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A Comparison of Resistance Training Techniques and their Effect on the Running Speed of College Football Players

Josiah H. Bartlett

A COMPARISON OF RESISTANCE TRAINING TECHNIQUES AND THEIR EFFECT ON THE RUNNING SPEED OF COLLEGE FOOTBALL PLAYERS.

by

Josiah H. Bartlett

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This Thesis submitted by Josiah H. Bartlett in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

W.C. Koenig
(Chairman)

John L. Quadoy

Richard D. Landry

A William Johnson
Dean of the Graduate School

Permission

Title A Comparison of Resistance Training Techniques and Their effect on the Running Speed of College Football Players.

Department Health, Physical Education, and Recreation

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ABSTRACT

A COMPARISON OF RESISTANCE TRAINING TECHNIQUES AND THEIR EFFECT ON THE RUNNING SPEED OF COLLEGE FOOTBALL PLAYERS.

Josiah H. Bartlett, Master of Science

This study was undertaken to determine which of the three most popular methods of resistance training, when used as a supplement to football practice, would have the greatest effect on increasing the running speed of the college football player.

Forty-two freshman and sophomore football players at the University of Minnesota Technical College - Crookston served as subjects. The subjects were divided into three experimental groups. Experimental Group I participated in football practice and isotonic resistance training, Experimental Group II participated in football practice and isometric resistance training, and Experimental Group III participated in football practice and resistance running training.

Each group was tested prior to, and at the end of, an eight week training program. The test was a 40-yard dash, run from a three point starting position.

The significance of difference between the pre and post-test means within each group was tested by the t technique for correlated scores for small samples. Comparisons were made between groups to establish whether there was any significant difference. For this purpose the post test means of the three groups were tested by the one-way analysis of covariance and expressed as an F ratio. Rejection of the null hypothesis was assumed at the .01 level.

The conclusions drawn from this study were:

1. Experimental Groups I and III made significant improvement at the .01 level in running speed during the experimental period as measured by the 40-yard dash,

2. the football team as a whole made a significant improvement in running speed at the .01 level,

3. the one-way analysis of covariance between the groups failed to show a significant difference between the improvements in running speed that each experimental group made.

CHAPTER I

INTRODUCTION

Most research done on the improvement of running speed has been conducted in the sport of track and field. This is understandably so because speed is the only criterion upon which a performer is judged in the shorter races, and a very important ingredient in the longer distances.

Running speed is also a very important aspect of other sports and is becoming increasingly more so. Football has undergone vast changes since its inception. In its early history, the era of the single wing and the absense of the forward pass, football was a game of power with considerably less options available to the offense. When the rules of football began to change, one of the biggest innovations was the advent of the forward pass. This increased the options available to the offense and opened the game to a wider diversification of talents. This is not to say that speed was unimportant in the early history of football, but rather that its importance has increased significantly as football has evolved into the game it is today.

Probably the best example of the importance of speed and quickness in football was the success of the football program at the University of Alabama in the early nineteen-sixties under Paul "Bear" Bryant. His teams were often outweighed by fifteen or twenty pounds per man but won because of superior speed. Bryant was the first to build a football program around speed and quickness and win national championships.

Today's football players are becoming bigger and faster each

year. Team weights are going up while mean dash times are coming down, indicating that the bigger and faster a team can become, the more effective it will be. To be successful, college teams must not only recruit bigger and faster athletes, but they also must implement programs that will improve the players in these two important categories.

Statement of the problem

The problem of this study was to determine a method of resistance training which, when used as a supplement to football practice, would increase the running speed of the college football player.

Need for the Study

Almost every college football team has, along with regular practice, its own unique training system as a supplement to develope muscular strength and endurance. The more important objectives of this training would be the increase of strength, explosive power and running speed of the players.

This writer feels that, because there are so many different methods being employed by football coaches with respect to supplementary training, there is a need for further investigation that might lead to determining a best method, or possibly eliminating an ineffective method of supplementary training.

This study represents an effort on the part of the writer to contribute additional data and findings to aid the football coach in directing a successful football program, especially in the area of supplementary training.

Purpose of the Study

The purpose of this study was to determine if any of the three

most popular resistance training programs would have an effect on the speed performance of football players in running the 40-yard dash.

Delimitations of the Study

This study was limited to:

1. young men between the ages of 18 and 21 who were members of the 1973 University of Minnesota-Crookston football team,
2. training of 14 subjects in each of three experimental groups,
3. a training period of five days a week for eight weeks,
4. running speed as determined by use of the 40-yard dash,
5. the data secured from pre and post tests.

Definition of Terms

Throughout this study the terms exergenie, isometric contraction exercises, isotonic contraction exercises, mean, resistance running, resistance training, running harness, subjects, supplementary training, weight machine and the abbreviation RM were used. In order for a more complete understanding of the material presented, these terms should be clarified as to their use in this study.

Exergenie - An exercising device first developed by Physical Fitness Inc.. This instrument permits isometric and isotonic exercising with a controllable resistance which results from the friction of the movement of a nylon line winding around a steel shaft.

Isometric contraction exercise - A type of exercise during which muscular contraction is exerted against an immovable resistance resulting in no change in muscular length.

Isotonic contraction exercise - A type of exercise during which muscular contraction is exerted against a movable resistance which

involves a change in muscular length, either shortening or lengthening.

Mean - is best defined as the sum of all the scores divided by the total number of scores.

Resistance running - is best defined as running against additional external resistance which would not have to be overcome in the normal running situation.

Resistance training - is best defined as performing muscular contractions against resistances higher than those that would be imposed by gravity alone.

Running harness - a heavy duty cotton strapping which is worn around the thorax and is attached to a rope and some type of resistance device for the purpose of performing resistance running.

Subjects - refers to all the University of Minnesota-Crookston football players who participated in the training for this study.

Supplementary training - is best defined as any training or drill which is not directly involved in the improvement of a skill to be used in that sport.

Weight machine - sometimes referred to as a Universal Gym, is an all-inclusive machine which has graduated weights, benches and bars and works on the principles of levers and pulleys, on which as many as fifteen individuals can exercise, in a rotation, all of the major muscle groups of the body.

RM - an abbreviation which indicates a maximum number of repetitions that can be performed without resting by an individual.

REVIEW OF LITERATURE

The improvement of running speed has been the concern of man since his inception on earth. Early man's survival depended a great deal upon his strength and speed. Running and jumping as forms of competitive sport are as old as the recorded history of mankind. However, it has only been since the beginning of the modern Olympics that accurate records have been kept regarding the running speed of man.

Man's improvement in running speed can be shown by the simple comparison of the winning times of the Olympic 100-meter dash and in the United States by comparison of the best high school 100-yard dash times. The winning time in the Olympic 100-meter dash in 1896 was 12.0 seconds. From 1900 to 1930 it was lowered and remained about 10.8 seconds. From 1932 to 1960 the record was lowered to 10.3. In 1960, Armin Hary ran a 10.2, and this time was subsequently lowered by Hayes in 1964 to 10.0 and Hines in 1968 to 9.9 seconds.

McCullough(1) researched the best high school dash times and found:

> The fastest 100-yard dash run in 1946 was timed at 9.7 seconds, with four boys running 9.8 seconds and five being timed in 9.9 seconds. The great improvement in the times for 1963 showed the fastest time as 9.4, with four boys running 9.5 seconds and 7 boys running at 9.6 seconds.

There are many factors which are responsible for the improvement of running speed in humans. Some of these factors are improvement of facilities, equipment, coaching, competition, diet, average size of the population, increased research and improved training methods. It has been well established through scientific investigation that running

speed can be improved through training.

John Jesse(2) stated, "Because strength contributes significantly to an increase in velocity(speed) coaches and physiologists emphasize its development as the easiest and most positive manner of increasing power and speed."

Jensen(3) stated, "Strength is a factor in running speed because great force is required to accelerate the body and keep it in rapid motion. There is no doubt that lack of sufficient strength is a serious handicap to many would-be athletes."

George B. Dintiman(4), Chairman of Health and Physical Education at Virginia Commonwealth University, and one of the leading authorities on running speed has stated:

> It has become apparent that the strength of the muscles involved in the sprinting action determine, to some extent, the maximum running speed of an individual. Strength is essential to sprinting in 1) the leg drive against the track: it is the strength of the muscles in the hip, knee, and foot and the ability to straighten these areas quickly that decides a large part of the sprinters speed, 2) the drive from the starting blocks, 3) the attainment and maintenance of a long stride, 4) acceleration to maximum speed, 5) the powerful leg drive, and 6) maximum speed during the coasting phase. One cannot hope to achieve success in sprint running without the muscular strength necessary to move the legs with speed.

Clarke(5) lent support to the importance of strength:

> Speed also depends upon strength. This is merely another way of saying that a strong man can lift more than a weak one, or that the strength of a motor limits the speed of an automobile... Other things being equal, the stronger the individual, the faster he can run.

Morehouse and Miller(6) pointed out that the importance of strength in accelerating the limbs at high speeds is well recognized and determines to a large extent, the speed of running. Carnes(7) stated: "By increasing his leg power, a boy can increase his speed. The fact that practically all champion sprinters use weight training as a means of improving

sprinting performance is strong argument for the importance of strength."

The improvement of running speed is regulated by a number of factors, some subject to change and others unalterable. Unalterable, inherent factors such as length of levers, general somatotype, overall body size, and a physiological tendency to possess great speed (intrinsic speed of muscle contraction) probably determine ultimate speed capacity. Dintiman(4) explained this variation of intrinsic speed of muscle contraction when he wrote:

> Muscles differ in ability to contract at a high rate of speed with the postural muscles relatively slow and the flexor muscles fast. The properties of skeletal muscle, which vary from individual to individual, place some limitations upon maximum speed potential. The amount of sarcoplasma is more abundant in some muscle fibers and contains pigment granules giving it a reddish appearance (red muscle) while in others it is less abundant and muscle fibers are rather pale (white muscle). In many individuals both types of fibers are evident in every muscle. The white contract faster than the red counterparts which do possess greater capacity for endurance. In individuals where the white fibers predominate, greater speed of contraction is possible. When the red fibers dominate, less speed is possible. Thus, maximum speed potential will vary from one individual to another.

Thomas Vaughan(8) in his book, Science and Sport, stated this about running speed. "So much of the element of speed is due to hereditary factors such as speed of nervous impulse, somatotype, body levers, etc., which cannot be easily altered in any individual." Vaughan went on to state that speed can be improved by 1) improving power to weight ratio, 2) developing mechanical advantage techniques, 3) training the central processing mechanism of the stimulus response component, 4) maximizing the awareness signal (keen senses, strength of signal), 5) increasing preparatory tension before movement, and 6) decreasing resistance to movement (fat, joint stiffness).

It can be concluded that each individual has a number of hereditary factors which will place a limit on his speed potential. However, it is

also true that the majority of athletes have not attained their maximum speed potential. Most researchers agree that running speed can only be improved through 1) increasing stride length, 2) increasing starting ability and accelerating to maximum speed, 3) increasing the rate and efficiency of leg movements per second, and 4) increasing the conditioning level to allow one to maintain maximum speed over extended distances.

This writer was concerned with the comparison of three supplementary resistance programs and their effect on running speed. Because of this concern the remaining review of literature was limited to studies involving strength training and its effect on running speed. The review was separated into three parts: isotonic training, isometric training, and resistance running training.

Other factors which are important to the improvement of running speed were taken into consideration, but were not directly involved with the purpose of this study. They include flexibility, psychology, form, reaction time, movement time, agility and sprint training. These factors were kept constant during the training period in that all subjects participated in identical flexibility, reaction and movement, psychological, form and sprint training programs during football practice. Some agility drills and the amount of running varied during practice sessions according to a player's position. These programs are explained in greater detail in Chapter IV.

There have been many studies conducted involving various aspects of strength development and its relationship to diversified areas of athletic performance, but only a few studies involving the comparison of strength training programs and their effect on running speed.

Isotonic Training

Chui(9) conducted a study to determine the effects of systematic

weight training on power as related to jumping, the shot put and the sixty yard dash. Increases in running speed were only slight. Chui concluded from his study that there was a probability of increasing speed through a systematic weight training program.

In a study by Masley(10) to determine whether increased strength gained through weight training was accompanied by increased speed of movement, the following conclusions were drawn:

1. The weight training group showed a greater increase in speed and co-ordination.

2. The amount of strength gained through weight training had a close relationship with the increase in speed and co-ordination.

Vanyo(11) conducted a study to determine what effect a systematic weight training program involving the arms and shoulders of junior high boys would have on their performance in running the sixty yard dash. At the end of a sixty day training period, he concluded that the weight training group showed a greater improvement in running speed than the non-weight training group although both were significant at the .01 level. However, the difference between the improvement made by the weight training group and that of the non-weight training group was statistically non-significant at the .01 level.

O'Shea(12) conducted a study using an eight week training program of heavy resistance and low repetitions(4-5) to increase dynamic strength and to determine its effect on the 400-meter run. For purposes of comparison he included two other training groups of (9-10) repetitions and (14-15) repetitions. All three groups trained using four sets of exercises involving the bench press, seated dumbbell curl and squat. O'Shea found that all three groups improved significantly in strength

and speed as measured by the 400-meter dash(4.4 seconds mean improvement). He concluded by stating that any of these methods of progressive weight training of large muscle groups can be effective in lowering the times in the 400-meter dash.

Fishbain(13) placed twelve students each into experimental and control groups in an attempt to determine the effect of weight training upon performance in the 35-yard dash, standing broad jump and rope climb. The experimental group participated in a nine week weight training program while the control group attended regular physical education classes. The results showed that the experimental group improved significantly more than the control group in the 35-yard dash and the standing broad jump.

Dintiman(14), in research done for his doctoral dissertation in 1964, conducted one of the few studies that considered strength and flexibility training as supplements to actual sprint training. One-hundred and forty-five subjects were randomly assigned to one of five training groups for an eight week period. The groups were listed as 1) flexibility and sprint training, 2) weight training and sprint training, 3) flexibility, weight training and sprint training, 4) sprint training, and 5) inactive. The study was undertaken to determine whether a flexibility training program, a weight training program and the combination of both training programs would affect running speed when used as a supplement to conventional sprint training methods. All one-hundred and forty-five subjects were tested for running speed as measured by the 50-yard dash with a running start, body flexibility as measured by the Cureton Flexibility Test, and leg strength as measured by the leg dynamometer with the use of the belt. Upon completion of

the eight week training period each subject was retested in the same areas. The two groups which participated in flexibility training increased significantly in each of four flexibility measures. All groups, except the inactive, increased significantly in leg strength and running speed. Dintiman used the Newman-Keuls Multiple Range Test to compare all the possible combinations and listed these major conclusions:

1. The flexibility training program, used as a supplement to sprint training, did not improve sprinting speed significantly more than did the sprint training alone.

2. The weight training program, used as a supplement to sprint training, did not increase sprinting speed significantly more than did the sprint training program; however, a difference in adjusted means of only 0.01 of a second prevented significance at the .05 level.

3. The use of both flexibility and weight training, as supplements to sprint training, increased sprinting speed significantly more than did the sprint training program alone.

Kusinitz(15) also examined the effects of a supplementary weight training program on running speed as measured by the 50-yard dash, 60-yard dash and 300-yard shuttle run. A control group participated in a daily running program five times weekly. An experimental group combined the same running program with a progressive weight training program comprised of three workouts a week. It was concluded that weight training and running is more effective in improving both strength and running speed than running alone. The amount of speed changes due to progressive weight training and running were not significantly related to the amount of changes in strength.

Dintiman(16), in 1965, attempted to correlate an increase in hip

and ankle flexibility with an increase in running speed as measured by the 50-yard dash with a running start. His results were not statistically significant.

Kruczalak(17), in an article on strength training for sprinters, stated that overall strength and innate speed of muscle movement are not significantly related. Emphasis should be placed on movements that simulate sprinting (weight training, body weights, hill running, jumping and moving quickly). Increased power was most effective when a minimum amount of muscle mass was produced. Weight training with twenty percent of maximum strength and 8 to 15 repetitions performed with rapid, forceful contractions was advocated.

Not all results involving weight training are as encouraging as those previously cited. Hellixon(18) randomly assigned twenty-four subjects to control and experimental groups in an effort to determine the effects of near maximum weight training on running and jumping ability of first-year high school track performers. The experimental group received weight training five days weekly for six weeks while the control group remained idle. No significant difference was found between groups on the verticle jump, 100-yard dash, running broad jump and one mile run.

Woodall(19) tested the effects of increased strength in the arms and upper body upon running speed. Twenty-four subjects were placed into experimental and control groups on the basis of 100-yard dash times. After a six week period of weight training administered to the experimental group, all subjects were retested in the 100-yard dash. No significant difference was noticed between the 100-yard dash times of the two groups.

Isometric Training

Isometric contraction is, in fact, neither new nor revolutionary, but only recently has it begun to be applied to a wide variety of sports. Karpovich(20) felt that isometric contractions have their limitations. He stated that they did nothing for either the heart or lungs and did not increase endurance or stamina. This is a commonly accepted fact, and serves to lend importance to the use of isometric training only as a supplement to athletic conditioning. Isometrics may have their true value in time and equipment costs saved. Hettinger(21) declared, "For practical purposes, in order to train the muscle for increasing muscle strength, it is suggested to exercise the muscle group to be trained by making one isometric contraction against a resistance each day."

John Ralston(22), former head coach at Stanford University and now head coach of the Denver Broncos of the National Football League, made this statement pertaining to isometric training:

> Since the arrival of Billy Cannon on the campus of L.S.U. much has been written about his success in college and professional football because of his use of isometric exercises. This is another means of overloading the muscle, and it's through the "overload principle" that muscle will gain strength and size. Stanford University combined isometric and isotonic exercises in its conditioning program. Both build strength; isometric builds strength more rapidly with less effort, but body bulk or weight gains seems to increase more when on weight training. When the two are combined excellent results occur.

Biggs(23) in his book, Conditioning for Football, recommended isometric training and listed these advantages:

1. it is excellent in developing strength quickly,
2. it can be performed in a short period of time,
3. little or no equipment is needed,
4. it is excellent for use in latter part of season to prevent loss

of muscular strength,

5. permits more people to work at the same time in a limited area.

In 1964, Chui(24) conducted a study involving the comparison of isometric and isotonic contractions, and their effect upon strength and speed of movement. Ninety-six male students at Iowa State University participated in the study which lasted nine weeks. The findings were:

1. Gains in strength made by use of isometric contractions are not greater than gains made by use of isotonic contractions. Also, gains made by use of rapid contractions are not significantly greater than gains made by use of slower contractions.

2. Gains in strength obtained in performing a resistance movement are accompanied by gains in the speed of execution of the same movement against no resistance.

3. Gains in speed of movement measured against no resistance made by the use of isometric contractions are not significantly greater than gains made by use of isotonic contractions.

In a study by Berger(25) comparing isometric and isotonic training, it was found that training statically for six to eight seconds at two different positions was more effective for increasing strength than training isotonically with 2-RM for two sets but not as effective as 6-RM for three sets. The author also determined that training isometrically for six to eight seconds at two different positions was as effective in increasing strength as training isotonically with 2-RM for two sets, 6-RM for two sets, or 10-RM for either two or three sets. According to Berger, the advantage of static training is that a greater number of exercises can be performed five or six days a week for extended periods of time without great fatigue. This could not be

done with weight training. Most lifters and weight trainers seldom train more than four times weekly because of great muscle fatigue. Static training may result in a greater increase of strength, not because of greater effectiveness of this kind of program, but because of the greater number of training sessions it permits.

Relative to isometric training, two important points have been established:

1. Strength will increase at a faster rate when muscles are contracted with near maximum force, six to eight repetitions daily.

2. Strength will increase more evenly throughout the range of motion if the contractions are done at various positions.

Research which supports these concepts has been done by Hettinger and Muller(26), Ball(27), Rasch and Morehouse(28) and Rich(29).

Numerous college and professional athletes utilize isometrics in their training routines. Frank Budd, former world record holder in the 100-yard dash, used a series of exercises to improve sprinting. Bob Pettit testified that isometrics have improved his jumping and game performance and added years to his career. The rapid strength gains and the ability to simulate basic athletic movements appear to be the key features of this type of program. It has been estimated that one year's use can produce 100 percent strength gains for normal individuals. Since additional muscle bulk and viscosity do not accompany training, strength acquired is of the type desirable for improved sprinting speed(4).

Dintiman(4) summarized the advantages and disadvantages of isometric training from his research findings:

1. Strength increases equal to those produced through weight

training are achieved although isometric workouts consume less than one-third the time. One workout weekly is sufficient to maintain strength gains.

2. Cardiovascular/respiratory endurance, local muscular endurance and explosive power are relatively unaffected by most programs.

3. A two to three percent strength gain weekly can be expected. Studies have shown that strength can be increased as high as five percent for ten weeks, or a fifty percent gain with only one six second contraction at two-thirds the maximum muscle strength.

4. Exercises must be performed at varied angles throughout the range of motion since static strength acquired at one angle may not carry over to other angles. Specific, rather than general, strength may be obtained with limited carry-over to athletic performance.

5. Isometrics have been shown to improve verticle jumping ability, 30-yard dash times and agility.

6. Motivation tends to be lower in isometric training than in weight training.

7. Controlling the amount of force that is applied by each individual is near impossible in group situations.

8. Strength gains occur more rapidly in the early stages of training and for the untrained athlete. Gains occur slowly for the highly trained athlete.

In view of the limitations of isometrics, it is evident that this form of training should not replace weight training if improved sprinting speed is the desired outcome. Isometric running and starting exercises and several others that simulate sprinting should, however, be incorporated into the program.

Resistance Running

Resistance running programs strive for improved strength in the muscles involved in the running action as a means of improving running speed. The area of resistance running would include the wearing of weights on the body (usually worn on the ankles, wrists or chest), the use of a running harness, incline or staircase running and sled work or use of dummies in football practice.

In a study involving resistance running, Hanke(30) compared two sprinters who trained with weighted vests with two sprinters who did not. The basis of comparison was the improvement in time in the 100-yard dash. He found that the two subjects who had trained with the weighted vests made greater improvement, although not at a significant level when compared to the pair of subjects who had not used weighted vests. However, the statistical validity of Hanke's study was hindered by his sample size.

Simpson(31) conducted a study involving junior varsity football players in which thirty-four boys were divided into two training groups. The subjects were tested in the 50-yard dash, dodge run, standing broad jump and 600-yard run. Each group participated in the same eight week supplementary conditioning program except that the experimental group wore ankle weights of two and one-half pounds each and a weight vest of nine pounds. After eight weeks the boys were retested. Simpson found that the experimental group had made a significant improvement over the control group in the broad jump and dodge run, but failed to show a significant difference in the means of the times in the 50-yard dash. He also found that the control group improved significantly over the experimental group in the 600-yard run. This would indicate a considerable

amount of doubt as to the effectiveness of wearing leg weights in the training of distance runners.

McCullough(1) conducted a study to determine what effect the wearing of wrist weights during practice would have on the improvement of sprinting speed. Forty-three college freshmen were divided into three groups according to a pre-test for running speed as measured by one 50-yard dash. The control group took part in the testing phases but did not participate in any sprint training. Instead, they participated in other unrelated physical education activities. Experimental groups I and II participated in the same sprint training program, except that group II wore three pound wrist weights during all training. The results of this study indicated that all three groups made a significant improvement at the .01 level in running speed during the experimental period. However, there was no significant difference between the improvements each of the groups made. In looking at the critical ratio of t values, it can be assumed that the group that trained with hand weights improved more than did the other two groups.

Negative findings were uncovered by Winningham(32) in his study of the effects of training with ankle weights on running speed. He found that training with two or five pound weights hindered 100-yard dash times.

It has been found that wearing weights during the practice sessions of a sport is harmful to "timing" and is therefore detrimental to the athlete. Jesse(2) explained this when he wrote:

> The problem involved in the use of weights attached to the body during practice of the event itself, involves the principle of "specificity of training." Each event makes specific demands in terms of its pattern of load, rate, repetition and duration. The neurophysiological adjustments to these demands are so specific and so precise that weight added to the equipment or

> the body will affect the athlete's performance in terms of speed, timing and co-ordination. There is no harm in attaching weight to the body if this type of training is not used in the practice of any event which requires skill.

Wearing weights during football practice, for instance, would affect the rate at which a quarterback dropped back to pass, the time required for a receiver to run his pattern, or move to catch the ball, the timing between the backs and linemen in blocking and getting through the hole, to mention just a few of the problems.

Another factor in resistance running is that it is extremely difficult to maintain normal stride length and the same rate of leg movement while performing under increased resistance. Opponents of resistance running contend that such training will shorten stride length and subsequently hinder running speed. Advocates of resistance running say that, if this method is combined with flat surface training, flexibility exercises and stride training, it will not decrease stride length and can improve running speed through improved strength.

Along this line, Milakov and Cox(33) conducted a study involving four experimental training groups. Group I trained only on uphill surfaces, Group II trained only on flat surfaces, Group III trained only on downhill surfaces, and Group IV trained on all three surfaces. It was found that Group IV improved sprinting speed significantly more than groups participating on only one type of surface.

Summary of Related Literature

From the review of related literature, it may be seen that some researchers have reported significant increases in speed following resistance training programs, while some have found no change, and a few have indicated negative results. Isometric programs have been

praised by many, however there is a glaring lack of substantiated research revealing what effects isometric contraction exercises have on the running speed of athletes. It would appear that the most preferred program of researchers and coaches alike, to improve running speed, would be that of rapid and forceful contractions. However, it appears that much of the research in this area is clouded because many researchers have directed their efforts solely toward the effects of increased upper body and/or lower body strength upon running speed. A serious limitation of these studies has been the trend to consider weight training as a replacement for, rather than a supplement to sprint training.

In regard to improving running speed through the use of resistance training programs, the following conclusions are substantiated by the related literature:

1. Muscular strength can be increased through resistance strength training programs.

2. The speed of muscular contraction is increased through strength training programs.

3. Strength in the muscles involved in the running action is essential to the attainment of superior sprinting speed.

4. Resistance training causes some muscle shortening and therefore should be used in conjunction with flexibility and sprint training exercises.

5. It is unrealistic to consider strength training as a replacement for actual sprint training. Running speed has been significantly improved following strength training programs that were used as supplements to actual sprint training.

CHAPTER II

METHODS AND PROCEDURES

The football team at the University of Minnesota Technical College at Crookston is a member of the Minnesota Junior College Athletic Conference and competes against other junior colleges in the state of Minnesota. The football season began with fall camp on August 30th, and concluded with a victory over Lakewood Junior College in the Minnesota Junior College Championship Game on November 3, 1973.

The experimental period for this study began on September 1 and ended eight weeks later. The players participated in resistance training five days a week at the end of practice. During pre-season, when there were three practices daily, the players performed resistance training after the morning practice only.

Selection of Subjects

The subjects used in this study were freshman and sophomore football players at the University of Minnesota Technical College, Crookston, Minnesota.

Forty-two subjects were selected for this study and were categorized in three position groups consisting of offensive backs and ends, defensive backs and linebackers, and interior offensive and defensive linemen. For purposes of this study, speed was measured by the 40-yard dash.

These forty-two subjects were then placed into three experimental groups of fourteen subjects each. The placement of subjects into the

three experimental groups was based upon their performance in the 40-yard dash in the pre-test and the position group in which they were categorized. This was important because it was felt that the mean and standard deviation of the dash times of the three groups should not be significantly different. Equal dispersion of the subjects into the experimental groups from the categorized position groups was important because of the differences in practice routines which each group followed during the season. For instance, the backs and ends did considerably more running during a normal practice schedule. Also, the different somatotype characteristics inherent in each of the three position groups were equally dispersed throughout the training groups.

Of the forty-two subjects who were selected to participate in the study, thirty-three were able to complete the post test. Nine subjects were disqualified from the study, seven because of injury and two because they decided to leave the team. Of the fourteen subjects who started in each group, twelve completed testing in Experimental Group I, ten completed testing in Experimental Group II and eleven completed testing in Experimental Group III.

Testing Procedure

In this study the instrument of measurement was the 40-yard dash. The subjects were tested on their performance in running 40-yards from a stationary start on a running surface measured and marked off on the football practice field.

The 40-yard dash was selected because it is used by nearly every coach and scout at all levels of competition to determine the running speed most applicable to the sport of football. Excluding height and weight, the 40-yard dash time is the player's most important statistic.

The test was administered before training began and at the conclusion of training eight weeks later. The testing period took approximately forty minutes to complete.

The subjects ran in alphabetical order after a period of stretching and warm up. Each subject was instructed to take a three point stance with his down hand resting behind the starting line. After a minimum pause of one second the subject could begin running at his own discretion. The timers started their watches on the first movement of the hand and arm which was placed on the ground, and stopped when the subject's chest hit the finishing string. After each subject had completed his first trial, second and third trials were run keeping the same alphabetical order. This allowed for an approximate rest interval of fifteen minutes between trials, which is regarded as the optimum time by most researchers.

The timing instruments employed in this study were three stop watches calibrated in tenths of a second. Three timers timed each subject, and the mean time of the three watches was used for the time of that particular 40-yard dash. The best mean time of the three trials was listed as the subject's time for the 40-yard dash. The timers, all coaches of the team, have had considerable experience using the stop watch, and were thoroughly briefed on the testing procedure used in this study. The reliability and objectivity of the three timers was tested with excellent results during a pilot study done in the spring of 1973.

Training Procedure

The subjects were divided into three training groups labeled as isotonic, isometric, and harness.

Experimental Group I worked with the Universal Gym weight machine and performed isotonic contractions using six exercises. These included

the bench press, leg press, curl, knee extension, knee flexion and toe raise. Each subject performed three sets of seven repetitions, except for the toe raise where he performed three sets of fifteen repetitions. Rapid and forceful movement of the weights was stressed, and the subjects were instructed to increase the resistance load by five to ten pounds a week.

Experimental Group II performed isometric contractions using exergenies constructed out of eye bolts, iron plates, one inch wooden dowels, and 1400 pound test nylon rope as shown in figure 1, page 49. Their training schedule consisted of six exercises which included the upright press, power lift, curl, leg press, knee extension and knee flexion. Each subject performed two sets of one repetition of each exercise. The subjects worked in pairs and one held the exergenie while the other was training and vice versa. The exercises were performed by exerting a maximum force against the exergenie while the training partner counted to ten. At the end of ten seconds the rope was allowed to move just enough so that the subject had to exert a maximum force to move the bar through the entire range of motion.

Experimental group III trained by using a running harness and running against a resistance of twenty-five pounds on a calibrated exergenie. The exergenie was fitted with one-hundred feet of nylon rope with a harness attached to each end. The exergenie base was then attached to a fence at the edge of the field at a height of four feet. The players paired up and worked together in the training period. One subject would sprint out against the resistance while the other would jog back toward the exergenie so that he was not placing any additional resistance upon the rope. When he got to within ten feet of the exergenie he would shout, stop, and the process was repeated with the roles

reversed. Each subject did three sprints and then rested while the other subjects trained. When the subjects felt that they had recovered, they then performed three more sprints so that each subject performed a total of six resistance sprints daily.

Statistical Procedure

Following the collection of data, it became necessary to choose a method of analysis that would test the significance of the differences between the means on the pre and post tests for the three experimental groups. This was referred to as a within group analysis. It was also necessary to test the significance of the difference between the means of the three groups on the post test. This was referred to as a between group analysis. The null hypothesis was assumed in analyzing the differences between the means.

There are several methods used to test the null hypothesis. To make within group comparisons of the means for the three experimental groups, the t technique for testing the significance of the difference between the means appeared most suitable in this study. This test determines the ratio between the mean difference and the sampling error of the difference. This ratio was expressed as t and was verified in a table of t (34).

The entire team as a whole (33 subjects), was also compared on the pre and post tests by means of the t technique for testing the significance of the difference between the means.

Finally, to test for the significance of differences between the means of the three experimental groups on the post test, it was necessary to conduct a one-way analysis of covariance on the data obtained in the

pre and post tests. This procedure was selected because the means of the three groups on the pre-test were potentially different due to the reduction of group size during the experimental period. The one way analysis of covariance would indicate if any of the three resistance training programs varied significantly from the other two, thus establishing a best or worst supplementary training program.

For this study it was decided to test the null hypotheses at the .01 level of significance. The data were analyzed in the above manner and conclusions were drawn from the obtained results.

Appendix A, page 41, contains the raw data which were used in the statistical treatment. The subjects were allowed three trials on the pre- and post-tests and this appendix contains the three stop watch times and the computed mean of the subjects' best trial on the pre- and post-tests.

CHAPTER III

ANALYSIS OF DATA

This study was undertaken to determine which of three methods of supplementary resistance training was most effective in improving running speed. The following results were obtained by an analysis of the data collected in this study.

Results of Within Group Comparisons

After the completion of the post test, the t technique for testing the significance of the difference between the means was applied to the pre and post-test data of each group individually and then to the groups combined. The results were used to determine if there were any significant changes in running time for 40-yards during the experimental period.

Experimental Group I had a mean difference of 0.103 seconds between the pre-test and post test. The mean score on the pre-test was 5.23 seconds, and the post test mean was 5.13 seconds. The standard deviation of difference was 0.085, and the standard error of difference was 0.024. This resulted in a critical ratio of 4.189 with 11 degrees of freedom which indicated significance at the .01 level. The null hypothesis was rejected (see table 1, page 29).

On the 40-yard dash, Experimental Group II had a mean score of 5.19 seconds on the pre-test and a mean score of 5.11 seconds on the

post test, resulting in a mean difference of 0.084 seconds. The standard deviation of difference was 0.105 and the standard error of difference was 0.033. This resulted in a critical ratio of 2.540 with 9 degrees of freedom which was not significant at the .01 level. The null hypothesis was retained for this group. (see Table 1, page 29)

Experimental Group III had a mean score of 5.17 seconds on the pre-test and a mean score of 5.05 seconds on the post-test which resulted in a mean difference of 0.114 seconds. The standard deviation of difference was 0.082 and the standard error of difference was 0.025. This resulted in a critical ratio of 4.596 with 10 degrees of freedom which indicated significance at the .01 level. The null hypothesis was rejected (see Table 1, page 29).

The improvement in running speed of the entire team was analyzed in the same manner. All of the subjects together had a mean score of 5.20 seconds on the pre-test and a mean score of 5.10 seconds on the post test which resulted in a mean difference of 0.101 seconds. The standard deviation of difference was 0.087 and the standard error of difference was 0.015. This resulted in a critical ratio of 6.55 with 32 degrees of freedom which indicated significance at the .01 level. The null hypothesis was rejected (see Table 1, page 29).

TABLE 1

WITHIN GROUP MEAN COMPARISONS ON
THE PRE-TEST AND POST TEST

Group	Mean Difference (Pre-test Post test)	Standard Error	t Value	Level of Significance
Experimental Group I	.103 (seconds)	.024	4.19	Significant at .01 level
Experimental Group II	.084 (seconds)	.033	2.54	Not significant at .01 level
Experimental Group III	.114 (seconds)	.025	4.59	Significant at .01 level
Three Groups Combined	.101 (seconds)	.015	6.55	Significant at .01 level

After the t technique for testing the significance of differences between means had been employed, it was believed that Experimental Groups I and III had made speed increases which were significant at the .01 level, while Experimental Group II had failed to show a significant improvement in running speed at the .01 level. The three groups considered as a whole made a speed increase which was significant at the .01 level.

Between Group Comparisons on the Post Test

The between group comparison was the statistical analysis of major concern in this study. The investigator wanted to determine if there was any significant difference between the groups in regard to the increase in running speed as analyzed by the analysis of covariance.

The analysis of variance of the post test results indicated an F ratio of .235 with 2 and 30 degrees of freedom which did not indicate significance at the .01 level. The analysis of covariance of the post test results indicated an F ratio of .291 with 2 and 29 degrees of freedom which was not significant at the .01 level. As a result of the between group comparison of the post test results, it was believed that there were no significant differences between the three groups in regard to improved speed performance which could be attributed to the methods of exercise used during the experimental period.

Between group mean comparisons on the post test are shown in Table 2.

TABLE 2

BETWEEN GROUP MEAN COMPARISONS ON THE POST TEST

Group	Pre-test Mean	Pre-test S.D.	Post test Mean	Post test S.D.	Adjusted post test mean
Experimental Group I	5.24	.27	5.13	.31	5.09
Experimental Group II	5.20	.25	5.11	.34	5.12
Experimental Group III	5.16	.27	5.05	.28	5.09
Total	5.20	.26	5.10	.30	5.10

The adjusted post test means were calculated for the analysis of covariance due to the inequality of the means and standard deviations of the three experimental groups on the pre-test. The results of programming the one-way analysis of covariance are shown in Table 3.

TABLE 3

ANALYSIS OF VARIANCE - POST TEST

	sum of squares	degrees of freedom	mean square	F ratio
Treatment	.046	2	.023	.235
Error	2.915	30	.097	
Total	2.960	32		

ANALYSIS OF COVARIANCE - POST TEST

	sum of squares	degrees of freedom	mean square	F ratio
Treatment	.004	2	.002	.291
Error	.217	29	.007	
Total	.221	31		

From the table of F ratios(34) it was noted that an F ratio greater than 3.32 was needed with 2 and 30 degrees of freedom, and an F ratio greater than 3.33 was needed with 2 and 29 degrees of freedom to indicate a significant difference between the means of the three experimental groups.

CHAPTER IV

DISCUSSION

This study was undertaken to determine which of the three most popular supplementary resistance training programs would have the greatest effect on the running speed of college football players.

In looking at the results of this study it can be seen that the entire squad had a mean improvement of one-tenth of a second in the 40-yard dash. This was a significant improvement. However, due to the experimental design (the lack of a control group), this improvement in running speed cannot be attributed to the supplementary strength training programs alone. The major consideration for not having a control group was the desire to have all of the athletes participate in strength training programs which have been proven effective in increasing strength and power, and in limiting the frequency of muscle and joint injuries.

In observing the within group comparison of each group taken separately, it was found that Experimental Group II, or the isometric training group, failed to show a significant improvement in running speed from the pre-test to the post test. This indicated that for this study the isometric resistance program was less effective than the isotonic or resistance running programs for increasing running speed.

The one-way analysis of covariance involving post test results took into consideration the group size and initial running speed differences. This analysis showed that, even though there were differences

in improvement in the within group comparisons, there was no significant difference between the post test and adjusted post test means of the experimental groups.

The supplementary training programs were not the only phases of the entire training program that the subjects participated in during the experimental period. Due to the fact that the subjects as a group significantly improved their running speed, it is important for the reader to have an understanding of the entire training program.

The improvement of running speed has been attributed to many areas of training. These would include:

1. agility training,
2. endurance training,
3. explosive power training,
4. flexibility training,
5. maximum effort training (sprinting),
6. reaction time training,
7. stride and form training,
8. strength training.

It can be safely stated that all of these areas of training were incorporated into the daily practice routine. For the benefit of the reader, a brief explanation of the maximum effort training aspect of the practice session is given because of its importance to the improvement of running speed as shown by the related literature.

During maximum effort sprint training the subjects had ten 40-yard sprints to run and were required to run each sprint as fast as possible. The subjects were to concentrate on exploding out of the start and continue driving all the way through the finish line. A coach at each

finish line had a stop watch and announced the winning time of each race. To add incentive and competition, a chart was posted each day with the winner of each group moving up a group and the loser of each group moving down to the next group below. The players did not know which sprint was counted as the official race of the day, which aided in obtaining a maximum effort for every sprint. After sprints, the players went to their respective strength training stations.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

In this study, forty-two University of Minnesota-Crookston football players were divided into three experimental groups based on the results of a pre-test in the 40-yard dash and the position group in which they were categorized. The three groups used in this study each participated in football practice and then worked at a different resistance training program.

Each group was tested prior to and at the end of an eight week training program. Each of these tests consisted of three 40-yard dashes timed by three coaches using stop watches calibrated in tenths of a second. The three stop watch times of each trial were averaged and the best mean time of the three trials was used as the subject's time for the pre and post tests. The results were analyzed for the following purposes:

1. to compare pre-test performance with that of the performance on the post test for each group to determine any significant changes in running speed,

2. to compare the pre and post test times of all the subjects collectively to determine if any significant changes in running speed resulted from the eight week training program,

3. to compare the performance of the three groups on the post

test to determine whether or not the changes in speed performance were significantly different between the experimental groups.

Comparisons were made between the mean differences within each group as indicated by the pre and post tests. The significance of difference between the pre and post test means within each group and with the groups together was tested using the t test.

Comparisons were made between the mean differences of the three groups on the post test by means of the one-way analysis of covariance.

Conclusions

The following conclusions were believed justified by the analysis of data obtained in this study:

1. The results of this study indicate that Experimental Groups I and III made significant improvement at the .01 level in running speed during the experimental period as measured by the 40-yard dash.

2. Experimental Group II did not improve its running speed to a significant degree from the pre-test to the post test.

3. The football team as a whole made a significant improvement in running speed as measured by the 40-yard dash.

4. The one-way analysis of covariance between the groups showed no significant difference between the improvements in running speed that each experimental group made. The results of this study failed to show which supplementary resistance training program is the most effective in improving running speed.

Recommendations

The following recommendations were made as a result of this study:

1. a similar study should be made using a control group to determine just how important a role in-season resistance training programs play in the improvement of running speed,

2. a similar study should be made using larger samples and a longer training period,

3. since the wearing of football equipment is a form of resistance training in itself and would tend to decrease the stride and rate of leg movement, research should be done in regard to the effect of sprint assisted training as a supplement to football practice that would compensate for this effect.

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APPENDIX A

THE THREE STOP WATCH TIMES AND THEIR MEAN OF THE FASTEST TIME FOR EXPERIMENTAL GROUP I ON THE PRE-TEST

Subject	Stop Watch A	Stop Watch B	Stop Watch C	Mean Time
Kukowski	4.90	4.80	4.90	4.87
Green	4.90	4.90	4.80	4.87
Evenson	4.90	4.90	4.90	4.90
Anderson	5.10	5.00	5.10	5.07
Poppel	5.20	5.10	5.20	5.17
Clayton	5.30	5.30	5.30	5.30
Heibert	5.20	5.30	5.20	5.23
Pucciarelli	5.40	5.40	5.30	5.37
Faul	5.40	5.40	5.40	5.40
Slinden	5.40	5.40	5.50	5.43
Snook	5.40	5.50	5.50	5.47
Dehler	5.80	5.70	5.80	5.77
Group Mean	....	....	....	5.23

THE THREE STOP WATCH TIMES AND THEIR MEAN OF THE FASTEST TIME FOR EXPERIMENTAL GROUP II ON THE PRE-TEST

Subject	Stop Watch A	Stop Watch B	Stop Watch C	Stop Time
Spiva	4.80	4.80	4.80	4.80
Hodek	5.00	5.00	5.00	5.00
Kelson	5.00	5.00	5.00	5.00
Gunderson	5.00	5.10	5.10	5.07
Popp	5.20	5.20	5.10	5.17
Zitzloff	5.20	5.20	5.30	5.23
Uttermark	5.20	5.20	5.40	5.27
Brodeen	5.30	5.30	5.30	5.30
Thompson	5.50	5.40	5.40	5.47
Money	5.70	5.60	5.70	5.67
Group Mean	....	....	....	5.19

THE THREE STOP WATCH TIMES AND THEIR MEAN OF THE FASTEST TIME FOR EXPERIMENTAL GROUP III ON THE PRE-TEST

Subject	Stop Watch A	Stop Watch B	Stop Watch C	Mean Time
Wagner	4.80	4.80	4.80	4.80
Knudsen	4.90	4.90	4.90	4.90
Rogalla	4.90	4.90	4.90	4.90
Aretz	5.10	5.10	5.00	5.07
Reichstadt	5.00	5.10	5.10	5.07
Youngquist	5.10	5.10	5.10	5.10
Hagen	5.20	5.10	5.20	5.17
Bolden	5.30	5.20	5.30	5.27
Mortenson	5.30	5.30	5.30	5.30
Toutges	5.40	5.40	5.50	5.43
Quackenbush	5.80	5.80	5.70	5.77
Group Mean	....	....	....	5.17

THE THREE STOP WATCH TIMES AND THEIR MEAN OF THE FASTEST TIME FOR EXPERIMENTAL GROUP I ON THE POST TEST

Subject	Stop Watch A	Stop Watch B	Stop Watch C	Mean Time
Kukowski	4.80	4.80	4.80	4.80
Green	4.70	4.70	4.80	4.73
Evenson	4.80	4.80	4.80	4.80
Anderson	4.80	4.90	4.80	4.83
Poppel	5.10	5.20	5.10	5.13
Clayton	5.20	5.20	5.20	5.20
Heibert	5.20	5.20	5.20	5.20
Pucciarelli	5.20	5.20	5.30	5.23
Faul	5.20	5.20	5.20	5.20
Slinden	5.40	5.40	5.50	5.43
Snook	5.20	5.30	5.30	5.27
Dehler	5.80	5.80	5.80	5.80
Group Mean	....	....	....	5.13

THE THREE STOP WATCH TIMES AND THEIR MEAN OF THE FASTEST TIME FOR EXPERIMENTAL GROUP II ON THE POST TEST

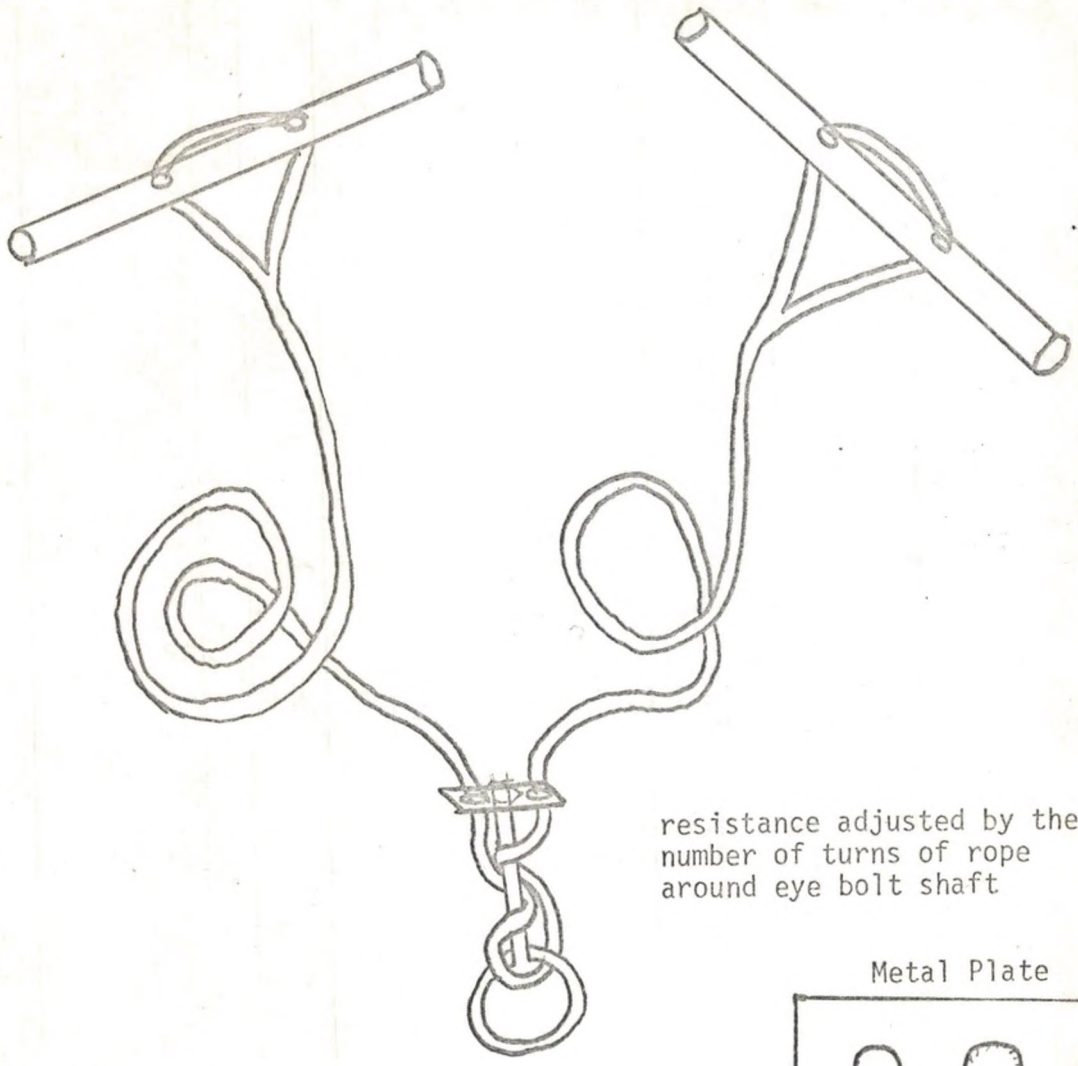
Subject	Stop Watch A	Stop Watch B	Stop Watch C	Mean Time
Spiva	4.50	4.60	4.50	4.53
Hodek	5.00	4.80	4.80	4.87
Kelson	4.80	4.80	4.80	4.80
Gunderson	4.90	5.00	4.90	4.93
Popp	5.10	5.20	5.20	5.17
Zitzloff	5.20	5.20	5.20	5.20
Uttermark	5.30	5.30	5.20	5.27
Brodeen	5.20	5.10	5.20	5.17
Thompson	5.60	5.40	5.50	5.50
Money	5.70	5.70	5.70	5.70
Group Mean	....	....	....	5.11

THE THREE STOP WATCH TIMES AND THEIR MEAN OF THE FASTEST TIME FOR EXPERIMENTAL GROUP III ON THE POST TEST

Subject	Stop Watch A	Stop Watch B	Stop Watch C	Mean Time
Wagner	4.60	4.70	4.70	4.67
Knudsen	4.70	4.80	4.70	4.73
Rogalla	4.80	4.80	4.90	4.83
Aretz	4.80	4.80	4.80	4.80
Reichstadt	5.00	5.00	5.00	5.00
Youngquist	5.00	5.10	5.10	5.07
Hagen	5.10	5.10	5.10	5.10
Bolden	5.10	5.10	5.20	5.13
Mortenson	5.40	5.30	5.30	5.33
Toutges	5.30	5.20	5.30	5.27
Quackenbush	5.60	5.60	5.60	5.60
Group Mean	....	....	....	5.05

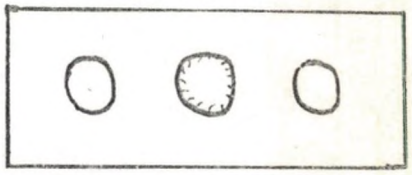
APPENDIX B

FIGURE 1



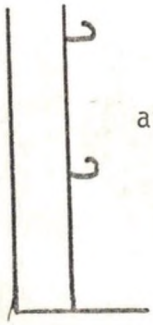
resistance adjusted by the number of turns of rope around eye bolt shaft

Metal Plate



drilled and smoothed 3/8" holes

threaded 3/8"



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- 2"x12" board