettes smoked per day. After the treatment period, a comparison of the two groups revealed no significant differences in smoking behavior. Those findings, however, are contrary to a similar study by Hart (1973) who investigated subliminal effects on the modification of attitudes towards alcoholism. Furthermore, it has been reported that auditory subliminal conditioning has been successful in modifying the behavior of smokers (Chabot, 1976), and in the treatment of obesity (Becker, 1976).

2.2.1 Summary

The review of relevant literature revealed inconsistencies in the results obtained from studies examining the effects of subliminal stimuli in inducing behavioral changes.

Helson's (1948) adaption-level theory has demonstrated subliminal stimulation to be effective in influencing anchor-value-norm judgments in the areas of tone (Bevan & Pritchard, 1963; Zenhausen & Hansen, 1974), size (Boardman & Goldstone, 1962; Kennett, 1962; Farne, 1963), intensity of shock (Black & Bevan, 1960; Goldstein et al., 1962), body boundary (Fisher, 1975) and, activation (Borgeat et al., 1981). Nonsignificant results, however, have been reported by Champion & Turner (1959), Murch (1968) and, Hovsepian & Quatman (1978).

Subliminal stimulation has also been found to affect drive levels (Byrne, 1959; Smith et al., 1959; Goldstein & Davis, 1961; Spence & Ehrenberg, 1964) and, overt choice behavior (Zuckerman, 1960; Schiffs, 1961; Worthington, 1964; Worthington & Dixon, 1964). When this later contention, however, was tested to examine its effects on

consumer buying power (Defleur & Petranoff, 1959; Hawkins, 1970; George & Jennings, 1975), no significant results were obtained.

In terms of behavior modification, the most significant demonstrable effects have been found using Silverman's (1976) subliminal psychodynamic activation techniques in the clinical treatment of psychopathic behavior. Equivocal results have been found when employing this paradigm with normal subjects (Greenberg, 1977; Heilbrum, 1980; Palmatier & Bornstein, 1980; Parker, 1982; Arrlam & Siller, 1982; Haspel & Harris, 1982), and other techniques (Hart, 1973; Chabot, 1976; Becker, 1976; Glover, 1979).

Although many investigators support the contention that subliminal stimulation can alter behavior and may be of therapeutic value (Lee & Typer, 1980), the literature remains equivocal. Despite steadily growing commercial exploitation using various subliminal techniques, Moore (1982) concludes:

> Empirical support for subliminal influences of a pragmatic nature is neither plentiful nor compelling. On the basis of research evidence accumulated to date, the most one could hope for, in terms of marketing application, would be a potential positive affective response to a subliminal stimulus. (p.46)

CHAPTER III

METHODS AND PROCEDURES

The purpose of this study was to investigate the effect of auditory subliminal stimuli on an athlete's ability to perform a physical task involving static muscular strength and endurance. In this chapter, the methodology used in the study is described in the following sections: (3.1) Subjects; (3.2) Instrumentation; (3.3) Design and Experimental Treatments: (3.4) Testing Procedure; and, (3.5) Recording and Tabulation of Data.

3.1 Subjects

Seventeen male athletes of the Confédération Interallée d'Officiers de Réserve (CIOR), ranging in age from 18 to 23 years, served as volunteer subjects in the study. Only right hand dominant subjects whose mother tongue was English were selected. A pure tone threshold hearing test to establish any frequency tonal deficiencies was given to all subjects prior to the actual experimentation. The subjects were not informed of the purpose of the study and were sequentially assigned in counterbalanced order to each of three experimental conditions. The counterbalanced assignment of subjects served to nullify any experimental bias that may have occurred due to systematic exposure of the test conditions.

3.2 Instrumentation

The instrumentation system used in the collection of data, consisted of a proving ring or transducer with a specially designed attachment to minimize extraneous arm movements. This instrumentation consisted of mechanical and recording equipment (Figure 1) and is referred to as a static muscular force apparatus. Four strain-gauges were attached to the transducer to allow both flexion and extension of the elbow flexors. The strain-gauges were of a length and resistance of five millimeters and 120 $\pm$ .3 ohms, respectively.

The calibration of the instrumentation entailed the conversion of the mechanical force exerted by the subject on the transducer to a proportional electrical voltage that was displayed on an Intersil liquid crystal (LCD; model ICL7106 A/D converter) voltmeter. This device was sensitive to forces ranging from one to over 45 kilograms. The calculations for calibration of the instrumentation indicated a linear relationship between forces (kg) and voltage (V^{-3}) throughout the entire range (see Appendix A). The voltmeter was connected in series with an electronic amplification system utilizing four comparators to activate a light mechanism[1] and a timing device to record RIME (see Appendix B). The light mechanism, consisting of three different coloured lights,

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[1] These comparators, despite fine adjustments, created a slight gap on the activation of the lights. This accounted for the $\pm$ 5% variation to the MVC resistance load.

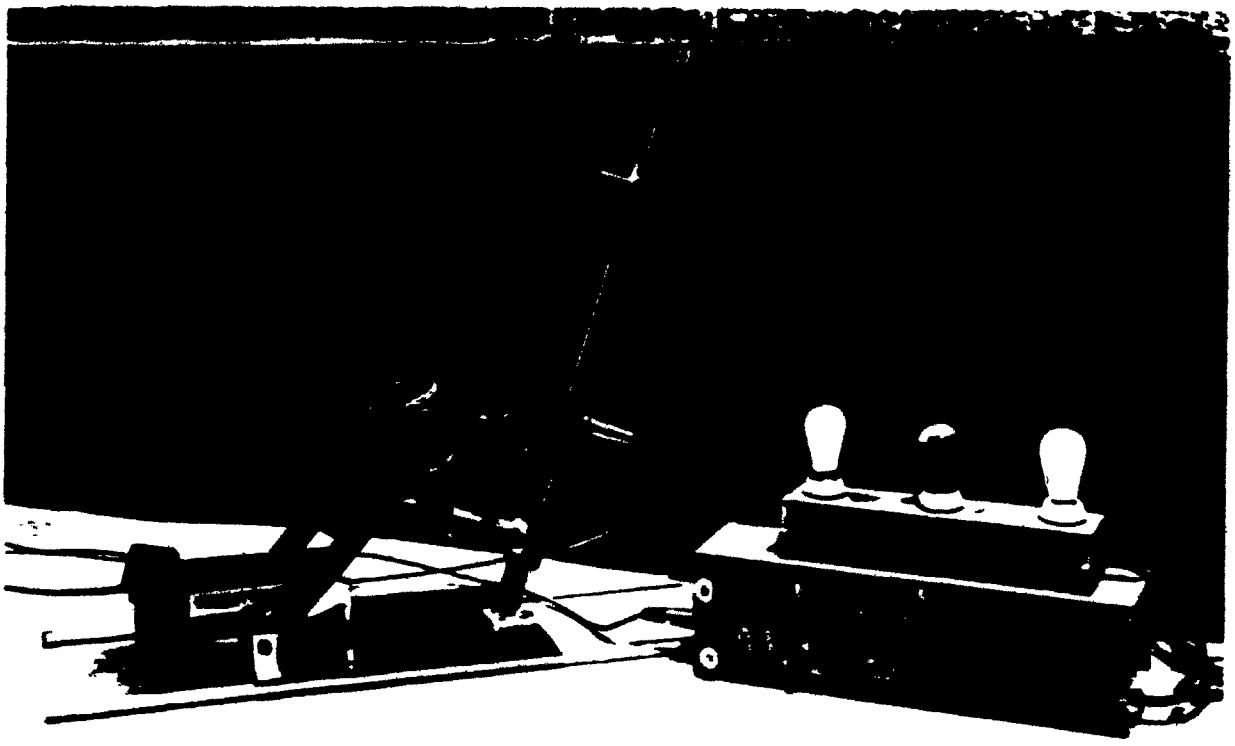

Figure 1. The Static Muscular Force Apparatus Used to Record The Subjects Maximum Voluntary Contraction (MVC) and Relative Isometric Muscular Endurance (RIME) Scores.

which guided the subject's physical efforts to maintain a resistance load equivalent to 30 ± 5% of his initial MVC. The green light indicated to the subject that he was on target, while the red and yellow lights indicated that he should make corrections by either increasing or decreasing the applied force, respectively. Furthermore, the green light activated a stop watch circuit (Intersil TIL 804-B) that displayed the RIME time (.01 sec). The stopclock could only be stopped when the red light was activated for a continuous three second interval.

The voltage input in the force transducer and output recorded on the voltmeter were zero-set prior to each testing session. In addition, a calibration mechanism was included in the instrumentation which indicated if the apparatus was functioning properly for previously determined resistance loads of 40.82, 16.33 and 12.25 kilograms. This technology precluded the timely procedure of daily calibration using standard weights.

The instrument used to administer the pure-tone threshold and SDT was a two channel clinico-diagnostic audiometer (model: Amplaid 300) equipped with a Maico hearing instrument panel and headphones. This apparatus was calibrated prior to the actual data collection. All testing occurred in an industrial acoustics soundproof charber, six cubic feet in dimension.

3.3 Design and Experimental Treatments

The experimental design was a treatment-by-subjects, repeated measures design. To control for possible sources of external invalidity a double blind procedure was used, such that neither the experimenter nor the subject was aware of the particular treatment condition. The three conditions of the study were as follows:

3.3.1 Positive Subliminal Stimuli: The condition in which subjects were exposed to an auditory subliminal message that urged them to increase their performance at the physical task involving static muscular contraction of the elbow flexors.

3.3.2 Negative Subliminal Stimuli: The condition in which subjects were exposed to an auditory subliminal message that attempted to inhibit their optimal performance at the physical task involving static muscular contraction of the elbow flexors.

3.3.3 No Subliminal Stimuli: The control condition in which the subjects received no subliminal message while performing the physical task involving static muscular contraction of the elbow flexors.

The content of the positive and negative subliminal messages were each composed of two words. The investigator selected two lists of ten words; one that would raise and a second that would depress an athlete's level of motivation for a related physical task. (see Appendix C). The two lists were then presented to 60 nonexperimental, undergraduate physical education students, who were asked

to number these words in order of potential to motivate or depress performance. Those words that were chosen over 50 percent of the time as the students first three choices were then used to select two words for inclusion in the subliminal text. The words selected for the positive subliminal message condition were "drive" and "pull" while, for the negative condition the words were "stop" and "relax".

These words, or auditory message, were recorded on a TDK (Audua L-1800) high output, low-noise sound recording tape using only two of a four channel Sony stereo tape recorder (model: TC-227-4). Each of the words were repeated three times in succession at a rate of 120 words per minute for both the negative and positive auditory messages. On the remaining two channels, the investigator's instructors (see Appendix D) and sound effects[2] were recorded with programmed silent intervals to reduce the masking effect of the supraliminal stimuli on the subliminal message. The original instruction tape was reproduced for each of the experimental conditions thereby enabling subjects to receive standard instructions, sound effects and silent intervals. All recording was performed in a soundproof chamber.

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[2] There are two reasons the sound effects were included with the instructions: First, to enable the subject to listen to something interesting during the rest intervals and secondly, to enable the experimenter to conceal, within the instructions, the true purpose of the study. Sound effects were taped from Gemcom Inc., SFX Sound effects Volume 8, Gateway Records (GSLP4608) World Music Services, 1979.

In order to make the auditory message recorded in the first two channels subliminal, the output of the tape recorder was connected to an audiometer (model: Amplaid 300) which operated as a db attenuator. This procedure allowed for independent adjustment of the volume of the auditory message and the instructions. Therefore, adjustments to the volume of the auditory message to a db level equivalent to the subject's previously determined SDT minus five decibels[3], resulted in the subject not being capable of consciously perceiving the content of the message.

3.4 Testing Procedure

Subjects were informed as to the general nature and particular requirements of the physical task by means of a standardized set of instructions (see Appendix E). Each subject reported to the laboratory on four separate occasions: The first session served to familiarize the subject with the test apparatus and to allow for a hearing test. The remaining three sessions consisted of the test conditions in which the subjects were sequentially assigned in counterbalanced order. An interpolated one week rest interval between the pre-test and each of the experimental test conditions was provided in order to minimize any training effect.

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[3] Sweet (1964) suggested that individual variability could manifest itself in a threshold shift of 5 db. Therefore, to ensure that the message was subliminal, the criterion volume for each subject will be the SDT minus five db.

3.4.1 Pre-Test Protocol

A pilot study revealed that the RIME time could be improved with a few practice trials. However, once the subject had familiarized himself with the apparatus and, after two trials of applying a constant force of 30 ± 5% MVC, the RIME scores stabilized. Therefore, a pre-test was carried out to allow the subject to familiarize himself with the testing procedure and apparatus. In addition, a hearing test of pure-tone threshold was administered during the pre-test session to ensure that the subject's hearing was normal throughout the frequency range tested. The Hughson-Westlake technique (Carhart & Jerger, 1959) of ascending limits was used as the recommended method for clinical determination of pure-tone thresholds. Subjects who demonstrate any tonal deficiencies would have been deleted as an experimental subject and those who successfully completed the hearing test were administered a speech detection threshold test using the guidelines described by the American Speech-Language-Hearing Association (ASHA, 1979).[4] The purpose of this test was to determine at which db level the auditory stimuli must be adjusted to ensure it registers below the subjects' threshold of awareness.

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[4] Rudmin (1983) recommends the use of spondee digits rather than spondaic words (as described by ASHA, 1979) as the standard test material, because of the increased probability that subjects can perceive digits better than words at low threshold levels.

3.4.2 Test Protocol

An initial MVC, treatment MVC and RIME time was calculated and recorded for each subject in each of the conditions of the study. The testing procedure ensuing in the three experimental conditions was as follows: The subject was instructed to lay in a supine position in the acoustical soundproof chamber, placing his dominant arm in the static muscular force mechanical apparatus. In this type of measurement movement artifacts may result, therefore, care was taken to discourage involuntary movements of the arm. To further minimize arm movement, particularly during high intensity contractions, the arm was firmly secured to the apparatus by means of velcro straps , ensuring these straps in no way interfered with normal blood flow. In addition, the base of the apparatus was not secured in order to restrict the force applied to only the muscle group involved in forearm flexion. In order to obtain maximum force of the elbow flexors, the subject's arm was placed in a position between supination and pronation (Downer, 1953) and, at an angle at the joint of 110 degrees (Clarke & Barley, 1960). A ball and socket joint was used to attach the wrist cuff at right angles to the transducer to ensure that the force applied on the transducer would always be linear.

Once the subject was placed in the proper test position, he was asked to listen to the prerecorded instructions prior to securing the headphones. After a relaxation period of five minutes the subject was instructed to apply force at a comfortable rate of muscular

contraction until he reached his maximal force. This procedure was repeated three times and the mean of the two best trials constituted the initial MVC score. One minute recovery periods were allowed after each trial to negate any fatigue effects (Kroll, 1966; 1970). A ten minute rest interval was then permitted to allow the subject to recover and for the application of the treatment. The subject then repeated the same testing procedure to obtain a treatment MVC score which was followed by another rest and treatment interval of ten minutes. Thirty percent of the treatment MVC was used as the criterion to determine the specific workload for each subject's RIME[5]. Once the rest interval was completed, during which time the light mechanism was set so that the green light illuminated at 30 ± 5% of the subject's MVC, a RIME score was obtained.

All testing took place with the subject in the acoustic soundproof chamber in complete darkness except for the illumination produced by the response light mechanism (Figure 2). The experimenter was located just outside the acoustic chamber and was not able to observe the subject (Figure 3).

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5 This criterion load has been found to have greater psychological (e.g., motivation) than physiological factors (e.g., intramuscular occlusion) affect muscular performance. (Strong, 1963; Kroll, 1970).

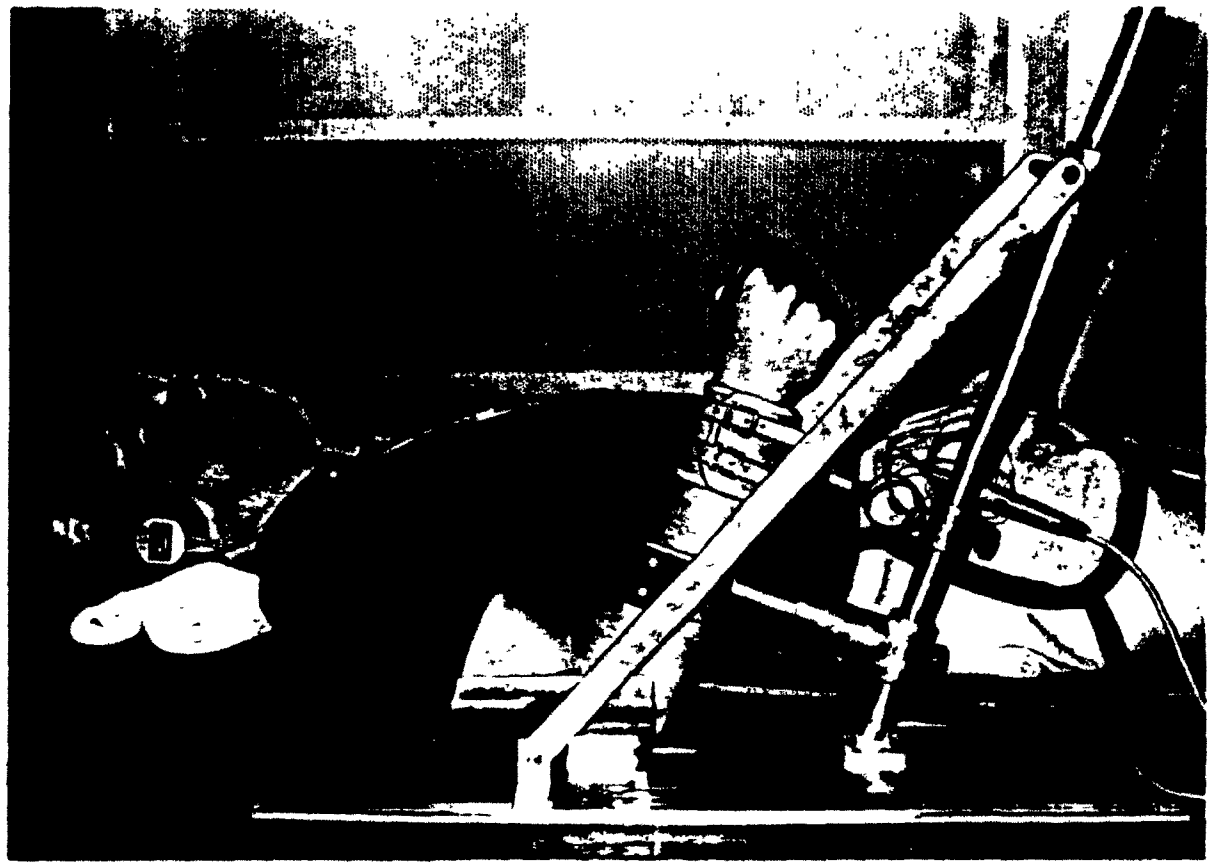

Figure 2. A View of the Subject in the Acoustic Chamber Attached to the Mechanical Force Apparatus.

Figure 3. A View of the Experimenter Outside the Acoustic Chamber.

3.5 Recording and Tabulation of Data

Scores representing initial MVC, treatment MVC and RIME were recorded for each subject under all test conditions. The initial and treatment MVC scores were the mean of the best two of three maximal static contractions of the elbow flexors for each subject. They were tabulated and recorded from the static muscular force apparatus and expressed in kilograms (kg). The RIME score represented the amount of time in seconds that the subject maintained a static contraction of 30 ± 5% of the initial MVC. The test was terminated when a subject was unable to apply a force to the resistance load for a continuous three second interval.

The scores were then analyzed by a repeated measures analysis through multivariate procedures (Finn & Mattsson, 1978) in order to ascertain if any reliable differences existed among the experimental conditions in terms of changes between initial and treatment MVC scores and RIME time.[6] The MANOVA program utilized for the analysis is attached (see Appendix F).

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6 A repeated measures MANOVA was used for the analysis of data because a significant negative correlation between strength and endurance was reported by many investigators (Tuttle et al., 1950; 1955; Barnes, 1980).

CHAPTER IV

RESULTS

The purpose of this study was to investigate the effects of auditory subliminal stimulation on an athlete's ability to perform a physical task involving static muscular strength and endurance. Strength was defined as the mean of the best two of three maximum voluntary contractions (MVC) that a subject could exert during a static contraction of the elbow flexors. The relative isometric muscular endurance (RIME) was the length of time that a subject was able to apply a static contraction with a resistance equivalent to 30 ± 5% of initial MVC. The present chapter was divided into the following three sections: (4.1) Analysis of MVC Scores; (4.2) Analysis of RIME Scores; and, (4.3) the Results of a Multivariate Analysis of Variance for the MVC and RIME Data.

4.1 Analysis of MVC Scores

The mean initial and treatment MVC scores were calculated for the 17 subjects within the positive, negative and control conditions and are presented in Table 1. Inspection of the data revealed that the mean scores for the treatment MVC were either slightly higher or lower than the initial MVC scores, for both the positive and negative subliminal stimuli conditions respectively. Little change, however, was noted within the control condition. The graph (Figure 4) illustrates the treatment scores among the three experimental conditions.

TABLE I

Means and Standard Deviations of Initial and Treatment Maximum Voluntary Contraction (MVC) Scores for Male Athletes under Positive, Negative and Control Conditions

Condition	Initial MVC (kg)		Treatment MVC (kg)	
	M	SD	M	SD
Positive	33.25	2.96	33.35	2.98
Negative	33.42	3.06	33.25	3.04
Control	33.48	3.40	33.46	3.25

The intercorrelations between the initial and treatment MVC scores for all conditions were calculated. The intercorrelations between initial and treatment MVC for the positive ($r = .98$), negative ($r = .99$) and control ($r = .99$) conditions were all found to be statistically significant ($p < .001$). Furthermore, the between-day correlation coefficients which were considered to be the correlation of MVC scores between conditions, obtained

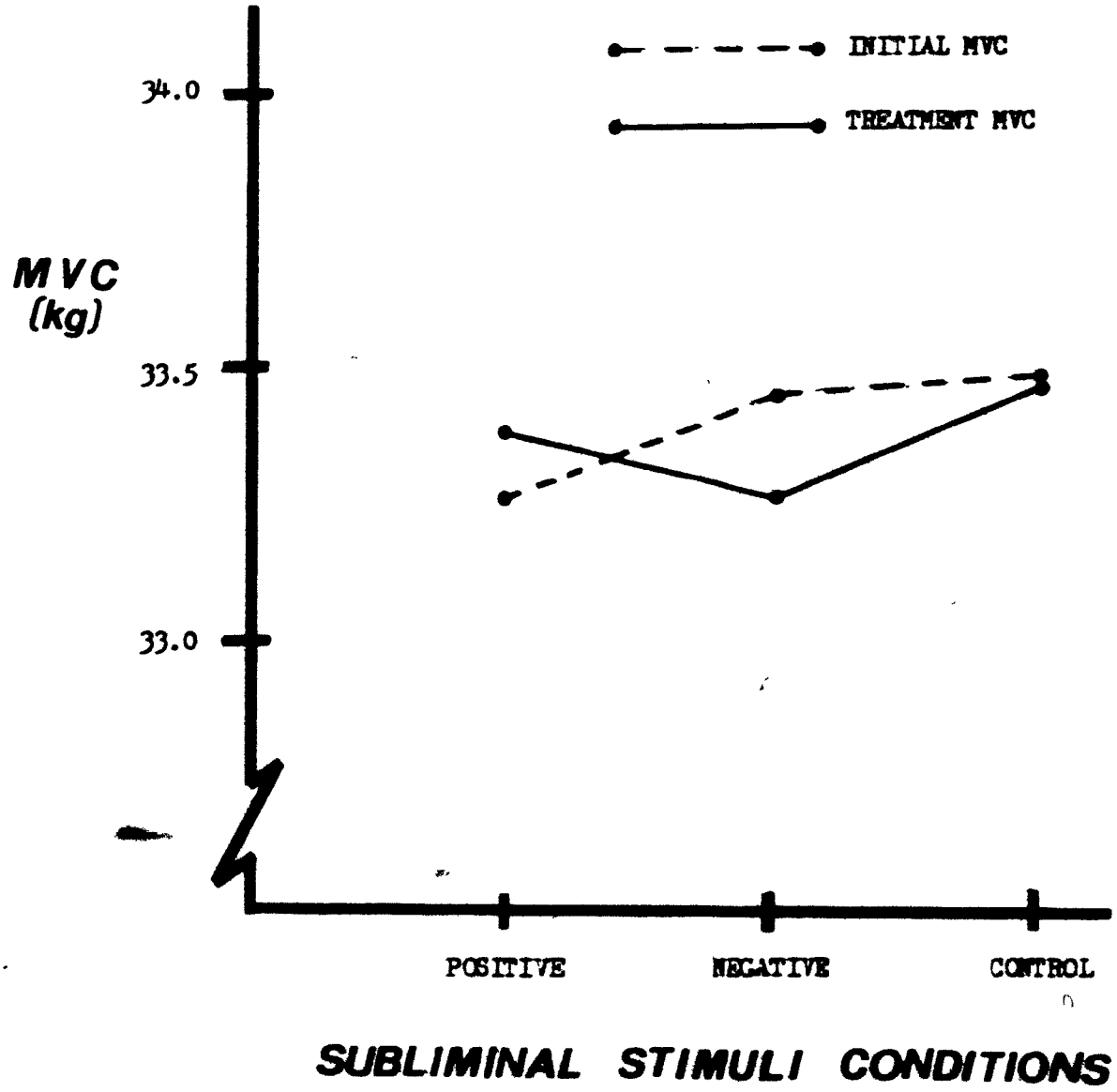

Figure 4. Mean Initial and Treatment Maximum Voluntary Contraction (MVC) Scores for Male Athletes Under a Positive, Negative and, Control Subliminal Stimuli Conditions.

from each subject after a one week rest interval, were also significant ($p < .001$) and ranged between $r = .96$ and $r = .98$ (see Table 5 of Appendix G).

The test of the grand mean for the change scores, calculated as the difference between the treatment and initial MVC scores, revealed that there were no significant differences, $F\ (1,16) = 0.241, p > .05$, among the three experimental conditions in terms of MVC performance scores (see Table 6 of Appendix H).

4.2 Analysis of RIME Scores

The mean endurance scores for all subjects in each of the experimental conditions were calculated and are displayed in Figure 5. Inspection of the data revealed that the subjects were able to endure the isometric contraction of 30% of their initial MVC longer under both subliminal stimuli conditions than the control condition. The descriptive statistics pertaining to RIME time scores are presented in Table 2. Quantitatively, the mean endurance score was highest for the positive condition ($M = 341$ secs), followed by the negative ($M = 335$ secs) and the control ($M = 328$ secs) conditions.

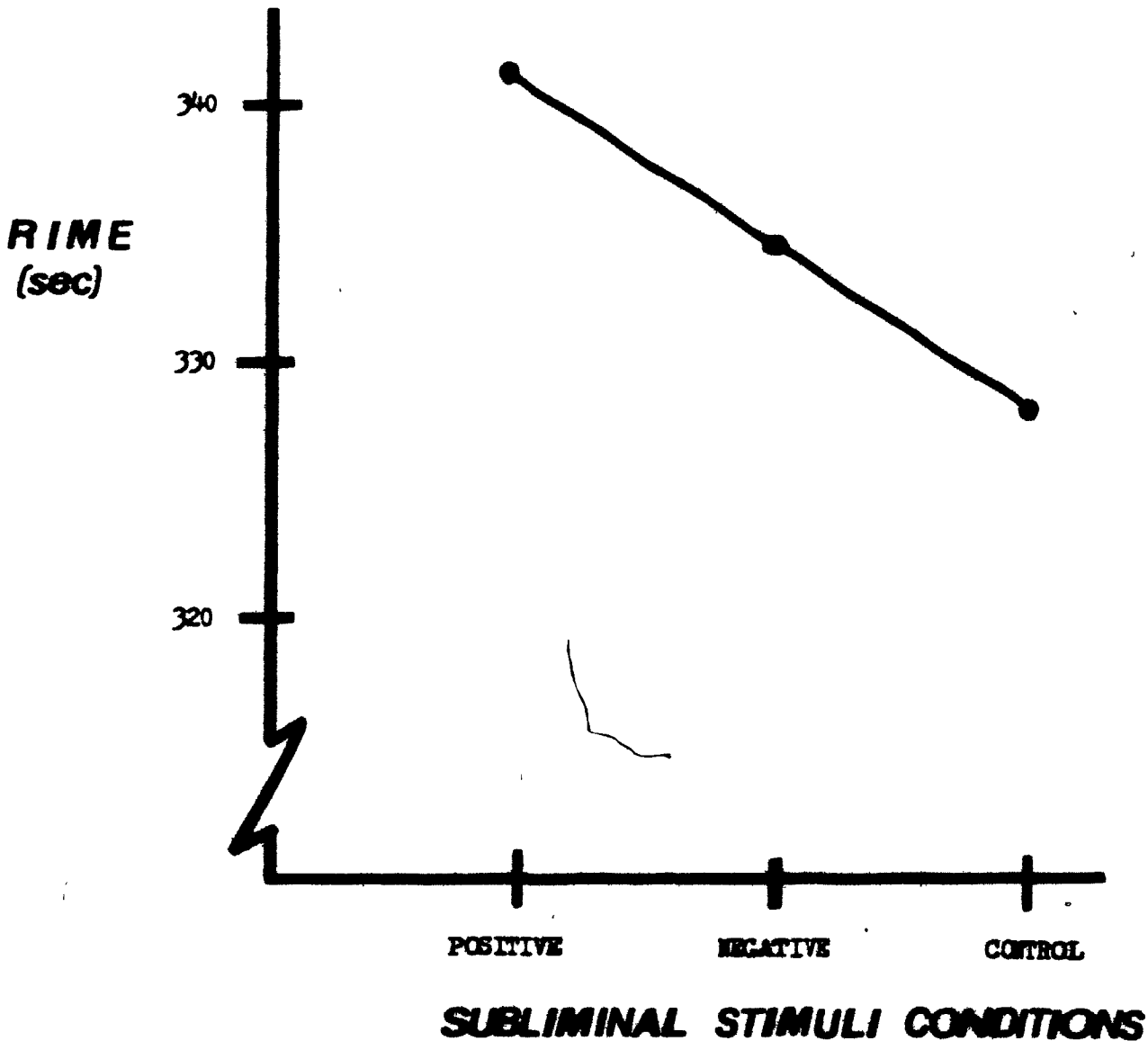

Figure 5. Mean Relative Isometric Muscular Endurance (RIME) Scores for Male Athletes Under a Positive, Negative and, Control Subliminal Stimuli Conditions.

TABLE 2

Means and Standard Deviations of Relative Isometric Muscular Endurance (RIME) Scores for Male Athletes under Positive, Negative and Control Conditions

Condition	RIME (secs) M	SD
Positive	341	84
Negative	335	67
Control	328	83

The between-day correlation coefficients for the endurance test were obtained from the correlations of the RIME scores among the three experimental conditions. All correlations were significant ($p < .001$) and ranged between $r = .89$ for the negative versus the control condition and, $r = .93$ for the positive versus the negative condition (see Table 5 of Appendix G).

4.3 Results of a MANOVA for the MVC and RIME Data

As displayed in Table 5 of Appendix G, significant ($p < .05$) inverse correlations were obtained between the two dependent variables

MVC and RIME, particularly within the control conditions (r = -.52).[7] Consequently, a repeated measures analysis through multivariate procedures was used to determine if any statistically significant differences were evident among the experimental conditions. The results of this analysis are reported in Table 3.

Inspection of the single degree of freedom contrasts (Finn, 1974) indicated that the condition of positive subliminal stimuli and the control condition did not differ, multivariate F (2,15) = 1.113, $p > .05$. The negative subliminal stimuli and control condition contrast was also nonsignificant, multivariate F (2,15) = 1,288, $p > .05$. Finally, the contrast between the two subliminal stimuli conditions did not significantly differ , multivariate F (2,15) = 0.981, $p > .05$. Unvariate F ratios are included in Table 3 and also show nonsignificant results ($p > .05$) for all contrasts.

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[7] The inverse relationship between muscular strength and endurance is consistent with previous studies examining these variables with a similar physical task (Start & Graham, 1964; McGlynn, 1969; Barnes, 1980). This result, therefore, can be interpreted as partial validation of the static muscular force apparatus for measuring strength and relative endurance performance.

TABLE 3

Comparisons Among the Three Experimental Conditions For Maximum Voluntary Contraction (MVC) and Relative Isometric Muscular Endurance (RIME) Scores: Multivariate Analysis of Variance.

Contrast	df	Multivariate F	p	Univariate F[a] MVC	Univariate F[a] RIME
Positive versus Control Condition	2, 15	1.113	0.35	0.397	2.32
Negative versus Control Condition	2, 15	1.288	0.31	0.918	0.574
Positive versus Negative Condition	2, 15	0.981	0.40	2.017	0.525

[a] Univariate df = 1, 16. All univariate F have a p >.05
See Table 5 at Appendix H for detailed univariate ANOVA summary.

CHAPTER V

DISCUSSION

The purpose of this study was to investigate the effects of auditory subliminal stimulation on the strength and endurance of male athletes during a physical task of isometric contraction of the elbow flexors. Some investigators (Howes, 1954; Ericksen, 1956; Neisser, 1967; Barber & Rushton, 1975) have demonstrated subliminal effects to be "experimental artifacts" on the basis that numerous studies had failed to use appropriate control measures. To minimize potential artifactual results, the present study used a counterbalanced design with repeated measures to negate possible test sequence bias and interindividual variability. Further, the double-blind procedure ensured control for possible sources of external validity (e.g., experimenter bias). A control condition was used in the study to compare the positive and negative treatment conditions with the effects of no subliminal stimulation. The efficacy of the subliminal stimuli could then be determined.

Analysis of the results for the strength scores revealed that the differences in initial and treatment MVC scores among the three conditions were found to be statistically nonsignificant ($p > .05$). Hence, the null hypothesis which stated that there would be no significant differences in MVC scores among the experimental conditions was accepted.

Inspection of the RIME data indicated that subjects were able to endure the isometric contraction of 30% of their initial MVC longer in the two treatment conditions than during the control condition. These differences, however, were found to be statistically non-significant ($p > .05$). Thus, the null hypothesis which predicted no significant differences in RIME performance would be found among the three experimental conditions was accepted.

The results from this study can, therefore, be interpreted as evidence that subliminal audio-conditioning is not necessarily an effective means of altering isometric muscular performance of the elbow flexors. The lack of subliminal conditioning effects was apparent in both MVC and RIME scores. These results are in accord with the conclusions offered by a number of investigators (Hawkins, 1970; George & Jennings, 1975, Glover, 1979). Previous documentation which concluded that subliminal stimulation may result in behavioral changes (Silverman, 1976; Chabot, 1976; Becker, 1976; Palmatier & Bornstein, 1980; Parker, 1982; Ariam & Siller, 1982) was not supported in this investigation. However, the paucity of antecedent experimentation investigating subliminal conditioning using auditory stimulation and muscular performance does not allow for extensive comparison with the results of the present study.

Under the assumption that subliminal stimulation can modify behavior, then, either the conditions for the experiment were not suitable for obtaining such effects, or behavioral changes were pro-

duced but were not reflected in the strength and endurance scores. With regard to the first alternative, some investigators (Fisher & Paul, 1959; Fiss, 1966; Murch, 1969; Dixon, 1971) have noted that unless conditions are ideal for subjects in subliminal studies, then few effects will be found. Ideal conditions for producing subliminal effects are those in which the subject is in a comfortable, relaxed state, with a low level of arousal. It may be that despite the optimal experimental environment in the present study, the nature and length of the physical task may have created conditions which were not conducive to a relaxed, passive state. Perhaps, if the subjects had been given programmed relaxation techniques, the subliminal stimulation may have demonstrated a more pronounced change in the dependent variables.

It is possible that the subjects in the present study were not susceptible to the subliminal stimuli. Ikai and Steinhaus (1961) concluded on the basis of their evidence that "psychologic rather than physiologic factors determine the limits of performance" (p. 161) and that motivation was the most significant psychological factor to affect muscular performance. Kroll (1959) noted that the performance of highly motivated subjects could not be improved even with additional stimuli such as "motivational suggestions". Furthermore, Jones (1962) concluded that girls were less motivated than men in maximum strength tests. Therefore, it is plausible to suggest that the male athletes used in this study were highly motivated individuals who

could not be additionally influenced with auditory suggestions. The consequence of this possibility may have negated the potential effects of the subliminal stimuli. Perhaps, the subliminal effects would have been more evident had non-athletic male and/or female subjects been used in the experiment.

The use of "Subliminal Psychodynamic Activation Techniques" (Silverman, 1976) that have been reported in many of the studies demonstrating behavioral changes (Greenberg, 1977; Heilbrum, 1980; Parker, 1982) have used previously proven effective subliminal stimuli of psychodynamic content (e.g., Mommy and I are one). Although the procedure used in the present study in the selection of words for the subliminal messages was similar to that of other studies which have found subliminal conditioning effects (Glover, 1979; Borgeat et al., 1981), they may not have been of sufficient emotional impact to elicit an influence in the physical task. The potential effectiveness of the subliminal stimuli may have been confirmed had the experimental procedure included a means of verifying an overt affective response. This could have been demonstrated physiologically using a biofeedback apparatus to monitor GSR or psychologically, by eliciting evoked guesses as to the content of the subliminal messages.

An explanation for the possibility that the subliminal stimuli produced effects which were not reflected in the results, may be that the responses to a subliminal stimulus do not necessarily appear immediately after its presentation. Many studies on the Poetzl

phenomenon have demonstrated that the effect of subliminal stimulation may not appear for periods of up to two days after presentation (Poetzl, 1960; Henley, 1975; Lee & Typer, 1980). In the present study, the effects were expected to occur during the subliminal treatment period. Consequently, the effects of the subliminal stimuli may have been evident if the muscular performance tests were executed after the presentation of the auditory stimulation.

It is also possible that, if the subliminal messages had affectively influenced the subjects, the nature of the task might not have been suitable for measuring this effect. Perhaps, the comparison among conditions of the subjects' ratings of perceived exertion (Borg, 1962) for the physical task, might have demonstrated significant changes in adaptation-levels and hence, the effectiveness of the subliminal stimuli.

A perusal of the literature on subliminal auditory stimulation has shown that the length of presentation and the intensity of the subliminal stimuli has occurred as long as 45 minutes (Fisher, 1975) and, as much as 30 db below recognition threshold (Zenhausern & Hansen, 1974). In the present study, the duration of the subliminal stimuli, without the masking effect, was approximately sixteen minutes. The intensity of the stimuli varied from -10 db to 5 db (sound pressure level) depending on the subject's previously determined speech detection threshold minus five decibels. The various intensity levels of

subliminal stimulation were necessary to accommodate the intra and interindividual differences in auditory thresholds. These auditory intensity variations ensured that the stimuli was presented below each individual's specific threshold of awareness. Perhaps, however, subliminal effects would have been demonstrated had the subliminal stimuli been presented for a longer period of time and/or at different intensity levels.

CHAPTER VI

SUMMARY AND CONCLUSION

Empirical evidence has supported the fact that a motivated condition is essential for effective performance of motor skills and that verbal encouragement was found to significantly increase strength and endurance scores (Barber, 1966; Kroll, 1970). Although many investigators support the findings that subliminal stimulation can alter behavior (Silverman, 1978a; Lee & Typer, 1980) and, despite the growing commercial exploitation using such techniques as "subliminal audio-conditioning" (Key, 1980; Borgeat et al., 1981), the research literature remains equivocal. However, a plethora of research literature which has been extensively reviewed by Bevan (1964), Dixon (1971) and Erderly (1974) has supported the contention that subliminal perception does exist. Consequently, an effort was made to scientifically subject its principles to the aim of this investigation.

6.1 Summary

The purpose of the present study was to investigate the effects of auditory subliminal stimuli on the ability to perform a physical task involving muscular strength and endurance. Strength was defined as the mean of the best two of three maximum voluntary contractions (MVC) that a subject could exert during a static contraction of the

elbow flexors. The relative isometric muscular endurance (RIME) consisted of the accumulated time that a subject was able to sustain a contraction of a resistance load equivalent to 30% of his MVC. The test was terminated when a subject was unable to maintain the prescribed force on the resistance load for a continuous three second interval.

A pretest was conducted to familiarize each subject with the testing procedure and apparatus and to administer a pure-tone threshold (PTT) and speech detection threshold (SDT) hearing test. Each individual's SDT minus five decibels was then used as the test criterion volume to ensure that the stimuli was received below their threshold of awareness.

Seventeen male athletes of the Interallied Confederation of Reserve Officers, ranging in age from 18 to 23 years, served as volunteer subjects in the study. English-speaking, right-hand dominant subjects were assigned in counterbalanced order to each of three experimental conditions: A positive subliminal stimuli condition, in which subjects received a subliminal message that attempted to motivate them to improve performance; a negative subliminal stimuli condition, in which subjects received a subliminal message that suggested performance retirement; and a control condition in which no subliminal message was used. A double-blind paradigm was used such that neither the experimentor nor the subjects were aware of the particular treatment condition. Initial and treatment MVC and RIME scores were obtained for all subjects in each of the experimental conditions.

A repeated measures analysis through multivariate procedures was conducted to determine if there were any significant differences for the dependent variables among the three experimental conditions. The analysis of the strength data revealed that the differences between initial and treatment MVC scores among the conditions were statistically nonsignificant ($p > .05$). Inspection of the RIME data indicated that the subjects were able to endure the isometric contraction of 30% of their Initial MVC longer in both subliminal stimuli conditions than during the control condition. These differences, however, were found to be statistically nonsignificant ($p > .05$). Significant intraclass correlations between strength and endurance ($r = -.52$) were noted in a post-hoc analysis.

6.2 Conclusion

Generalizations derived from the data must be restricted to the inherent limitations of this investigation. These include the nature of the task and the sample tested. Therefore, based upon the results and within the limitations of this study, it was determined that subliminal audio-conditioning is not an effective means of altering strength and endurance performances for an isometric contraction of the elbow flexors.

6.3 Suggestions for Further Study

In view of the dearth of literature related to the effects of subliminal audio-conditioning, further research appears warranted. Previous documentation has investigated such variables as the effects of individual differences in arousal, motivation and intensity levels. The majority of the literature attempting to determine the efficiency of subliminal stimulation to modify behavior has found that it may more than likely produce an affective rather than overt response. Therefore, the present study notwithstanding, a review of previous literature has disclosed an absence of inquiry in the measurement of an individual's affective responses to a physical task as a result of subliminal stimulation. Further, the effects of a visually presented subliminal stimuli on physical performance has been void of earlier investigations. The practical implications of subliminal conditioning, which has been demonstrated in some empirical studies and now being commercially employed, deem subsequent examination in this area desirable.

It is suggested that future research in measurement of physical performance accompanied with subliminal suggestions include comparisons of: males and females, athletes and non-athletes, stimuli intensity levels, duration periods, experimental tasks and different types of subliminal messages.

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APPENDIX A

TRANSDUCER CALIBRATION TABLE

AND GRAPH

TABLE 4

Transducer Calibration of Readings Recorded in Volts($\times 10^{-3}$) to an Equivalent Weight (kg).

VOLTS x 10^{-3} (MV)		KILOGRAMS (kg)	
0.48		1	
	2		4.13
2.42		5	
	4		8.26
4.85		10	
	6		12.40
7.28		15	
	8		16.53
9.70		20	
	10		20.66
12.13		25	
	14		28.93
14.55		30	
	16		33.06
16.98		35	
	18		37.19
19.40		40	
	20		41.32
21.82		45	

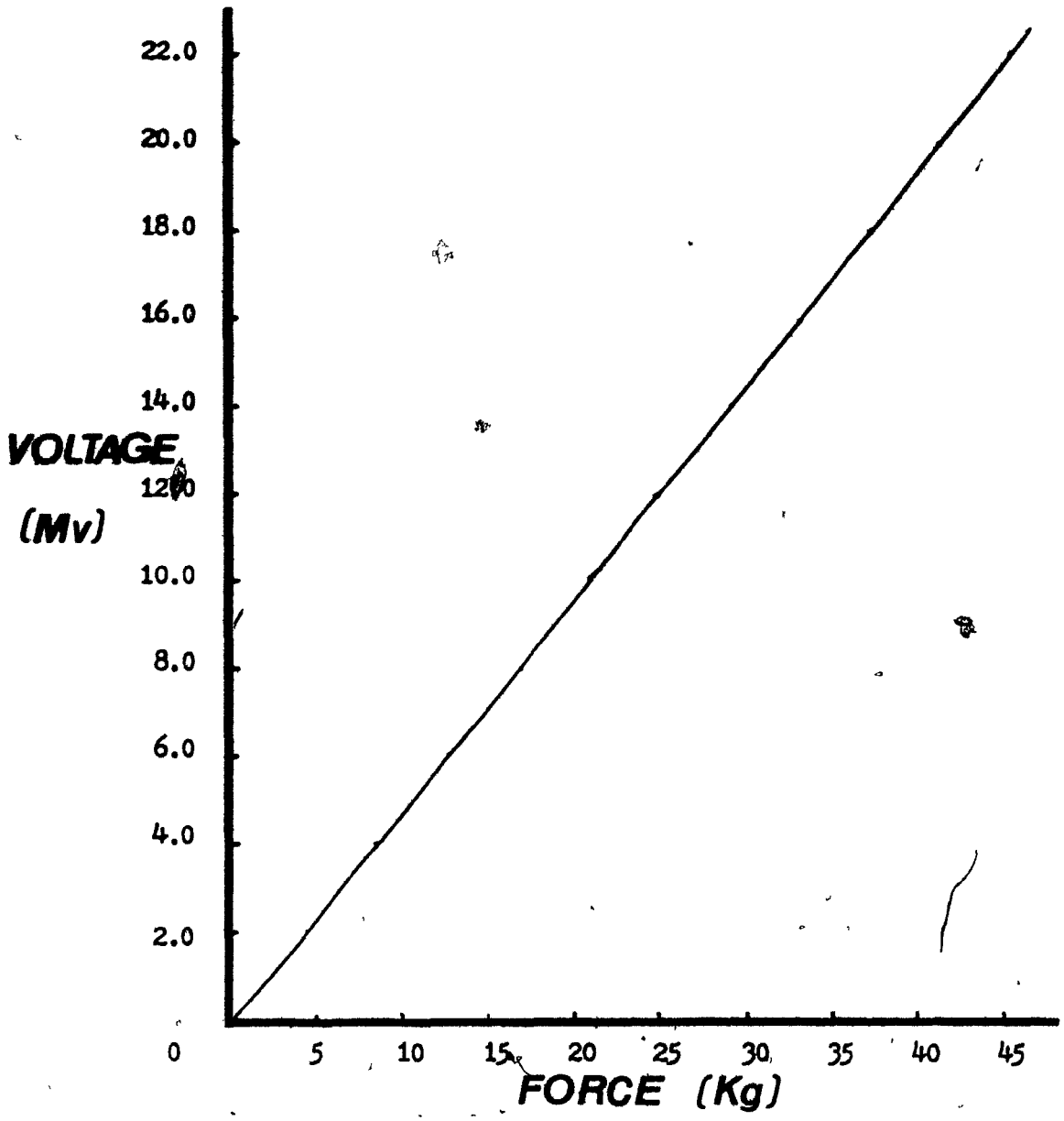
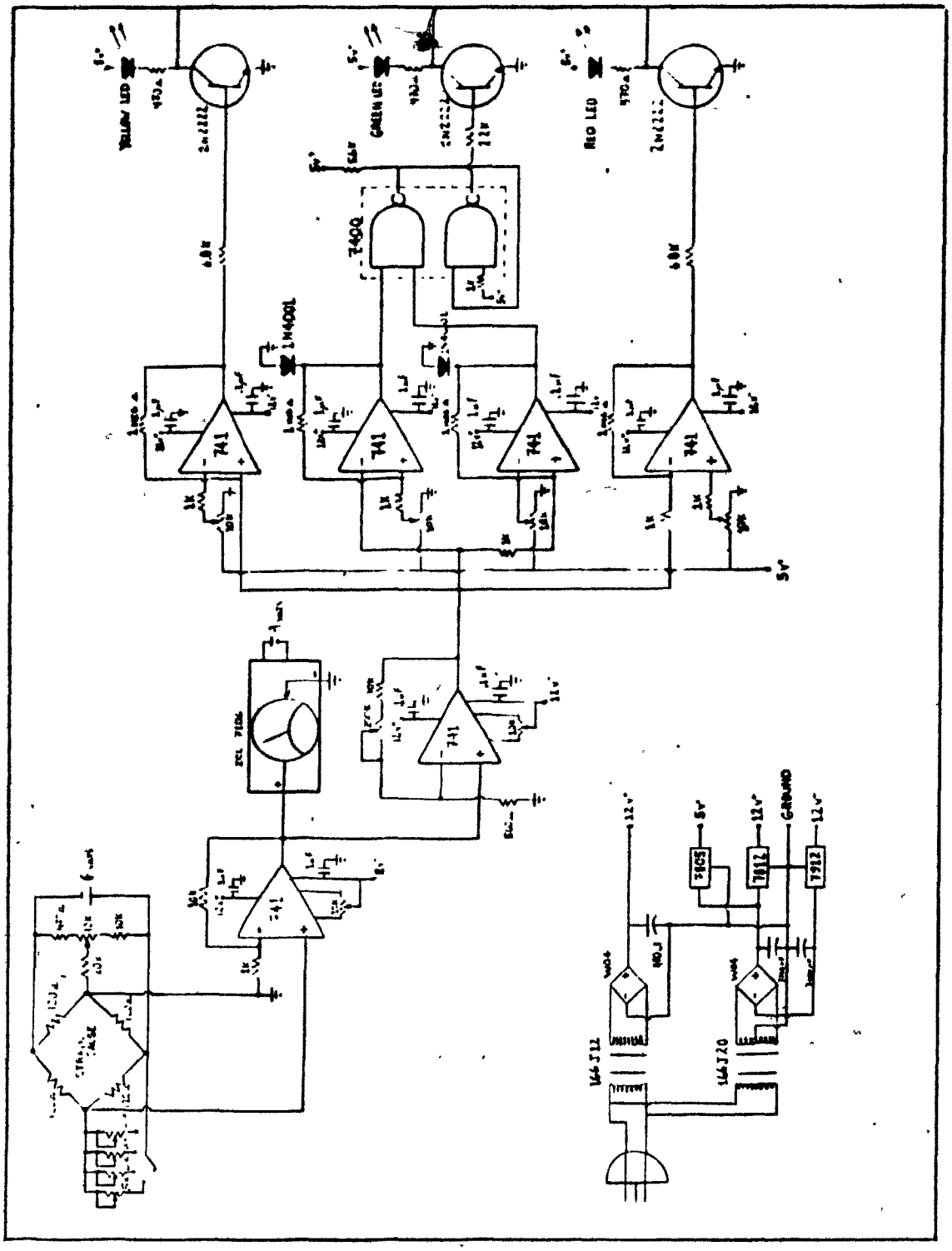


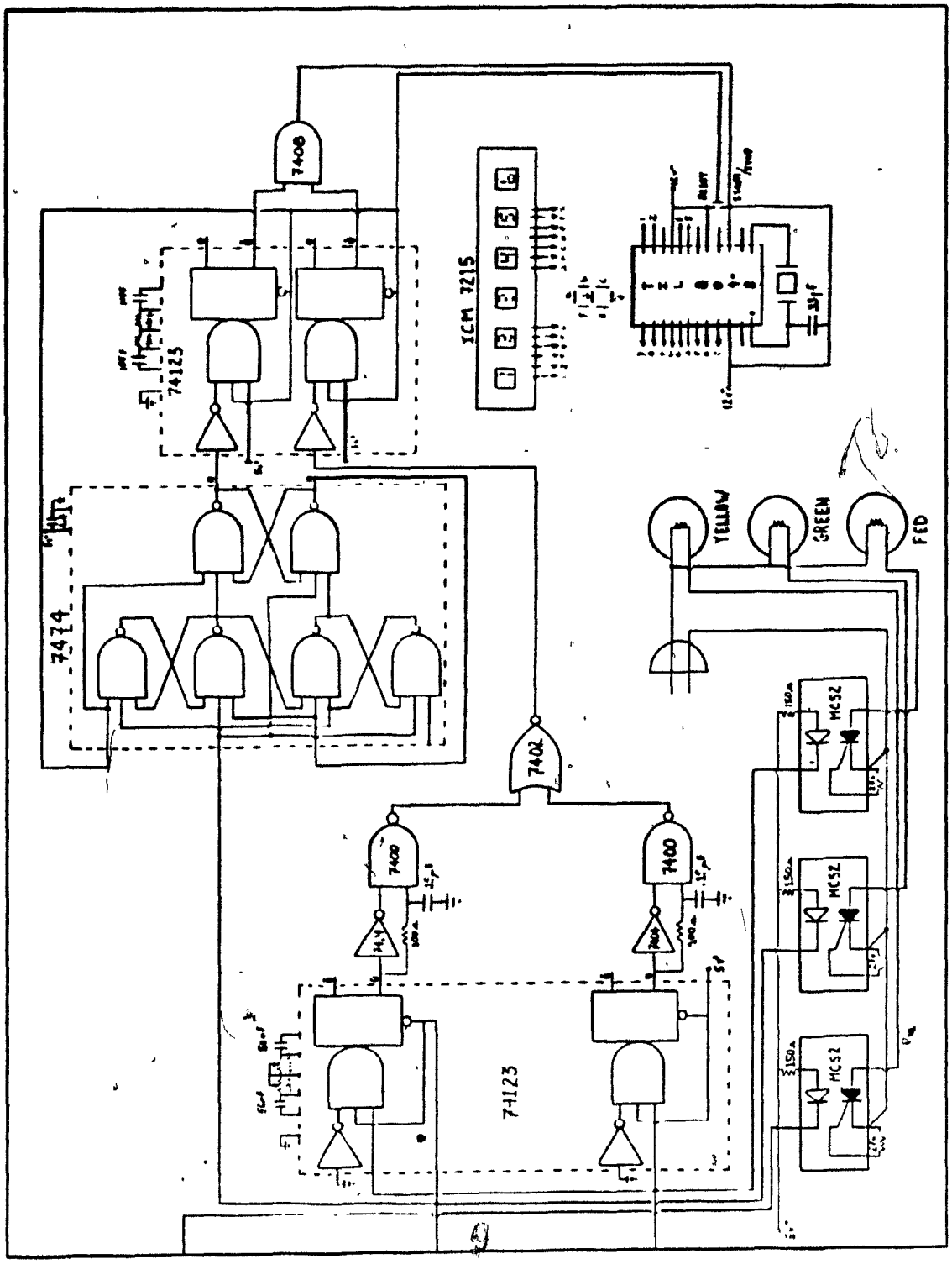
Figure 6. Transducer Calibration Graph Indicating a Linear Relationship Between Force (kg) and Voltage (Mv).

APPENDIX B

ELECTRONIC CIRCUIT SCHEMATIC OF THE STATIC MUSCULAR FORCE RECORDING APPARATUS



Continued on page 79


7400
74123
7474
ICM 7215
YELLOW
GREEN
RED
7402
7400
7400
74123
MCS2
MCS2
MCS2

APPENDIX C

QUESTIONNAIRE PRESENTED TO NON-EXPERIMENTAL SUBJECTS FOR THE SELECTION OF WORDS TO BE USED AS SUBLIMINAL STIMULI FOR THE POSITIVE AND NEGATIVE EXPERIMENTAL CONDITIONS

Number in order of priority the following words which would arouse or motivate you to work harder at a physical task (i.e., Cable Tensiometer of Elbow Flexion) to determine your maximum strength and endurance.

Drive

Forge

Fuck

Haul

Mad

Pull

Sex

Strong

Thrust

Tug

Number in order of priority the following words which would impel or induce you to work less at a physical task to determine your maximum strength and endurance.

Exhausted

Fatigue

Give up

Hurting

Painful

Relax

Sluggish

Sore

Stop

Tired

APPENDIX D

INVESTIGATORS TAPED INSTRUCTIONS PRESENTED TO SUBJECTS FOR ALL EXPERIMENTAL CONDITIONS

INVESTIGATORS TAPED INSTRUCTIONS

Testing 1-2-3 .....-10

As you are well aware, the purpose of this study is to test the reliability of your strength and endurance performance over a three week period using this newly designed apparatus. The reason you are in this dark soundproof acoustics chamber is to control for extraneous variables such as visual and auditory cues that could affect your performance. This testing session will be executed in three phases which will be explained to you as we go along. At this time I want you to close your eyes and relax for a few minutes before we begin phase one. You will notice that scattered throughout all rest intervals you will be hearing special sound effects. Please ensure that your right forearm is not pulling on the wrist cuff.

(Five minute rest interval)

We are ready to begin phase one which will consist in obtaining three maximum isometric strength scores of your elbow flexors. When I say GO, I want you to contract your elbow flexors or bicep brachii at a comfortable rate until you reach your maximum contraction and then relax for one minute. This procedure is the same as you did during the first practice session. Remember this contraction should last no longer than five seconds and, if the apparatus lifts off the ground, it means that you are cheating by using your shoulder muscles to assist you in the elbow flexion.

STANDBY - GO

(One minute rest interval)

Ready for the second contraction, STANDBY - GO

(One minute rest interval)

Ready for the third contraction, STANDBY - GO

Phase one is now completed. You will now get a ten minute rest interval. Remember to relax your right arm so that you are not pulling on the wrist cuff.

SUBLIMINAL STIMULATION STARTS HERE.

(Ten minute rest interval)

We are now ready to begin phase two which will be identical to phase one and consist of obtaining three more maximum isometric contractions of your elbow flexors. When I say GO I want you to contract the bicep of your right arm until you reach your maximum contraction and then relax for one minute.

STANDBY - GO

(One minute rest interval)

Ready for the second contraction, STANDBY - GO

(One minute rest interval)

Ready for the third contraction, STANDBY - GO

Phase two is now completed. You will now get a ten minute rest interval. Remember to relax your right arm so that you are not pulling on the wrist cuff.

(Ten minute rest interval)

We are now ready to begin phase three which will consist of determining your maximum endurance time at an isometric contraction of the elbow flexors with a resistance equivalent to only 30% of your maximum strength. When I say GO I want you to slowly begin contracting the bicep of your right arm until the green light is on, and to keep it on as long as possible. If the red or yellow lights go on, make the appropriate correction as fast as possible to get back on green. STANDBY - GO.

APPENDIX E

PRE-EXPERIMENTAL INSTRUCTIONS

All subjects were given a copy of the following pre-experimental instructions during the pre-testing session:

> In order to standardize testing procedures, you are requested to refrain from the following, two hours prior to the testing time:
>
> NO smoking
> NO coffee or tea
> NO consumption of any food
> NO alcohol
> NO excessive exercise
>
> If for any reason you feel that there might be a physiological or psychological reason (i.e., cold, physical injury or death in the family) that could affect your performance, please contact me as soon as possible to cancel your testing session.
>
> For accurate test results, and for your own comfort, a standard test attire will be required. You are requested to take each test wearing a T-shirt and shorts only.

The following instructions were given to each subject during the time he was being positioned in the mechanical apparatus and prior to placing the headphones over his ears for each of the experimental conditions.

> The purpose of this test is to examine the reliability of the apparatus and to examine the effects of a one week rest interval on your strength and endurance scores. Remember how you were taught to perform the physical task and I emphasize that you must only contract the bicep muscle of your right arm. Please restrict all unnecessary movements of the arms and legs. Simply lie in the proper anatomical position when performing the contraction. The entire session should take no more than 35 minutes. Listen attentively to the taped instructions and relax.

APPENDIX F

MANOVA PROGRAM FOR ANALYSIS OF REPEATED MEASURES DATA

```
THE EFFECTS OF AN AUDITORY SUBLIMINAL STIMULI
REPEATED MEASURES ANALYSIS THROUGH MULTIVARIATE PROCEDURES
   9   0   3   1   1  12   1  20                    1   1       1
THE PURPOSE OF THIS INVESTIGATION WAS TO DETERMINE THE EFFECTS OF AN
AUDITORY SUBLIMINAL STIMULI ON THE ABILITY TO PERFORM A PHYSICAL TASK
INVOLVING STATIC MUSCULAR STRENGTH AND ENDURANCE.  SUBJECTS (N=17)
WERE SEQUENTIALLY ASSIGNED IN COUNTERBALANCED ORDER TO EACH OF THREE
EXPERIMENTAL CONDITIONS:
      1. A POSITIVE SUBLIMINAL STIMULI CONDITION, IN WHICH
      SUBJECTS RECEIVED A SUBLIMINAL MESSAGE THAT ATTEMPTED
      TO MOTIVATE THEM TO IMPROVE PERFORMANCE;
      2. A NEGATIVE SUBLIMINAL STIMULI CONDITION, IN WHICH
      SUBJECTS RECEIVED A SUBLIMINAL MESSAGE THAT SUGGESTS
      PERFORMANCE RETIREMENT; AND
      3. A CONTROL CONDITION IN WHICH NO SUBLIMINAL MESSAGE
      WAS ISSUED.
CHANGE SCORES BETWEEN INITIAL AND TREATMENT MAXIMUM VOLUNTARY CONTRACTION
(MVC) AND RELATIVE ISOMETRIC MUSCULAR ENDURANCE (RIME) TIME WAS CALCULATED
FOR ALL SUBJECTS IN EACH OF THE EXPERIMENTAL CONDITIONS.  THIS DATA WILL
BE ANALYSED BY A REPEATED MEASURES ANALYSIS THROUGH MULTIVARIATE PROCEDURES
(FINN & MATTSSON 1978).
FINISH
(5X,2(F4.2,1X),F3.0,/,5X,2(F4.2,1X),F3.0,/,5X,2(F4.2,1X),F3.0)
  10  17   2   1
  11  17   5   4
  12  17   8   7

P-MVC1  P-MVC2  P-RIME  N-MVC1  N-MVC2  N-RIME  C-MVC1  C-MVC2  C-RIME  P-MVC
N-MVC   C-MVC   GRM-MVC GRM-RIMEP/C-MVC P/C-RIMEN/C-MVC N/C-RIMEP/N-MVC P/N-RIME
/INCLUDE SUBDSORT
(12F2.0)
 1  0  0  0  0  0  0  0  0  0  0  0   P-MVC1       01
 0  1  0  0  0  0  0  0  0  0  0  0   P-MVC2       02
 0  0  1  0  0  0  0  0  0  0  0  0   P-RIME       03
 0  0  0  1  0  0  0  0  0  0  0  0   N-MVC1       04
 0  0  0  0  1  0  0  0  0  0  0  0   N-MVC2       05
 0  0  0  0  0  1  0  0  0  0  0  0   N-RIME       06
 0  0  0  0  0  0  1  0  0  0  0  0   C-MVC1       07
 0  0  0  0  0  0  0  1  0  0  0  0   C-MVC2       08
 0  0  0  0  0  0  0  0  1  0  0  0   C-RIME       09
 0  0  0  0  0  0  0  0  0  1  0  0   P-MVC        10
 0  0  0  0  0  0  0  0  0  0  1  0   N-MVC        11
 0  0  0  0  0  0  0  0  0  0  0  1   C-MVC        12
 0  0  0  0  0  0  0  0  0  1  1  1   GRM-MVC      13
 0  0  1  0  0  1  0  0  1  0  0  0   GRM-RIME     14
 0  0  0  0  0  0  0  0  0  1  0-1   P/C-MVC      15
 0  0  1  0  0  0  0 0-1  0  0  0   P/C-RIME     16
 0  0  0  0  0  0  0  0  0  0  1-1   N/C-MVC      17
 0  0  0  0  0  1  0  0-1  0  0  0   N/C-RIME     18
 0  0  0  0  0  0  0  0  0  1-1  0   P/N-MVC      19
 0  0  1  0  0-1  0  0  0  0  0  0   P/N-RIME     20
   1   0   0                          1
0.
CO.
   1       1          1
13.
1.
   1       1          1
14.
1.
   2       1          1
15,16.
1.
   2       1          1
17,18.
1.
   2       1          1
19,20.
1.

STOP
```

APPENDIX G

INTRA-CLASS CORRELATION MATRIX OF MVC AND RIME SCORES FOR THE THREE EXPERIMENTAL CONDITIONS

TABLE 5

Intra-Class Correlation Matrix of Initial and Treatment Maximum Voluntary Contraction (MVC) and Relative Isometric Muscular Endurance (RIME) Scores for the Three Experimental Conditions.

			MVC						RIME		
			Positive		Negative		Control		Positive	Negative	Control
			Initial	Treatment	Initial	Treatment	Initial	Treatment			
MVC	Positive	Initial	1.00								
		Treatment	0.98*	1.00							
	Negative	Initial	0.97*	0.97*	1.00						
		Treatment	0.97*	0.97*	0.99*	1.00					
	Control	Initial	0.98*	0.97*	0.97*	0.97*	1.00				
		Treatment	0.97*	0.96*	0.96*	0.96*	0.99*	1.00			
RIME	Positive		-0.44	-0.37	-0.36	-0.37	-0.40	-0.40	1.00		
	Negative		-0.36	-0.31	-0.36	-0.35	-0.35	-0.36	0.93*	1.00	
	Control		-0.51**	-0.47	-0.47	-0.47	-0.54**	-0.52**	0.91*	0.89*	1.00

* $p < .001$
** $p < .05$

APPENDIX H

SINGLE DEGREE OF FREEDOM CONTRASTS FOR MVC AND RIME SCORES AMONG THE THREE EXPERIMENTAL CONDITIONS

TABLE 6

Single Degree of Freedom Contrasts for Maximum Voluntary Contraction (MVC) and Relative Isometric Muscular Endurance (RIME) Scores Among the Three Experimental Conditions.

Variable	Contrast	df	SS_w	MS_e	MS	F[a]	p
MVC	Grand Mean	1, 16	2.06	0.127	0.031	0.241	0.63
	Positive versus Control	1, 16	2.29	0.139	0.055	0.397	0.54
	Negative versus Control	1, 16	1.75	0.103	0.095	0.918	0.35
	Positive versus Negative	1, 16	2.64	0.146	0.295	2.017	0.18
RIME	Positive versus Control	1, 16	22,319	1218.6	2821.2	2.32	0.15
	Negative versus Control	1, 16	24,889	1501.7	861.2	0.574	0.50
	Positive versus Negative	1, 16	17,792	1076.7	564.9	0.525	0.48

[a] For 1 and 16 df, F must equal or exceed 4.49 for significance at the .05 probability level.