RODRIGUEZ, GLORIA JEAN. A Comparison of the Effects of Mental and Physical Practice upon Abdominal Strength in High School Girls. (1967) Directed by: Dr. Celeste Ulrich. pp. 72.

The purpose of this study was to determine the relative effects of physical practice, mental practice, and a combination of physical and mental practice on increasing abdominal strength in fifty-six female high school students. Abdominal strength was measured by the cable tensiometer.

Subjects were divided into one control group and three experimental groups; the three experimental groups met daily for five minutes for a total of seventeen practice days during a four week period.

In order to determine if the various practice methods were effective as a means of changing abdominal strength, all groups were tested for abdominal strength on the beginning, middle, and final days of the study. Analysis of the results by use of Fisher's "t" for differences between both correlated and uncorrelated means indicated that:

1. Seven practice sessions of physical practice, mental practice, and mental-physical practice proved ineffective in increasing abdominal strength.

2. Seventeen practice sessions of physical practice were effective in increasing abdominal strength.

3. Seventeen practice sessions of mental practice were ineffective in increasing abdominal strength.

4. Seventeen practice sessions of mental-physical practice were effective in increasing abdominal strength but not as effective as physical practice. It was conjected that the effectiveness of the combination of mental and physical practice appeared to be the result of the physical phase of the practice sessions.

A COMPARISON OF THE EFFECTS OF MENTAL AND PHYSICAL PRACTICE UPON ABDOMINAL STRENGTH IN HIGH SCHOOL GIRLS

by

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CHAPTER I

INTRODUCTION

Man is an integrated being and responds as a unified whole rather than as an absolute thinking being in one instance and as a purely physical being in some other instance. (9) The concept of action as an entity, separate and isolated from thinking, is no longer plausible. ". . . it is wholly impossible to divorce the brain or its thoughts and learning processes from many other 'physical' or bodily states or processes. They coexist and interact one upon the other." (9:46) Functions which are purely physical do not exist.

That there exists a relationship between mind and body is irrefutable, but the exact relationship is complex; and there are many gaps in our knowledge as to the organic relationship that exists between mind and body, and the extent to which one element influences the other.

> Physiologists and psychologists have acknowledged the fact that mental activity can initiate certain physiochemical changes that are peculiar to muscle contraction. They point out that muscular tension can be realized by thinking about performing a motor activity. The occurrence of certain physiochemical changes and muscular tension serves as a catalyst for establishing a relationship between mental activity and muscular activity. (48:10)

Several studies (24, 25, 29, 30, 37) have shown that thinking about a particular muscular performance is capable

of bringing about tension in the muscles that would participate in this performance. Physiologists agree that the physical performance of a neuromuscular act cannot be classified as just physical, because the mental processes are also inextricably involved. Karpovich (5) related that the performance of a voluntary neuromuscular act originates in the cortex of the cerebrum and contraction occurs when the cerebellum initiates a stream of stimuli through the central nervous system that eventually arrives in the sensory end organ in the muscles. He commented that merely thinking about the performance of a physical act can result in various physiological changes.

Thus, physiologists have shown that a definite relationship exists between mental processes and muscular processes. Studies concerned with mental practice, i.e., thinking about a particular task without performing an overt muscular movement, explore this relationship. Many studies (21, 26, 41, 43, 46, 47, 49) conducted to determine the effects of mental practice in acquiring and improving motor skills have shown mental practice and combinations of mental and physical practice effective.

The concept that physical performance possibly can be increased through mental practice is relatively new, and little or no research has been conducted to determine the use of mental practice as a method of influencing such factors as strength, endurance, speed, balance, and agility. This study was designed to examine the relationship between mental

processes and muscular processes with regard to strength. Physical educators, athletic coaches, physicians, physical therapists, and military training personnel, among others, are cognizant of the importance that strength plays in the achievement of selected goals. If mental practice could provide a means to increase strength through the relationship that exists between mental and muscular processes, the concept of mental practice or a combination of mental and physical practice would be beneficial in terms of time and expense to those involved with strength development.

This study was undertaken to investigate the feasibility as to the rationale of employing mental practice alone or in combination with physical practice, as a means of increasing strength in the abdominal muscles.

CHAPTER II

STATEMENT OF PROBLEM

This study was conducted to determine the relative effect of three different practice methods on increasing abdominal strength as measured by the cable tensiometer. The three practice methods used were physical practice, mental practice, and a combination of physical and mental practice. A fourth group serving as a control group had no practice.

It was the purpose of this study:

(1) to test the hypothesis that abdominal muscular strength could be increased through mental practice.

(2) to determine if any change brought about through mental practice would be as great, greater than, or less than that achieved solely through physical practice.

(3) to determine if a change, if any, through a combination of mental and physical practice would be as great, greater than, or less than that achieved solely through physical or mental practice.

DEFINITION OF TERMS

Mental Practice. Thinking about a particular task without performing an overt muscular movement.

Physical Practice. Performing an activity involving overt muscular movement.

LIMITATIONS OF THE STUDY

The limitations of this study were:

(1) Only fifty-six high school female students from a single high school were used as subjects.

(2) The study involved only three different practice methods.

(3) The practice sessions were limited to four weeks in length or a total of seventeen practice periods.

(4) The study was limited to abdominal strength as measured by the cable tensiometer.

(5) The extent to which concentrated mental practice occurred was subjectively evaluated.

(6) Motivational techniques were used which were not defined operationally.

CHAPTER III

REVIEW OF LITERATURE

Literature was reviewed in four different areas in preparation for this study. The review is divided into studies concerned with the following areas: (a) The relationship between mental processes and muscular activity; (b) Mental-physical relationships and the acquisition and improvement of motor skills; (c) Abdominal strengthening; and (d) Strength testing.

The Relationship between Mental Processes and Muscular Activity

The relationship between mind and body is complex, and there are many gaps in our knowledge as to the organic relationship that exists and the extent to which one element influences the other. Specifically, with regard to this study, it was important to establish the relationship between mental activity and muscular activity. This section of the review examined literature concerned with this relationship.

Strength is the ability to exert tension against resistance. This ability depends essentially on the contractile power of muscular tissue.

> Muscle is a machine for converting chemical energy into mechanical work. The performance of work results from the shortening of the muscle against a load of resistance. The contraction of muscle involves three distinct though

> interrelated events: (1) stimulation of the muscle by impulses from the central nervous system, (2) chemical changes which furnish the energy for contraction, (3) the rearrangement of some of the structural elements of the muscle fibers into a shorter form. (8:16)

Mental activity is capable of stimulating the central nervous system and bringing about muscular contraction as well as other physiological changes.

> The brain not only originates the muscular contractions, but it also prepares the body for an exertion. This it does by sending impulses through the sympathetic nervous system to the respiratory, cardiac and vasomotor centers in anticipation of the effort. Therefore, the mere contemplation of activity may result in some increase in the breathing, in an augmentation in the frequency of the heart beat, in a rise in the arterial blood pressure, and in a redistribution of the blood in the body. (5:34)

The concept that mental activity can initiate certain physiochemical changes that are peculiar to muscle contraction has been acknowledged. It has been pointed out that muscular tension can be initiated by thinking about performing a motor activity. Morehouse and Miller reported that ". . .thinking about muscular performance has been shown to produce an increase in the tension of the muscles that would participate in actual performance." (8:69)

Jacobson (28) in his studies on muscular phenomenon during imagery found that:

> . . .during imagination or recollection of muscular acts or of matters that involve such an act on the part of the subject, contraction occurs in some of the muscle fibers which would engage in the actual performance of the act. (28:693)

He also found oculomotor contraction during visual imagery and tongue and lip activity during verbal imagery.

In another study conducted by Jacobson (29), electrodes were placed on subjects' biceps, and subjects were then asked to imagine lifting a ten pound weight. Under these conditions of imagined lifting, electrical fluctuations occurred in the biceps region of the arm performing the imaginal lifting which were absent prior to and following the imaginal lift. Jacobson concluded that ". . .contraction of specific muscles takes place following the instruction to imagine an act performed with the voluntary musculature. . ." and that ". . .the movement generally is confined within the group of muscles whose contraction would be required for the actual performance of the voluntary act." (29:711)

Shaw (37) conducted a study in which three students lifted weights and then repeated the task by just thinking about it; the students could not imagine weight lifting without contracting their muscles. An electrical indicator revealed greater muscular activity when the students thought of lifting heavier weights than when they were mentally lifting lighter weights.

Freeman (25) indicated that mental work was accompanied by variations in muscle tension. From his work, he concluded that photographic registration of the thickening of several muscle groups provided valid evidence of the spread of neuromuscular activity during mental work.

In another study by Freeman (24), when explaining the relationship between mental activity and the muscular processes, he stated:

> . . .the degree of completeness of higher neural integration (called mental) will vary with the amount of afferent stimulation of the cortex set up and maintained in great part by the processes of muscular tension. The excitation irradiated by these processes acts to lower the thresholds of irritability in the higher (cortical) centers. The increased excitability of these centers by such means is an essential condition for their reaction to specific patterns of external and internal stimulation of normal intensity during waking. (24:436)

Razor (48) reported on a study by Egstrom where eleven subjects were asked to think about pulling a provided handle back toward them with a maximal flexion effort. The subjects thought about performing the activity for a period of ten seconds, three times a week for four weeks. Egstrom found no statistically significant increase in strength beyond that of a control group which did not practice mentally.

Razor (48) conducted a study to determine the relative effect of four different methods of practice on increasing hand grip strength. At the end of nine and eighteen sessions of practice using the hand dynamometer to test hand grip strength, he tested groups of physical practice, mental practice, physical-mental practice, mental-physical practice and no practice. Among his findings were:

1. Physical practice was effective as a means of increasing dominant and non-dominant hand grip strength.

2. Mental practice, after nine practice sessions, proved effective as a means of increasing non-dominant hand grip strength, but continued mental practice resulted in a loss of strength to the extent that it negated this initial gain and an insignificant increase resulted.

3. Mental practice did not prove effective as a means of increasing dominant hand grip strength.

4. Physical practice was superior to mental practice as a means of increasing dominant and non-dominant hand grip strength.

5. Combinations of physical and mental practice were found effective as means of increasing grip strength and were superior to mental practice, but not physical practice, as methods of increasing hand grip strength. The effectiveness of the combination methods, and their superiority to mental practice, appeared to be the result of the physical phase of the practice procedure. (48:95)

Kelsey (32) conducted a study to determine the effectiveness of mental practice as a means of increasing endurance in performing sit-ups. He tested groups of no practice, physical practice, and mental practice at the beginning and end of a twenty day experimental period using the "total number of sit-ups" for testing purposes. Subjects in the physical practice group performed physical sit-ups for five minutes daily, and subjects in the mental practice group performed mental sit-ups for five minutes daily. Kelsey found that:

> Subjects receiving no practice showed no significant improvement in muscular endurance. The group receiving physical practice improved 322 percent or increased an average of 112.52 sit-ups, and the group receiving mental practice improved 29 percent or increased an average of 10.14 sit-ups. In both of these the improvement was statistically significant at the .01 and .05 levels of confidence

> respectively. There were statistically significant differences in the mean final scores between physical practice and no practice, and between physical practice and mental practice. In both instances the significant difference was in favor of physical practice. There was no statistically significant difference between mental practice and no practice.
>
> It was concluded that both physical practice and mental practice, under the conditions of the experiment, were effective in increasing muscular endurance. The degree of increase with respect to mental practice, however, was not sufficiently large enough to advocate its use exclusive of physical practice where physical practice is possible. (32:53)

Kelsey suggested that a combination of the two elements of physical and mental practice be employed.

Richardson (35) reported a study done by Steel concerning muscular endurance and mental practice:

> He used four groups of 14 school boys selected at random. Each member of the PP group performed bench presses, lifting three-quarters of his initial poundage on each of the eight days intervening between initial and final performance. Each of these daily trials consisted of four lifts and a 60 sec. rest followed by four more lifts. The MP group practiced for 10 minutes daily. A fourth group, in addition to the NP group, had four lifts PP followed by five min. of MP each day. Compared with the PP group which gained 8.54 percent between initial and final performances, this PP MP group gained 12.66 percent. Though both groups showed a significant improvement (p..01) the PP MP group was not significantly superior to the PP group. (35:100)

According to Karpovich and Hale (31) Malarecki reported ". . .that not only actual warming up exercises but merely

imagining exercises increased the speed of running 60 meters." (21:1117)

In another study reported by Razor (48), Strong attempted to determine how maximum muscular contraction as measured by the hand grip dynamometer would be affected by selected suggestions which tended to be positive or negative in context. Using visual, auditory, and self-spoken suggestions, the investigator found that self-spoken suggestions brought about the highest scores on the hand dynamometer. The investigator attributed this to greater concentration on the task at hand, ". . .indicating a psychological-physiological relationship."

Bowers (16) investigated the effect of isotonic muscular contraction by means of "autosuggestion" on muscle strength and size as compared to the effects of isometric and static contractions. Initial measurements of elbow flexion strength of left and right arms were made by means of a cable tensiometer. Forearm and biceps girth measurements of both arms and muscle action potential recordings during autosuggested contraction were also taken at the beginning of the study. Subjects were divided into four groups: (a) Control; (b) Autosuggestion exercise group in which the subjects performed five isotonic elbow flexion contractions by repeated self-suggestions; (c) Isometric exercise group in which subjects used an "all-out" isometric contraction held for a ten second duration against an immovable tensiometer cable

strap; and (d) Static contraction group in which subjects performed five static contractions for a fifteen second duration. Among Bower's conclusions were:

1. Five autosuggested muscle contractions or five "all-out" isometric contractions performed three days per week for three weeks will produce significant strength.

2. Six weeks of training three days per week performing five isometric, static or autosuggested muscular contractions will significantly increase strength.

3. Isometric exercise is more effective in developing strength over a six weeks period than either static or auto-suggested exercise.

4. There is no difference in the strength resulting from six weeks of training using a five second static contraction and training utilizing autosuggested muscular contraction.

5. The suggestion of lifting a heavy weight used during the performance of auto-suggested muscular contraction helps bring about a more forceful contraction as indicated by increased measurements of muscle action potentials. (16:4525)

Summary. Most of the reported research indicated a relationship between mental processes and muscular activity. Thinking about a particular muscular performance has been found to be capable of bringing about tension in the muscles that would participate in physical performance of an overt act. Whether this relationship, through mental practice without physical practice, would be strong enough to increase physical performance in terms of strength and endurance is questionable, and more research is needed to draw definite conclusions about such an hypothesis.

Mental-Physical Relationships and the Acquisition and Improvement of Motor Skills

Numerous studies have been conducted where mental practice has been used as a means of acquiring or increasing skill in a motor activity. Clarke (21) conducted a study to determine the relative effectiveness of mental practice as a means of increasing skill in shooting basketball foul shots. One hundred forty-four high school boys were equated into two practice groups on the basis of arm strength, intelligence, and varsity, junior varsity, or novice experience. These groups were identified as physical and mental. Both groups showed highly significant gains in skill with "t" test scores of 10.5 and 7.7 respectively. The physical practice group had average gains of sixteen per cent for the varsity players, twenty-four per cent for the junior varsity players, and forty-four per cent for the novice players while the mental practice group showed average gains of fifteen per cent for the varsity players, twenty-three per cent for the junior varsity players, and twenty-six per cent for the novice players. Comparison showed that mental practice was almost as effective as physical practice for the varsity and junior varsity groups but not as effective for the novice group. Clarke suggested that it was possible that a certain amount of motor experience was necessary before mental practice could provide maximal effects.

Vandell, Davis, and Clugston (42) conducted a similar study involving the shooting of basketball free

throws and the throwing of darts. In the basketball shooting phase of the study which used high school boys as subjects, the no practice group did not improve, the physical practice group improved twenty-three per cent, and the mental practice group improved twenty-two per cent. With junior high school boys involved in a dart-throwing skill, the no practice group decreased two per cent, the physical practice group improved seven per cent, and the mental practice group improved four per cent. Although physical practice was superior with both groups of subjects, the improvement of the mental practice group was statistically significant at the .05 level of confidence.

Harby (27) conducted a study on two hundred fifty male subjects using films in conjunction with mental practice and basketball shooting. Mental practice involved watching a movie demonstrating the movement to be learned while physical practice was actual practice of the movement. From his study, Harby concluded that:

1. A physical skill can be learned by mental practice.
2. The effectiveness of mental practice varies with the length of practice and subjects.
3. Mental and physical practice combined are probably more effective than either mental or physical practice alone.

Hertz (47) divided subjects into "overt practice," "overt practice-implicit learning," and kinesthetic practice groups. He found that the overt practice-implicit learning group, which practiced physically as well as imagined

physical performance, and the kinesthetic group, which did not actually shoot the ball at the basket but instead shot at a small target, were as successful in shooting baskets as was the overt practice group which actually practiced basket shooting.

Halverson (46) investigated the effectiveness of mental practice on the one hand push shot using sixty college women students as subjects. She found over a period of five weeks which included seven periods, each of which were fifteen minutes in duration, that mental practice was effective but not as effective as physical practice in developing the one hand push shot.

Tufts (49) conducted a study to determine the effects of mental practice and physical practice on bowling scores of college women who were intermediate bowlers. Subjects were divided into two groups on the basis of their bowling average, motor ability, and their verbal test score on the Scholastic Aptitude Test. The physical practice group practiced by bowling one line three nights a week for three weeks while the mental practice group's activity consisted of fifteen minutes of mental rehearsal three nights a week for three weeks. An initial and final performance comparison of group means was made by having each subject bowl five lines before and after her particular practice procedure. Tufts found that mental and physical practice were equally effective in maintaining bowling performance and accuracy.

In a study of the tennis forehand and backhand drives, using seventy-five college women as subjects, Wilson (43) divided subjects, on the basis of the Broer-Miller Tennis Test, into three groups of mental practice, physical practice, and no practice. Each group repeated this test every other day for twelve days, and the physical and mental practice groups participated in their assigned types of practice on the other days while the control group did not participate on these days. Final indications were that there was no significant difference between the final performance of the three groups, although they all improved significantly at the one per cent level of confidence.

Razor (48) reported a study by Stebbins which involved five different groups learning a motor skill of tossing a rubber ball at a target which had various compartments of differing values. The groups were: (a) control group, (b) mental practice group, (c) physical practice group, (d) mental-physical practice group, and (e) physical-mental practice group. Stebbins concluded:

1. In learning a simple hand-eye coordination skill, the greatest amount of improvement is apparently made by using a combination of practice conditions. Both the physical-mental practice group and the mental-physical practice group produced significant improvement over the control group.

2. It appears that as much improvement in skill took place during mental practice as through physical practice, when mental practice preceded physical practice. It would seem,

> therefore, that either method is equally effective during the first half of the skill development period. (48:22)

Jones (30) conducted a study to determine whether subjects without previous experience could learn a gross motor skill without any form of physical practice or demonstration. A secondary purpose was to examine the effects of guided mental practice as compared to non-guided mental practice. He randomly selected seventy-one college men subjects from badminton classes and equated them on the basis of physical fitness. The groups were called directed mental practice and undirected mental practice; each group had six sessions of mental practice, three days each week for two weeks. At each session the undirected mental practice group read three times through the direction sheet which fully explained the execution of a gymnastic high bar stunt. The directed mental practice group listened to the instructor read aloud three times through the instruction sheet. There was no physical practice of the stunt during the experimental period. After the last session, each subject was tested on a pass-fail basis to determine whether they could execute the skill. Seventy-three per cent of the undirected group passed, but only forty per cent of the directed group passed--a difference which was significant at the two per cent level of confidence. Jones concluded that it was possible for subjects without previous experience to learn gross body skills of a gymnastic nature without the benefit of physical

practice or demonstration by reading only a mechanical analysis and by mentally practicing the skill. He also concluded that undirected mental practice was superior to directed mental practice.

Egstrom (22) investigated the effects of varying degrees of emphasis on conceptualizing techniques during the early learning of a new gross motor skill and found that conceptualizing was effective for acquiring and improving gross motor skills, although manual practice appeared more effective. A combination of conceptualizing and manual practice proved to be the most advantageous.

Waterland (50) compared a physical practice group and a mental practice group on a ten-pin bowling skill. The physical practice group was taught according to standard methods of teaching instruction while the mental practice group was taught according to the standard method with an additional emphasis on kinesthetic perception and mental practice before delivering the ball. Waterland found that learning a motor skill was facilitated when this additional emphasis coupled with mental practice preceded each overt performance.

Since thinking is obviously involved in mental practice, Start (40) conducted a study to determine if there was a relationship between intelligence and mental practice of the underhand basketball free throw in terms of initial scores, final scores and the amount of improvement on the

skill. He found a significant improvement at the five per cent level of confidence between the mean initial score and the mean final score of the group after mental practice; however, the improvement was not related to the intelligence of the subjects performing the test.

In a study reported by Richardson (35), Riley and Start equated four groups of girls, fourteen and fifteen years of age, and had them practice quoit throwing for twelve days. There was no improvement in the control group; the most improvement was found in the group which received alternate days of mental practice and physical practice; second in improvement was the group which received six days of physical practice followed by six days of mental practice; and third in improvement was the group which received six days of mental practice followed by six days of physical practice.

In a ring toss experiment, Twining (41) found a thirty-six per cent improvement in the mental practice group and a one hundred thirty-seven per cent improvement in the physical practice group. The mental practice group mentally rehearsed tossing rings for fifteen minutes daily while the physical practice group tossed seventy rings daily for twenty practice days. Twining indicated that, according to introspective comments recorded by subjects during mental practice, mental practice was most effective for only the first five minutes of each practice; beyond this, concentration became increasingly difficult.

Rubin-Rabson (36) studied the effects of mental rehearsal on piano playing and found that physical practice followed by mental practice led to significantly better retention than other practices. The criterion of measurement was one errorless repetition.

Perry (34), a psychologist, investigated the effects of actual and imaginary practice on a series of selected tasks of five practice periods of sixty seconds each. Tasks included: (a) three hole tapping, (b) card sorting, (c) peg board selection and placement, (d) symbol digit substitution, and (d) mirror tracing. He indicated that:

> Despite the small amount of time devoted to practice (300 seconds for each subject on each test) the data show significant gains from initial score to final score for all the tests in the series. This indicates that imaginary practice is effective in improving the score in a variety of tasks. (34:73)

Cratty (3) reported that Sackett found that the greater the amount of imaginary rehearsal, the greater the retention in a finger maze skill.

Smith and Harrison (38) conducted a study comparing the relative effectiveness of visual, motor, mental, guided, reversed visual, and no practice in fine motor skill acquisition of a stylus task. They reported that:

> The control, motor practice, and reversed-visual practice groups significantly improved performance in terms of correct hits and the total number of trials; they did not, however, reduce their number of errors. The visual and mental practice groups reduced their total number of errors and also increased their performance significantly in terms of correct hits

> and total number of trials. It was concluded that visual practice and mental practice improved accuracy on a punchboard learning task, whereas motor practice and guided practice did not. (38:299)

Summary. The reviewed research generally supported the contention that mental practice facilitated the acquisition and improvement of motor skills, although usually physical practice was more effective. Many studies concluded that a combination of mental and physical practice would be better than physical practice or mental practice alone for learning or improving motor skills.

Sit-ups and Abdominal Strengthening

Because of varying opinions about different types of sit-ups used to increase abdominal musculature, it was felt that it was necessary to review recent literature in this area.

Structurally and functionally the abdominal muscles have been well defined. The three major abdominal muscles used in performance of sit-ups are the rectus abdominus, oblique externus, and oblique internus. (39) The iliopsoas plays a role in the sit-ups depending on the position of the subject's legs and the type of assistance involved. (1, 10, 15, 39)

> The rectus abdominus and obliques produce spinal flexion. The iliopsoas produces flexion of the trunk on the thigh or the thigh on the trunk, depending upon which is fixed. Both groups function to control the position of the pelvis as it mediates between trunk and thigh movement. (39:67)

Positioning of the body can influence the participation of the abdominal and the iliopsoas muscle groups. Soderberg (39) reported on experiments done to determine the most effective exercise for increasing abdominal strength. The exercises involved straight and bent knee sit-ups with and without the feet being held down. The straight knee sit-up and the sit-ups with assistance ". . .reduced the capacity of the exercise to distinguish between subjects with weak abdominals and subjects with strong abdominals." (39:68) This was because the iliopsoas aided the abdominal muscles when it was put on stretch, i.e., when the legs were extended, and when the feet were held down. Thus, when the iliopsoas was being used, the work performed by the abdominals was decreased. (1, 39) When the knees were bent and feet not held down, activity was less in the hip flexors and increasingly more in the abdominals.

Soderberg (39), after reviewing literature of experimentation on this subject, concluded that: (1) the hip flexors could be instrumental in performing a full sit-up, especially when the subjects' legs were extended, (2) abdominal strength should not be tested with the entire sit-up maneuver and particularly not with legs straight, and (3) the trunk curl with knees bent and feet flat was far superior to the sit-up movement for testing and strengthening the abdominal muscles.

Wells (15) reported that the partial curl with shoulders just off the floor was found to be as effective for

strengthening the abdominals as the curl sit-up. The partial curl or trunk curl was described as ". . .tucking in the chin and flexing the vertebral column forward until the scapulae are just off the floor." (15:468)

Crowe, et. al. (45), conducted a study involving electromyographic readings of abdominal and hip flexor muscle activity during sit-ups performed with straight and bent leg positions. They found that activity appeared first in the rectus abdominus in both positions and that the hip flexor muscles did not become active until the scapulae were clear of the floor. Contrary to other studies, they found a marked increase in iliopsoas activity when the sit-up was performed with a greater degree of hip flexion.

Broer, in analyzing sit-ups, concluded that "Effort to lift by curling and to hold the upper body a few inches off the floor is probably more effective in abdominal muscle development than the complete sit-up exercise." (1:359)

Broer mechanically analyzed different sit-up positions which vary in degree of difficulty according to force of gravity, length of levers and positions of arms and legs.

> In the well known sit-up exercise the long trunk must be lifted against the force of gravity. Adjustment of the position of the arms and hands varies the degree of difficulty of this exercise because of the change in the distance of the weight from the fulcrum for the movement. When the arms are held forward the center of gravity of the upper body is as close to the fulcrum as possible. Reaching forward with the arms increases the ease of the sit-up since the momentum of the arms is transferred to the trunk and aids the abdominal muscles in overcoming inertia. When the hands are placed on the hips, the center of gravity moves slightly upward from the hips and the arms

> are no longer useful in supplying initial momentum. Therefore, this is somewhat more difficult. Crossing the arms over the chest and placing each hand on the opposite shoulder further lengthens the distance from the hips to the center of gravity of the upper body and increases the difficulty of the lift. The position with the hands placed at the back of the neck is even more difficult as the weight is still further from the fulcrum. In this position there is a tendency for the performer to swing the elbows forward and thus gain momentum which reduces the difficulty of the exercise. Placing the arms straight above the head lengthens the lever to its maximum. Because this makes the exercise so difficult, it is almost impossible to resist the tendency to swing the arms forward, and since the lever is so long, if this is done the momentum that can be developed is considerable, and when this is transferred to the trunk the exercise becomes easier instead of more difficult.
>
> Since the psoas muscles are put on the stretch when one lies on the back with legs straight, they are in an excellent position to assist the abdominal muscles causing the sit-up movement. Bending the legs and placing the feet flat on the floor releases the stretch of this muscle and it can no longer assist the movement to the same degree. For maximum exercise of the abdominal muscles the knees should be well bent and the feet should not be held. (1:358)

In developing strength through an exercise program, authorities (1, 11, 15) agree that each individual should be considered so that he can begin at his own level and progress at his own rate. Broer suggested that in developing the abdominal muscles, the exercises should always be executed with the knees bent and the feet flat on the floor. Then depending on individual strength, ". . .some may need to reach forward with their arms in the beginning. Others may be able to place the hands on the back of the neck and still keep the elbows out to the side. Still others may find other positions necessary." (1:359)

Wells stated that there are two methods of increasing the difficulty of an exercise for developing strength:

(1) increasing the magnitude of resistance

(2) increasing the length of the resistance arm of the anatomic lever involved. (14:482)

She then described a "Trunk Curling Series for Strengthening and Testing the Abdominal Muscles" which began at Step 1 with feet held down, arms reaching toward feet, and progressing in difficulty to Step 13 with feet not held down, holding a 10 pound weight on top of the head.

Summary. The literature generally indicated that abdominal strengthening when performing a full sit-up, could best be accomplished by utilizing a bent-knee position. It was generally concluded, also, that the curl was more effective than the full sit-up. Another definite implication was that to develop any individual's abdominal strength, an exercise program should be designed so that each individual can begin and progress at his own level and rate.

Strength Testing

For the testing procedures of this study, it was felt that it was necessary to review recent literature on practical tests of strength. Special attention was given to the tensiometer in measuring strength.

Among instruments used to assess strength of various muscle groups are the cable tensiometer, Newman myometer, strain gauge devices, and the Kelso Hellebrandt ergograph.

In 1956, Clarke (17) compared the effectiveness of four such instruments for recording muscle strength. Results indicated that the cable tensiometer had greatest precision for strength testing and proved to be the most stable and useful of the four types of instruments.

Meyers and Piscopo (33) conducted a study to determine the reliability of cable tension strength testing as compared to manuometer push apparatus. Cable tension tests had reliability coefficients of .98, .97, and .96 while the manuometer tests had .83, .85, and .91 reliability coefficients. Comparative results indicated that the cable tension method was the more reliable means of measuring push strength, and it was also indicated that this method was more adaptable for use.

In another study conducted by Clarke (20), the cable tensiometer was used to determine the objectivity of measuring the strength of affected muscle groups in orthopedic disabilities. Out of twenty-eight strength tests administered, ". . .22 of the tests had objectivity coefficients of .92 and above; 12 of these were between .95 and .97. Six of the tests had coefficients lower than .90, but no test was below .84." (20:135)

The tensiometer was originally designed to measure the tension of aircraft control cables. It was adapted in 1945 by Clarke and Peterson for use in muscle testing by recording the pounds of force exerted upon a cable as a result of a given muscular action. This instrument involves an application of force to create tension on a cable stretched between

two set points. As the force on the cable increases, the riser on the tensiometer over which the cable passes is depressed. The amount of tension applied is indicated by a maximum pointer, and this tension can be converted into pounds on a calibration chart. In most testing situations two tensiometers are needed--one which registers up to 100 pounds and another which registers up to 400 pounds. "The lower end of the 400-pound instrument is not accurate (below 30 pounds), while the 100-pound instrument does not allow testing of stronger muscle groups." (7:56)

Thirty-eight different muscle groups can now be tested by using the cable tensiometer. Clarke has worked on strength tests, keeping them up-to-date through extensive research involving strength measures, strength relationships, strength decrement fatigue patterns, and effect of gravity on scores. (2, 7, 20)

CHAPTER IV

PROCEDURES

It was the purpose of this study:

(1) to test the hypothesis that abdominal muscular strength could be increased through mental practice;

(2) to determine if any change brought about through mental practice would be as great, greater than, or less than that achieved solely through physical practice;

(3) to determine if any change brought about through a combination of mental and physical practice would be as great, greater than, or less than that achieved solely through physical or mental practice.

Selection of Subjects

Sixty-four high school girls from two Physical Education II classes at Page High School in Greensboro, North Carolina, were selected for this study. The subjects were fifty-six sophomores, five juniors, and three seniors ranging in ages fifteen through eighteen. High school classes were chosen because they met every day at the same hour.

At the time the study was begun, all proposed subjects had returned from a week's vacation; and a recreational sports unit consisting of table tennis, shuffleboard, quoits, horseshoes, and modified handball was started when they returned to school. These specific classes at Page High School were chosen because the particular unit in which these two

classes were to be involved during the time of the study would be a unit which would not include concentrated use of the abdominal muscles and would thus hopefully have little effect on the study.

Selection of a Type of Sit-up

In order to provide a control to assure that all subjects would be able to perform the same type of sit-up, the researcher met with the two classes prior to testing and training to establish a common beginning point in accordance with the majority of students' level and ability.

Broer (1) indicated that in developing the abdominal muscles using the sit-up, individual difference in strength could be accounted for through different types of sit-ups. "All should have the knees bent and the feet flat on the floor." (1:359) Knees are bent in order to decrease the use of the iliopsoas muscle which can no longer assist the abdominal muscles to the same degree as when the legs are extended. With the bent leg position, ". . .adjustment of the arms and hands varies the degree of difficulty of this exercise because of the change in the distance of the weight from the fulcrum for the movement." (1:357)

From Broer's mechanical and muscular analyses, the researcher devised the following steps (beginning with the most difficult) to be used in determining a type of sit-up the majority of students could perform:

Step One - Feet flat, hands behind neck, elbows held out in lateral plane.

Step Two - Feet flat, hands behind neck, elbows held close to head in sagittal plane.

Step Three- Feet flat, arms crossed over the chest, placing each hand on the opposite shoulder.

Step Four - Feet flat, hands placed on hips.

Step Five - Feet flat, arms extended straight above the head, swinging the arms forward for momentum.

For a constant degree of knee flexion, all students were instructed to lie with legs extended and then bend the legs, bringing the feet towards the hips until the soles of the feet were first flat on the floor.

Step One in the series of sit-ups was demonstrated by the researcher; and then as a group, all students were instructed to attempt at least one sit-up of this type. Approximately one-half of the proposed subjects could perform Step One. The same procedure was followed performing Step Two, and all but three subjects were successful at this level. These three subjects continued to be tested until there was a sit-up they could successfully perform. Two performed Step Four and one Step Five. Since the majority of students could perform Step Two, it was established as the type of sit-up to be performed by all subjects during the experiment. The three subjects who could not perform this sit-up were included in the experiment as a part of their class but were statistically eliminated from the study.

All subjects were asked neither to think about nor to perform sit-ups for the duration of the experiment except when instructed to do so.

Selection of a Measuring Device

The aircraft tensiometer, which is manufactured by the Pacific Scientific Company, Los Angeles, California, was used to measure abdominal strength. The cable tensiometer was selected because of its proven reliability and validity in strength testing. Clarke (20:135) obtained objectivity coefficients of .92 and above when using this instrument in strength testing.

In measuring subjects, an army surplus belt was used as an adjustable strap and was fastened around each subject's back just under the arm pits by an interlocking clasp. The belt was pulled tight, centering the clasp in the back between and just below the scapulae. A one-sixteenth inch flexible cable attached to a welded link chain was fastened to the interlocking clasp on the back of the trunk strap. (See Appendix, Figure 3.)

The testing table was especially designed for cable tension testing. The surface of the table is padded; and in the center, ten inches from one end is a seven by twenty inch slit. (See Appendix, Figure 1.) For this test a sturdy hook was secured below the slit to a two-by-four strip in the frame of the testing table. The cable and link chain were

dropped through the slit and attached to the hook. The appropriate link in the chain was selected so that the cable was taut. (See Appendix, Figure 2.)

The tensiometer measured the pulling force on the cable, and as the force on the cable increased, the riser on the tensiometer, over which the cable passed, was depressed. The amount of tension applied was indicated by a maximum pointer, and this tension was converted into pounds on a calibration chart. (See Appendix.)

Measurement and Grouping of Subjects

On the second day, two forty-minute class periods were used to measure all subjects for abdominal strength. The cable tensiometer from the University of North Carolina at Greensboro was used to measure abdominal strength.

An assistant fastened belts on the subjects, and the investigator then measured each subject. The testing position was demonstrated to all subjects at the beginning of the testing period. Each subject was to lie in a supine position with legs extended. She was then instructed to flex her knees, bringing her feet towards her hips until the soles of her feet were first flat on the table. Arms were crossed over the chest, placing the hands on the opposite shoulder. An assistant stabilized the hips. (See Appendix, Figure 4.)

To provide a type of constant motivation for each subject, while a single subject was being tested, the other subjects were stationed around the table and upon a given

signal from the experimenter, they yelled, "Pull". A reading of the tension exerted was recorded and converted into pounds according to the calibration chart. (See Appendix.) These same procedures were followed when the Middle and Final Tests were administered.

From the results of abdominal strength as measured by the cable tensiometer, two groups within each class were statistically equated using Fisher's "t" formula for small uncorrelated groups. Mean strength scores for the four groups were: (1) Mental Practice Group - 80.47; (2) Physical Practice Group - 79.00; (3) Mental-Physical Practice Group - 76.00; and (4) Control Group - 76.17. Fisher's "t" tests were then employed for all four groups, and it was found that all four groups were equated at the one per cent level of confidence. Thus the null hypothesis that there was no difference in the initial strength scores among the groups was accepted, and it could therefore be concluded that the subjects were drawn from a like sample with regard to strength.

There were thirty-nine subjects in the first class and twenty-five subjects in the second class. Nineteen subjects in the first class were placed in the Mental Practice Group and twenty were placed in the Physical Practice Group. The second class was divided into the Mental-Physical Practice Group with thirteen subjects and the Control Group with twelve subjects. The assignment of groups was designed in this manner for various reasons:

1. In order to have a larger number of subjects within an available block of time, two classes were used instead of one. Since these classes met at different times in the school day, each class was divided into two groups.

2. The first class was divided into the Mental Practice Group and the Physical Practice Group so that the researcher could conduct the mental practice in one room while the students' instructor could conduct the physical practice in another room.

3. The second class had fewer subjects; and it was felt that due to possible loss of subjects through absences, the class which included the Control Group should be the one with the smaller number. As a result, the class was divided into the Mental-Physical Practice Group which met in one room with the researcher and the Control Group which met for regular activity with their instructor.

Establishment of a Tolerance Level

A type of sit-up had been determined, and the subjects had been equated in groups. At this point it was necessary to establish a starting level in terms of number of the Step Two sit-ups for each individual in the experimental groups.

On the third day of the experiment, subjects were told which group they were to be in, and the purpose and importance of each group was explained individually to each group. Following this explanation, subjects in the three practice groups correctly performed as many of the Step Two sit-ups as they possibly could, thus establishing a starting or tolerance level. The subjects worked in pairs in counting sit-ups.

Counters were instructed to watch for observable signs of fatigue or incorrect performance of sit-ups. These signs included:

1. Feet coming up off the floor.
2. Broken rhythm.
3. The use of elbows to gain momentum.
4. Shaking or quivering movements.
5. Extreme paleness or redness in the face.

The number of correct sit-ups was recorded for each individual as her starting level number on a card which had been designed for the testing and training period of this study. (See Appendix.)

It was again emphasized that subjects neither perform nor think about performing sit-ups for the duration of the experiment except when instructed to do so.

Training Period

On the Monday following the establishment of tolerance levels, the seventeen practice session period began. Five minutes was established for the length of daily practice sessions. Twining (41), who has conducted much research concerned with mental practice, indicated that mental practice was most effective for only the first five minutes of each practice; beyond this, he stated that concentration became increasingly more difficult. Kelsey (32), conducting a study to determine the effectiveness of mental practice as a

means of increasing endurance in performing sit-ups, held five-minute practices for two groups of mental practice and physical practice.

In this study, the Mental and Physical Practice Groups met simultaneously for five minutes at the end of each class period. The Mental-Physical Practice Group met for five minutes at the beginning of the next class period; thus, all practice sessions were held for the same amount of time and within the same twenty minutes of the day.

It was decided that in cases of absences from school, subjects, if possible, could follow the same practice procedures at the same time of day at home. If, due to illness or any other reason, they missed practice at school or home for two days, they were statistically eliminated from the study. During the experimental period, one subject was dropped from the Physical Practice Group due to a week's illness. There were no other losses due to absence during the training period.

Cards for recording the starting level number and daily increase numbers were provided for the practice groups. (See Appendix.) For a control on numbers in terms of increase, all subjects were instructed to increase the number of sit-ups from their tolerance level by two each day thus utilizing the overload principle. Score cards were used for recording and hopefully motivating purposes in informing each subject where she was and how much she had increased.

Training Programs

Mental Practice Group. This group met with the investigator in a dance room while the Physical Practice Group met with their instructor in the gymnasium. Each individual in the Mental Practice Group mentally practiced her starting level number of sit-ups adding two to the number daily. Scores were recorded on cards daily. Demonstrations, loop films and imagery were used for mental practice. Demonstrations of the specified sit-ups were done by an undergraduate physical education major from the University of North Carolina at Greensboro. Loop films which had been made of a graduate student performing the specified sit-ups were also used during the study. Directions concerning the sit-up movement (see Appendix) were read to and by the subjects in order to aid the subjects in mentally practicing the movement. Different positions (lying down and sitting up) were tried on different days while imagining the sit-ups. Subjects were encouraged to ask questions and were asked questions by the researcher in an attempt to encourage and check active participation in mental practice. The detailed lesson plans appear in the Appendix.

Physical Practice Group. This group met with their instructor in the gymnasium while the Mental Practice Group met with the researcher in a dance room. Each subject performed her starting level number of sit-ups adding two to the number daily and recording the number daily.

Mental-Physical Practice Group. This group met in the dance room with the investigator while the Control Group met for regular activity with their instructor in the gymnasium. Each subject was instructed to divide her tolerance level number in half. These two numbers represented a starting mental practice number and a starting physical practice number. This was done in order to keep the total number and time equal to that of the other practice groups. For the first two and a half minutes of each session, this group followed the same daily lesson plan as the Mental Practice Group, daily adding one to their mental practice tolerance level number. When mental practice was completed by all individuals, all then began performing sit-ups, daily adding one to their physical practice tolerance level number.

Control Group. This group met for regular activity in the gymnasium with their instructor while the other half of their class, the Mental-Physical Practice Group, met in the dance room with the investigator.

Administration of Middle Strength Test

On the eighth day after the training period sessions had begun, a mid test was given. The original strength test utilizing the cable tensiometer, as previously described, was readministered. On the day the mid test was given, one member of the Control Group and three members of the Mental Practice Group were absent.

Administration of Final Strength Test

After the seventeenth day of training had been completed, the original strength test utilizing the cable tensiometer, was readministered. On this day, two members of the Mental Practice Group and one member of the Control Group were absent.

It was decided at the beginning of the study that anyone missing a testing day would be statistically eliminated from the study. During the entire study, eight subjects were dropped, one from absence during practice sessions, four from absence on the mid test day, and three from absence on the final test day. The Fisher's "t" test of significance was calculated between the new means of the reduced groups to determine their equality. New mean strength scores were: (1) Mental Practice - 78.32; (2) Physical Practice - 78.36; (3) Mental-Physical Practice - 76.00; and (4) Control - 75.50. Results continued to indicate no significant difference among the four groups.

CHAPTER V

ANALYSIS AND INTERPRETATION OF DATA

It was the purpose of this study:

(1) to test the hypothesis that muscular strength could be increased through mental practice;

(2) to determine if any change brought about through mental practice would be as great, greater than, or less than that achieved solely through physical practice;

(3) to determine if a change, if any, through a combination of mental and physical practice would be as great, greater than, or less than that achieved solely through physical or mental practice.

The following analysis of data was computed on fifty-six of the sixty-four female high school students who were in Physical Education II classes at Page High School in Greensboro, North Carolina. Seven students were not included in the statistical analysis due to absences during testing sessions, and one student was not included due to illness during practice sessions. Selected subjects were divided into four groups: one control group and three experimental groups. The three experimental groups practiced daily for five minutes with the Physical Practice Group performing sit-ups, the Mental Practice Group thinking about performing sit-ups, and the Mental-Physical Practice Group thinking about and then performing sit-ups. A test of abdominal strength,

as measured by the cable tensiometer, was administered to all groups on the first, ninth, and twentieth days of the experimental phase of this study. All raw data may be located in the Appendix.

Statistical Analysis and Interpretation for Differences among the Four Groups at the Beginning, Middle, and End of the Experiment

Fisher's "t" test of significance for uncorrelated means (13:380) was used to determine if there was a difference among the four groups at the beginning, middle, and end of the experiment. The five per cent level of confidence or below was accepted for statistical significance. The results of the "t" tests for the initial, middle, and final tests may be found in Tables I through III.

The "t" values computed from the administration of the initial test were not statistically significant at the five per cent level of confidence. Thus, it was assumed that there was no difference in the initial strength scores among the groups; the groups were assumed equated with regard to abdominal strength. Therefore, it was concluded that subjects were drawn from a like sample with regard to abdominal strength. The results of this analysis may be found in Table I, page 43.

The researcher was interested in knowing if there was any statistically significant difference among the four groups after seven practice sessions. The "t" values computed from the administration of the middle test were not statistically significant at the five per cent level of

TABLE I

MEANS AND SIGNIFICANCE OF DIFFERENCES AMONG THE CONTROL, MENTAL-PHYSICAL PRACTICE, MENTAL PRACTICE, AND PHYSICAL PRACTICE GROUPS ON THE INITIAL TEST

	N	M	"t"
Control Group	10	75.50	.056
Mental-Physical Practice Group	13	76.00	
Control Group	10	75.50	.338
Mental Practice Group	14	78.36	
Control Group	10	75.50	.371
Physical Practice Group	19	78.32	
Mental-Physical Practice Group	13	76.00	.253
Mental Practice Group	14	78.36	
Mental Physical Practice Group	13	76.00	.298
Physical Practice Group	19	78.32	
Mental Practice Group	14	78.36	.005
Physical Practice Group	19	78.32	

confidence. Thus, it was assumed that there was no significant difference in the middle strength scores among the four groups. The results of this analysis may be found in Table II, page 45. The researcher concluded that seven days of mental practice, physical practice, or a combination of mental and physical practice was not sufficient time to increase abdominal strength. Researchers (6,45) concerned with the development of strength through physical practice or training have conducted studies for at least three to six weeks in length, thus indicating that this is the minimal amount of time expected for statistically significant strength development.

The "t" values computed from the administration of the final test showed significant differences between the Control and Physical Practice Groups and between the Mental Practice and Physical Practice Groups. The greatest difference, statistically significant at the one per cent level of confidence, was found between the Control Group with a mean of 72.40 and the Physical Practice Group with a mean of 92.32. The difference existing between the Mental Practice Group with a mean of 73.64 and the Physical Practice Group with a mean of 92.32 was statistically significant at the two per cent level of confidence. The superiority of the Physical Practice Group can be attributed to the overload principle:

> . . .only an increase in intensity of work beyond that previously demanded of a muscle is the stimulus for an increase in muscular strength. (6:23)

TABLE II

MEANS AND SIGNIFICANCE OF DIFFERENCES AMONG THE CONTROL, MENTAL-PHYSICAL PRACTICE, MENTAL PRACTICE, AND PHYSICAL PRACTICE GROUPS ON THE MIDDLE TEST

	N	M	"t"
Control Group	10	71.30	.265
Mental-Physical Practice Group	13	69.08	
Control Group	10	71.30	.247
Mental Practice Group	14	73.43	
Control Group	10	71.30	.850
Physical Practice Group	19	77.89	
Mental-Physical Practice Group	13	69.08	.536
Mental Practice Group	14	73.43	
Mental-Physical Practice Group	13	69.08	1.210
Physical Practice Group	19	77.89	
Mental Practice Group	14	73.43	.614
Physical Practice Group	19	77.89	

> The intensity of the work required of a muscle must be increased over and beyond that to which it is currently accustomed for no matter how much a muscle is used it will not grow larger or stronger until it is overloaded. (12:85)

The ineffectiveness of the Mental Practice Group may be attributed to the lack of overload placed upon the muscles. Although a relationship has been shown to exist between mental processes and muscular activity (24, 25, 29, 30, 37), it appeared that in this particular study, this relationship was not strong enough to cause overload and thus to increase strength. The other between group comparisons did not indicate a statistically significant difference between mean scores. The results of these analyses may be found in Table III, page 47.

Statistical Analysis and Interpretation for Differences within the Four Groups between Initial and Middle, Initial and Final, and Middle and Final Scores

To test the significance of difference between initial and middle, initial and final, and middle and final scores within each group, Fisher's "t" test for correlated means (13:383) was used. The five per cent level of confidence or below was accepted for statistical significance. The results of these "t" tests for the four groups may be found in Table IV, page 48.

The "t" values computed between the initial and middle cable tensiometer tests of strength showed a statistically significant decrease at the one per cent level of confidence in strength in the Mental-Physical Practice Group. The

TABLE III

MEANS AND SIGNIFICANCE OF DIFFERENCES AMONG THE CONTROL, MENTAL-PHYSICAL PRACTICE, MENTAL PRACTICE, AND PHYSICAL PRACTICE GROUPS ON THE FINAL TEST

	N	M	"t"
Control Group	10	72.40	1.51
Mental-Physical Practice Group	13	85.15	
Control Group	10	72.40	.152
Mental Practice Group	14	73.64	
Control Group	10	72.40	2.917 ***
Physical Practice Group	19	92.32	
Mental-Physical Practice Group	13	85.15	1.349
Mental Practice Group	14	92.32	
Mental-Physical Practice Group	13	85.15	1.000
Physical Practice Group	19	92.32	
Mental Practice Group	14	73.64	2.719 **
Physical Practice Group	19	92.32	

**Significant at .02 level of confidence
***Significant at .01 level of confidence

TABLE IV

SIGNIFICANCE OF DIFFERENCE BETWEEN THE MEAN DIFFERENCES FOR INITIAL AND MIDDLE TESTS

GROUPS	N	Md	"t"	
Control	10	-4.20	-1.428	
Mental-Physical Practice	13	-6.92	-3.174	***
Mental Practice	14	-4.93	-1.162	
Physical Practice	19	- .42	- .182	

SIGNIFICANCE OF DIFFERENCE BETWEEN THE MEAN DIFFERENCES FOR INITIAL AND FINAL TESTS

GROUPS	N	Md	"t"	
Control	10	-3.30	-1.527	
Mental-Physical Practice	13	9.15	2.980	**
Mental Practice	14	-4.71	-1.236	
Physical Practice	19	14.00	4.795	***

SIGNIFICANCE OF DIFFERENCE BETWEEN THE MEAN DIFFERENCES FOR MIDDLE AND FINAL TESTS

GROUPS	N	Md	"t"	
Control	10	1.10	.278	
Mental-Physical Practice	13	16.08	3.865	***
Mental Practice	14	.21	.094	
Physical Practice	19	14.42	7.210	***

**Significant at .02 level of confidence
***Significant at .01 level of confidence

researcher has no explanation for this finding other than that the results may be particular to this sample of subjects. It may be noted, however, that Clarke (2), in conducting a study to investigate the conditioning effects from ergographic exercises of the elbow flexor muscles, also found a decrease in strength at the beginning of the study. "During the first week of the study, elbow flexion strength means dropped slightly." (2:85) This decrease in strength was not statistically significant, and no reason was given in attempt to explain the decrease. No statistical significance was found within the initial and middle mean strength scores of the other three groups. This is tenable in that the administration of the middle test took place after only seven days of practice, and it is assumed that this length of time is generally insufficient to develop an increase in strength when physically practicing or training; in view of this, the researcher concluded that it would therefore be even less tenable for the Mental Practice Group to increase in strength after this short period of time. The statistical results of this analysis may be found in Table IV, page 48.

The "t" values computed between the initial and final cable tensiometer tests of strength, which can be found in Table IV, showed a statistically significant increase in strength at the two per cent level of confidence in the Mental-Physical Practice Group and at the one per cent level of confidence in the Physical Practice Group with "t" values

of 2.98 and 4.795 respectively. Thus, both groups improved significantly from the beginning to the end of the experiment, the Physical Practice Group improving more and at a more acute level of statistical significance than the Mental-Physical Practice Group. The increase in strength can be attributed to the daily overload placed upon the abdominal muscles through physical practice. The Control and Mental Practice Groups showed no significant increase or decrease in strength. Thus, if contractions were occurring in the abdominal muscles through mental practice, they were minimal and of no measurable effect. As indicated, the Physical Practice Group improved more than the Mental-Physical Practice Group from the beginning to the end of the experiment; and the Mental Practice Group showed no statistically significant improvement from the beginning to the end of the experiment. In view of this, it may be assumed that the increase in strength shown by the Mental-Physical Practice Group may be attributed to the physical part of the mental-physical practice sessions.

The "t" values computed between the middle and final cable tensiometer tests of strength, which may be found in Table IV, showed a statistically significant increase in strength at the one per cent level of confidence in the Mental-Physical Practice and Physical Practice Groups with "t" values of 3.865 and 7.210 respectively. Thus, both groups improved significantly from the middle to the end of the experiment with the Physical Practice Group improving more than the Mental-Physical Practice Group as indicated by

its higher "t" score. The Control and Mental Practice Groups showed no statistically significant increase in strength. It can be assumed that the increase in strength in the Physical Practice and Mental-Physical Practice Groups can be attributed to the daily overload placed upon the abdominal muscles through physical practice as explained in the preceding paragraph. As in the initial-final score of the Mental Practice Group, results in the middle-final score of this group led the researcher to assume that if contractions were occurring in the abdominal muscles through mental practice, they were minimal and of no measurable effect.

Summary

The researcher concluded that physical practice was effective in increasing abdominal strength and that mental practice was ineffective in increasing abdominal strength. Mental-physical practice proved effective in increasing abdominal strength but not as effective in terms of mean increase as physical practice, and the researcher conjected that the strength increases could be attributed to the physical part of the mental-physical practice sessions.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the relative effects of three different practice methods on increasing abdominal strength as measured by the cable tensiometer. The three practice methods used were physical practice, mental practice, and a combination of physical and mental practice.

The subjects were fifty-six female high school students from two Physical Education II classes at Page High School in Greensboro, North Carolina. These two classes were each divided into two groups, with the Mental Practice and Physical Practice Groups in the first class, and the Mental-Physical Practice and Control Groups in the second class. The three experimental groups met daily for five minutes for a total of seventeen days during a four week period.

In order to determine if the various practice methods were effective as a means of increasing abdominal strength, all groups wer tested for abdominal strength as measured by the cable tensiometer on the first, ninth, and twentieth days of the experimental phase of this study.

Data were treated statistically (1) to determine any differences between the initial and middle, initial and final, and middle and final scores among the four groups, and (2) to

determine differences within the four groups at the beginning, middle, and end of the experiment. The following results were obtained:

1. There were no differences among the four groups at the beginning or at the middle of the experiment.
2. From the administration of the final test, statistically significant differences were found between the Control and Physical Practice Groups and between the Mental Practice and Physical Practice Groups. No other comparisons between groups were statistically significant.
3. A significant decrease in strength was found from the beginning to the middle of the experiment in the Mental-Physical Practice Group. No other significant differences were found within the other three groups from the beginning to the middle of the experiment.
4. A statistically significant increase in strength was found both from the beginning to the end and from the middle to the end of the experiment in the Mental-Physical Practice Group and the Physical Practice Group. The Control and Mental Practice Groups showed no significant increase

in strength from the beginning to the end or the middle to the end of the experiment.

The findings of the present study resulted in the following conclusions:

1. Seven practice sessions of physical practice, mental practice, and mental-physical practice proved ineffective in increasing abdominal strength.
2. Seventeen practice sessions of physical practice were effective in increasing abdominal strength.
3. Seventeen practice sessions of mental practice were ineffective in increasing abdominal strength.
4. Seventeen practice sessions of mental-physical practice were effective in increasing abdominal strength but not as effective as physical practice. It was conjected that the effectiveness of the combination of mental and physical practice appeared to be the result of the physical practice phase of the practice sessions.

Recommendations

It is suggested that further studies in this area be concerned with the following recommendations:

1. The study could be conducted over a longer period of time.

2. Daily motivation should be operationally controlled.
3. The study should involve more subjects and could be conducted with male subjects as well as female subjects.
4. If female subjects are used, the study could be structured to include data regarding the menstrual cycle in order to ascertain its effect, if any, on any changes noted.
5. The study could involve parts of the body other than the trunk.

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APPENDIX

SCORE CARD (FRONT)

NAME_____ GROUP_____

BIRTH DATE_____ DATE OF LAST MENSES_____

INITIAL TEST _____ _____

MID TEST _____ _____

FINAL TEST _____ _____

SCORE CARD (BACK)

NAME_____ GROUP_____

INSTRUCTIONS: Daily report the number of correct sit-ups you perform

STARTING LEVEL _____

DAY	NUMBER	DAY	NUMBER
1		10	
2		11	
3		12	
4		13	
5		14	
6		15	
7		16	
8		17	
9			

LESSON PLANS FOR MENTAL PRACTICE AND MENTAL-PHYSICAL PRACTICE GROUPS

Practice Number 1

Materials. Daily score cards, pencils, one assistant to act as demonstrator.

Instructions. I would like to introduce Miss _____, who is going to demonstrate for us today. (Demonstrator lies down.) The first day I came to your class, we talked about different types of sit-ups and how and why some are more difficult than others. We then decided one type of sit-up that all of you would think about performing during this study. Miss _____ will demonstrate this sit-up today. Before she begins, who can tell her what position her feet and legs should be in? Where should her hands and arms be? How far should she come up? (Demonstrator performs three sit-ups while researcher counts - up and one, up and two, up and three.) Now I want all of you to lie down in this position, close your eyes, and mentally picture yourself performing this type of sit-up. When you are finished performing your number of sit-ups, open your eyes, and sit quietly until you see that all of the class is finished. It is important that you relax immediately when you are done. When everyone is finished, record your number on your score card. (Mental Practice Group performs starting level number plus two; Mental-Physical Practice Group performs one-half of the starting level number plus one. Results are recorded daily.)

Practice Number 2

Materials. Daily score cards, pencils, mimeographed sheets of mental practice directions. (Refer to last page of lesson plans.)

Instructions. Today, I want you to read this mimeographed sheet as I read it to you. Then read it once again to yourself.

(Read.) Now lie down in the same position you did yesterday, close your eyes, and try to imagine and feel yourself performing these sit-ups. When you are through, open your eyes and sit quietly until you see that all of your class is done. (Mental Practice Group performs two additional sit-ups daily; Mental-Physical Practice Group one daily. Results are recorded daily.)

Practice Number 3

Materials. Daily score cards, and pencils.

Instructions. Monday you saw a demonstrator, and yesterday you read the mimeographed sheets, so I think you have the specific sit-up movement well established in your minds. Today I want you to lie in the same position, close your eyes, and perform the number of sit-ups you are supposed to do. When you are finished open your eyes and sit quietly. Record the number you mentally performed when everyone is finished.

Practice Number 4

Materials. Daily score cards, and pencils.

Instructions. Today for mental practice we are going to try a new position. I want you simply to remain in a sitting position; and with your eyes closed, imagine yourself going through the sit-ups, performing your designated number. When you are finished open your eyes and sit quietly. Record the number you mentally performed when everyone is finished.

Practice Number 5

Materials. Daily score cards, pencils, and paper.

Instructions. We are going to try the sitting up position with eyes closed again; however, today each time you complete a sit-up, you are to raise your hand. Perform your designated number, and record it when everyone is finished.

After results are recorded:

Today I would like to answer any questions you have, and I would like to ask some questions of you which will help me in conducting the remainder of this study. On the paper that I have handed to you, please answer the following questions: (1) Have you imagined yourself doing sit-ups every day at this time this week? (2) Have you had any trouble imagining yourself doing these sit-ups? (3) Which method or combination of methods of practice that we have done this week has helped you concentrate the most? Demonstration? Reading mimeographed sheets? Lying and imagining? Sitting and imagining? Sitting, imagining, and raising hands?

Practice Number 6

Materials. Daily score cards, pencils, loop film of specified sit-ups, and projector.

Instructions. Today on this loop film Miss _____ is going to demonstrate the sit-up for us. We can stop the projector at any place for questions or to point out body positions, etc. (Start projector.) Notice her feet; do they stay down the whole time? Notice the position of her arms and legs. Remember that because her legs are bent instead of out straight, she cannot use her leg muscles to help her up; instead she must use her abdominal muscles. Watch how she performs the sit-up -- up and one, up and two, up and three. (Stop projector.) Since the majority of you indicated last Friday that it was easiest to imagine doing these sit-ups in a lying down position with your eyes closed, we will go back to that method. Now that you have watched the film and again have the picture in your mind, I want you to lie down, close your eyes, and mentally practice your own number of sit-ups. Open your eyes and relax when you are finished, and when everyone is done record your results.

Practice Number 7

Materials. Daily score cards, pencils, mimeographed sheets.

Instructions. Same as Practice Number 2.

Practice Number 8

Materials. Daily score cards, and pencils.

Instructions. Same as Practice Number 3.

Practice Number 9

Materials. Daily score cards, loop film of specified sit-ups, and projector.

Instructions. Same as Practice Number 6.

Practice Numbers 10 through 17

Materials. Daily score cards, and pencils.

Instructions. Same as Practice Number 3.

DIRECTIONS ON MIMEOGRAPHED SHEETS FOR MENTAL PRACTICE SESSIONS TWO AND SEVEN

You have shown that you can do one or more of the designated sit-ups. As you read these directions, I want you first to see the complete movement of the sit-up in your mind.

1. Lie flat on your back with your legs straight.
2. With your feet remaining on the floor, slide them towards your hips -- so that your legs are bent at the knee, and your feet are flat on the floor.
3. Clasp your hands behind your neck, leaving your elbows close to your head.
4. From this position (bent knees and clasped hands), tuck your chin to your chest, and pull yourself up until your elbows touch your knees.
5. Let yourself down until your clasped hands touch the floor.

Now, read the directions again, and imagine <u>yourself</u> going through the sit-up. When you have done just this much look up, and wait for further directions.

TABLE V

CALIBRATION CHART FOR CABLE TENSIOMETER

Instrument Reading	Tension Pounds	Instrument Reading	Tension Pounds
2	5	36	57
3	6	37	58
4	7	38	60
5	8	39	61
6	10	40	62
7	12	41	64
8	15	42	65
9	16	43	67
10	17	44	70
11	18	45	72
12	20	46	75
13	21	47	77
14	22	48	78
15	23	49	80
16	25	50	82
17	26	51	83
18	27	52	85
19	28	53	88
20	30	54	90
21	32	55	92
22	33	56	93
23	35	57	95
24	36	58	97
25	37	59	100
26	39	60	101
27	40	61	102
28	41	62	104
29	43	63	105
30	45	64	106
31	47	65	108
32	48	66	110
33	50	67	112
34	52	68	115
35	55	69	117
		70	120

FIGURE 1

TESTING APPARATUS, INCLUDING TABLE, STRAP, CABLE, AND CHAIN

FIGURE 2

POSITION OF TENSIOMETER FOR ABDOMINAL STRENGTH TEST

FIGURE 1

TESTING APPARATUS, INCLUDING TABLE, STRAP, CABLE, AND CHAIN

FIGURE 2

POSITION OF TENSIOMETER FOR ABDOMINAL STRENGTH TEST

FIGURE 3

STRAP POSITION FOR ABDOMINAL STRENGTH TEST

FIGURE 4

POSITION OF SUBJECT AND ASSISTANT DURING
ABDOMINAL STRENGTH TEST

FIGURE 3

STRAP POSITION FOR ABDOMINAL STRENGTH TEST

FIGURE 4

POSITION OF SUBJECT AND ASSISTANT DURING ABDOMINAL STRENGTH TEST

TABLE VI

RAW DATA CHART

INITIAL, MIDDLE, AND FINAL ABDOMINAL STRENGTH SCORES

Subject	GROUPS											
	Control			M.P.			M-P.P.			P.P.		
	I	M	F	I	M	F	I	M	F	I	M	F
1	52	57	52	36	52	52	93	90	100	70	70	88
2	60	61	64	101	101	120	78	64	101	70	65	82
3	80	77	82	85	115	104	97	78	112	47	57	62
4	60	40	57	70	60	62	62	57	62	65	60	80
5	95	78	97	62	62	52	48	43	61	41	47	62
6	80	70	72	75	57	60	93	90	100	72	61	92
7	100	95	97	64	61	62	78	60	108	67	58	85
8	67	62	57	70	57	57	60	65	75	65	100	120
9	61	65	64	67	52	57	39	39	57	82	72	92
10	100	108	82	115	101	95	120	110	112	77	72	88
11				93	65	78	97	80	95	88	85	97
12				67	82	75	65	65	62	100	97	120
13				75	62	60	58	57	62	85	78	95
14				117	101	97				117	117	120
15										78	77	75
16										106	104	108
17										57	57	72
18										93	97	106
19										108	106	110