A STUDY OF RESPONSE TIME USING THREE SELECTED ATHLETIC TRAINING PROGRAMS

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ABSTRACT

CRAFT, Harold Kent,: A Study of Response Time Using Three Selected Athletic Training Programs

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Purpose of Study: The purpose of this study was to examine various training programs and to determine which of the training programs examined would best increase a sprinter's response time out of starting blocks.

Statement of Problem: This study was designed to determine which one, if any, of three training programs selected would provide the best results in increasing a sprinter's response time out of starting blocks. The training programs examined were: 1) repetitious start, 2) weight training, 3) exer-genie program. A fourth group constituted the control group.

Procedure: To conduct this study twenty high school freshmen and sophomore male and female physical education students were selected from a group of volunteers. These subjects were placed into four groups of five each. Each group contained one female athlete, one female non-athlete, two male athletes, and one male non-athlete. Three groups were assigned training programs to be conducted over a six week period. The fourth group was the control group and was not involved in a training program. The subjects were pre-tested and post-tested from starting blocks using the medium start form to a distance of ten yards with a Dekan electric timer. To determine the significance two statistical procedures were used: 1) t-test, and 2) analysis of covariance.

Conclusions: Within the limitations of this study it was concluded that: 1) there was no significant difference between the training programs studied and none of the training programs selected increased a sprinter's response time out of the starting blocks, and 2) a sprinter's response time from the starting blocks cannot be increased through the use of any of the training techniques employed in this study.

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Chapter 1

THE PROBLEM AND DEFINITION OF TERMS USED

Track and field for males, and more recently, for females, has become a very popular sport in the high schools of Kansas. Track is a sport which involves athletes with good speed in movement, strength, endurance, stamina, agility, quickness in reaction, and a good mental attitude. Many track coaches believe that the characteristics for speed needed to become a good sprinter are God given. Wallice O. Fenn (20) has found, for example, that the faster runners have the following movement characteristics: 1) longer length of stride, 2) faster number of steps (strides) per second, 3) greater height in front leg lift, 4) contact ground with a larger angle with the horizontal, therefore less wasted energy in forward pressure on the ground, and 5) less up and down movement of the body's center of weight. Since these movement characteristics seem to be God given, "it is a sad but true fact that sprinters appear to be born not made (14)."

An individual may have the potential necessary to become a good sprinter, but without proper training the individual may not perform to his maximum ability. The training process, for improvement of sprinting speed, would involve work in the areas of: 1) response time in starting,

2) starting form, 3) running form, 4) building leg and upper body strength, 5) finish form, and 6) mental attitude.

Many sprint races are won or lost as a result of a sprinter's response time out of the starting blocks. Response time in sprinting would be the time it takes the sprinter to react to the starting gun and move a predetermined distance. Since response time is of prime importance, there have been many training programs and starting forms devised to increase a sprinter's response time. There is, however, a lack of published material to determine which training programs would best increase a sprinter's response time out of the starting blocks. It would be worthwhile for the track coach to know which one of the training programs most commonly used would best increase the sprinter's response time out of starting blocks.

THE PURPOSE

The purpose of this study was to examine various training programs and to determine which one of the training programs examined would best increase a sprinter's response time out of starting blocks.

STATEMENT OF PROBLEM

This study was designed to determine which one, if any, of three training programs selected would provide the best results in increasing a sprinter's response time out

of starting blocks. The three training programs examined in this study were: 1) repetitious start, 2) weight training, and 3) exer-genie program.

STATEMENT OF HYPOTHESIS

It was hypothesized there would be no significant difference between each of the experimental training programs as compared to the control group in affecting a sprinter's response time out of starting blocks. It was further hypothesized there would be no significant difference between the combined experimental training programs and the control group in affecting a sprinter's response time out of starting blocks.

DEFINITION OF TERMS

Some of the following definitions have been defined specifically for the purposes of this study, while others have been defined as revealed in research.

Reaction Time

Reaction time was defined as "the interval between the start and the finish of a given movement (4)."

Movement Time

Movement time was defined as "the interval between the start and the finish of a given movement (4)."

Response Time

Response time was, for the purposes of this study, defined as the combination of reaction time and movement time. (See Appendix A)

Sprinter

A sprinter, for the purposes of this study, was defined as any individual who runs a race of 440 yards or less.

Starting Blocks

Starting blocks were devices used to give a sprinter a base for his feet to push against while starting a race from a crouched position.

Starting Device

The standard starting device used in competitive track races is a starting gun. In this study the starting device used was two blocks of wood clapped together to simulate the sound of a starting gun.

Athlete

An athlete in this study was classified as an individual that had trained for and had or was in the process of competing in a sport during the present school year.

Starting Form

The starting form used in this study was the medium start. "In this type of start the knee of the rear foot was

placed opposite the ball of the front foot when in the starting blocks (14)." The arms were extended to the ground even with the shoulders. The hands were rotated to a position so that the thumbs were pointing at each other approximately 8 to 10 inches apart. The head was in a position so that the neck was relaxed and the eyes were looking at the ground in front of the starting blocks. Upon hearing the command "runner get set," the sprinter's hips were elevated to a position slightly higher than his shoulders. The body weight was slightly forward. The head was in a downward position facing the track underneath the body. When reaching this position, the sprinter was to concentrate on listening to the sound of the starting device. When this sound was heard, the sprinter should explode from the starting blocks using a driving motion with both arms and legs. The sprinter gradually arose to a running position. (See Appendix B).

Standard Starting Procedure

In this study the standard starting procedure was 1) "runners take your mark;" 2) "runner get set;" and 3) the sound of the starting device.

1/2 Squat

"The barbell was placed on the shoulders at the back of the neck. Keeping the back straight and chest high, the exercise lowered into a one-half squat and rose (21)." (See Appendix C)

Toe Raises

The barbell was placed across the shoulders at the back of the neck, and the toes and balls of the feet were elevated on a two inch board to allow the heels to extend below the level of support and stretch the muscles. The exerciser raised fully on his toes, lowered, and repeated for ten repetitions (21). (See Appendix C)

Leg Press

In this exercise the participant laid on his back on a mat underneath the power rack containing the barbell. The subject was in a position so that he could push the barbell upward at a 90 degree angle from the body. The subject then brought his knees into his body and pushed the barbell upward to a full leg extension and lowered. (See Appendix C)

LIMITATIONS

In a study of this nature there are certain factors that were beyond the control of the experimenter. These factors are listed below.

1. The weather conditions prohibited the conducting of the training programs outside.

2. The weather conditions during the time of testing were beyond the control of the researcher.

3. The scale on the outside of the exer-genie indicated the amount of rotations of the cylinder which was equal to only an approximate weight.

4. School scheduling caused a delay in some training programs.

5. The participants were scheduled for the training programs around their class schedule.

6. The subjects for this study were of a limited number due to the time limitation of the class period.

7. This study could not make use of a starting gun because of the expense factor and the location of the training sessions.

DELIMITATIONS

There were certain factors in this study which the examiner was able to control. These controlled factors are listed below.

1. Freshman and sophomore physical education students were selected to participate in the study.

2. The facilities and equipment used in this study were the Hartford High School gymnasium, barbells, exergenie, starting blocks, and the Dekan timing device.

3. The training programs for this study were selected as generally being the most often used programs in sprint training.

4. The participants were placed into training programs according to their sex, athlete or non-athlete, and class schedule.

METHOD

This study employed the experimental type of design. The method used to obtain subjects was to ask for volunteers

from the freshman and sophomore physical education classes. These volunteers were then placed into the experimental training programs and the control group, according to their sex, participation or non-participation in athletics, and class schedule. The purpose of this division was to prevent the training programs from having an unequal amount of girls or boys and athletes or non-athletes.

The three experimental training programs and the control group each consisted of five subjects, the total subjects numbering twenty. Each group had one girl athlete, one girl non-athlete, two boy athletes, and one boy non-athlete. Each group was familiarized with the procedures and the purpose of the study. They were then taken to each exercise area and shown the proper techniques of their respective training programs.

The training programs involved in this study were: 1) repetitious start program, 2) weight training program, and 3) exer-genie program. The control group did not follow any training program, but were used only as a standard to establish whether or not any of the training programs were better than no training at all. The training programs were designed to operate three days a week for six weeks. The pre-testing and post-testing measurement device was the Dekan timing system.

Chapter 2

REVIEW OF RELATED LITERATURE

The purpose of this study was to determine which, if any, of the three training programs under study would best increase the response time of a sprinter out of the starting blocks. Many physical educators and coaches believe that reaction time--"the interval between presentation of the stimulus and the first sign of response (4)"--and movement time--"the interval between the start and the finish of a given movement (4)"--can be increased through exercise programs. Since response time in this study was a combination of both reaction time and movement time, it would seem that exercise programs could also increase the response time.

There have been some studies reported investigating the relationship between certain exercise programs and the increase of reaction time and movement time, but none dealing directly with response time. Therefore, the review of literature primarily dealt with the effects of increased strength in relation to reaction time and movement time, with the assumption that if either or both of these times be altered, response time will also be altered.

This chapter on review of literature was divided into two major sections: 1) strength increase as related to

speed of movement and 2) studies related to track starting techniques in general.

STRENGTH INCREASE AS RELATED TO SPEED OF MOVEMENT AND REACTION TIME

Whitney and Smith (30) conducted an investigation to determine which type of training program would best increase the speed of movement. The training techniques used in the study were: isometric-isotonic (A), dynamic-overload (B), and free-swing (C). "In programs A and B the design was such as to increase strength necessary to move a limb (30)." There were in each group 26 male college students. The movement primarily tested was the horizontal adductive arm swing. The subjects were given 10 practice and 12 official trials on the speed of movement test. Two static strength trials were given at various angles on the movement arc. The subjects were involved in their training programs for 10 weeks and then retested in exactly the same manner. The results of this study showed that "an increase in muscle strength of a limb does contribute to the speed of movement (30)." The study also shows that "regardless of the type of strength building program speed of movement will be favorably affected (30)."

A study into the comparative effects of isometric and dynamic weight training exercises on strength and on speed of execution of a single movements was conducted by Chui (2). Seventy-two male subjects performed weight

training exercises; Group I (isometric contraction method); Group R (rapid dynamic contraction method); and Group S (slow dynamic contraction method). The control group was made-up of twenty-four male subjects. A cable tensiometer was used to obtain eight strength scores for each subject. Speed of movement times against no resistance in six movements and against resistance in the same movements in specified increments were taken. The findings show:

> Group I, Group R, and Group S gained strength and at the same time gained in speed of movement measured against no resistance and against resistance. The findings in this study would appear to warrant the conclusions that: (a) gains in strength exerted in performing a movement are accompanied by gains in the speed of execution of the same movement against no resistance, and against resistance; and (b) gains in strength and gains in speed of movement against no resistance and against resistance made by the use of the one method was not significantly greater ($P = .05$) than gains made by the use of the other method (2).

Payne (23) conducted a twofold study the purpose of which was to determine which exercise program was most effective in producing a static strength gain and to determine the relationship between static strength and speed of movement. This study involved the use of seventy-two eighth grade girls divided into two experimental groups. One group was in an isometric exercise program, while the other was in an isotonic program. A control group played lead up games during the experimental period. Three tests were used to measure strength and speed of the arm and shoulder. Correlations before training indicated a higher relationship between static strength, and speed of a dominant arm movement than after training. "The results of the training

program indicated an increase in mean performance in all three groups with the isotonic groups being more superior (23)."

A study by Zorbas and Karpovich (33) involving six hundred persons investigated the effect of weight training upon the speed of muscular contraction. The study involved six hundred persons ranging from 18 to 30 years of age. One-half of the men engaged in weight training for six months. The other half of them did not engage in weight lifting. The subjects were required to do 24 rotations as rapidly as possible to record the rotary arm movement speed. The results showed that "the weight trainers were significantly faster on rotary arm movement than nonlifters (33)."

To determine the effect of repetition upon the speed of simple body movement Zwegan, Yankosky, and Williams (27) conducted a study. The subjects used in this study were selected at random from the Pennsylvania State University required physical education program. These subjects were divided into two groups. One group consisted of 19 subjects and the second group 11 subjects. Each group was given trials in the preferred-arm extension movement. The group with 19 subjects had 20 trials while the other group was given 50 trials. "The subjects were not informed as to the number of trials to be taken and all testing was conducted at approximately the same time of the day (27)." The measurement of time was to the nearest .001 of a second. The results showed that:

> The faster movement times were the result of a simple arm movement when repetition was used as a warm-up and that the more trials given the more significant became the differences in the means. In other words 50 trials resulted in faster movements than did 20 trials (27).

Tweit, Gollnick, and Hearn (29) conducted an investigation to study the effects of physical training on the total body reaction time in a group of low fitness individuals. "The subjects were 26 male college freshman of low fitness from the required physical education program at Washington State University (29)." Reaction time of the body was tested with a Model S-1 Chronometer. "The Rogers Physical Fitness Index and the Sargent Jump Test were administered before and after the training program to measure agility, explosive power, and fitness changes (29)." The subjects participated in a vigorous physical training program for six weeks. The results indicate that total body reaction times were increased as a result of a six week training program. "This suggested that a sub-fit individuals total body reaction time can be significantly improved by participation in a strenuous physical training program (29)."

A study into arm strength, effective arm mass, and speed in a lateral adductive arm movement was conducted by Clarke and Henry (3). This study involved 62 college males over a ten week period. Weight training exercise that did not involve the movement was given to half of the subjects,

while the other half became the control group by remaining inactive. The results of this study were as follows:

> The average of the training group improved significantly in speed, strength, and strength/mass ratio, whereas the average of the control group declined. There was no correlation between individual differences in speed and strength/mass ratio, but individual changes in the ratio correlated significantly (r = .405) with individual changes in speed. The reaction time of the weight lifters was not improved significantly (3).

The purpose of a study by Masley, Hairabedian, and Donaldson (16) was to determine whether increased strength gained through weight training was accompanied by an increase in muscular co-ordination and speed of movement. In this study 69 college physical education students were divided up into three groups; 1) a weight training group; 2) a volleyball group; and 3) a control group. The amount of time required to complete 24 rotary movements of the arm in a frontal plane was used to measure speed of movement. The results of this study "indicate that weight training increased speed and co-ordination over the six week training period (16)."

Speed of movement in a lateral adductive arm swing was timed at seven equidistant points on an arc of 120 degrees in a study conducted by Henry (9) on structure of speed and static strength in a lateral arm movement. The study involved the use of 36 males and 36 females being measured in the movement position for static strength and effective arm mass. A centroid factor analysis was on the

data received from the tests. The results of the test indicated the following:

> The structure for both sexes consisted of a single common factor for arm speed on a substantial item-specific factor for the first 17 cm. of movement, suggesting that the strength/mass ratio and speeds of movement were almost zero, except in the middle phase of the action, where the relationship was .29 for men and .27 for women. Circumferential speed for women was 17 percent slower than for men, partly because their arms were shorter. In angular speed, the sex difference was only 5 percent. Measured static strength available for a movement, and speed in that movement, were possibly correlated to a slight degree (9).

Gray, Start, and Walsh (8) conducted a study into the relationship between leg speed and leg power using a test of leg power based on scientific principles. The problem investigated in this study was the components of the term muscular power. Sixty-two adults used a refined bicycle erogometer in the leg speed test. The refined bicycle erogometer had a test-retest reliability of 0.969. A 0.470 correlation was established by comparing the factors of leg speed and leg power. These figures show

> mathematically lower than figures relating speed and power obtained by previous researches in this field and was probably due to the differences in the criterion measures together with sample and experimental error (8).

Morrie (22) applied Henry's "Menory Drum" theory of neuromotor reaction to the learning of simple and complex movements having such short duration that feedback in its classical monitoring aspect was excluded. This theory implies that:

> The amount of program simplification and reorganization in the learning of a simple movement is small and occurs early in the practice curve, while that for a

> more complex movement is larger and requires more practice to reach the limites of simplification (22).

This study involved the use of 102 college women. These women were divided equally in a simple movement group and a complex movement group. Each subject had 50 trials at a given task. "The simple movement task involved a forward movement of the arm while the complex movement required subjects to change the direction of arm movement (22)." Data on reaction time and movement was collected and,

> the complex movement group showed a greater shortening of reaction time than the simple movement group. The complex movement group continued to show improvement in reaction time throughout the experiment while the performance curve for the simple movement group leveled off during the first 20 trials. This data supported the theory (22).

A study by Meyers, Zammeri, Farr, and Baschnagel (18) was concerned with the effect of bench-stepping in the Harvard Step Test upon finger and foot reaction time and, secondly, with ascertaining the relationship, if any, between the reaction times and scores on the Harvard Step Test. This study involved the use of 80 university freshman males. These subjects were given tests on reaction time before, immediately after, and four minutes after the stepping exercise. Reaction times and pulse counts were given at the same intervals to 36 subjects, but without exercise. These subjects constitute the control group. By using the Pearson product-moment technique reliability coefficients of .56 and .68 were computed for foot and finger. The reliability coefficients of .55 and .62 for the foot and finger were

computed for the control group. This study did not find any effect of stepping exercise upon reaction time. There was no "apparent relationship between reaction time and the sum of the recovery pulse counts following exercise (18)."

Wilkin (31) conducted a study to determine if weight lifting has an effect on speed of movement. To carry out this investigation the examiner selected 9 chronic weight lifters, 19 beginning weight lifters, and 18 beginning golfers and swimmers. The subjects were placed in a weight training program for eight weeks. The method of pre-test and post-test was by the means of turning a handle. It was concluded that:

> Weight lifting has no slowing effect on the speed of arm movement, and that a semester of weight training does not increase speed of movement any more than golf or swimming (31).

STUDIES RELATED TO STARTING TECHNIQUES

A study into the effectiveness of four track starting positions on acceleration was conducted by Menely and Rosemier (17). This study involved the use of 30 male college freshman completing 90 starts as a group a day over a two week period for a total of 360 starts. The starting positions used were the bunch, medium, elongated, and the hyperextended. The subjects were timed by two Dekan timers at a distance of 10 yards and 30 yards. Each subject was timed three times from each starting position. The average of the three was used as the result. The study showed that

"the hyperextended start provided more acceleration at distances of 10 yards and 30 yards (17)." The conclusion drawn from this experiment was that "the wider the spread of the feet, the lower the time elapsed (17)."

The Jackson and Cooper (11) study investigated the efficiency of the sprinter's start by systematically altering the width of the hand position and the angle of the rear knee joint in the "get set" position. The medium start form was used as the starting form in this study with hand spacing of 8 inches and 20 inches between the thumbs. The starting form was also examined using knee angles of 90 degrees, 135 degrees, and 180 degrees. "The criterion measures included the following components of sprint-velocity curve: a) 0 to 10 yards; b) 10 to 30 yards; and c) 0 to 30 yards (11)." Twelve male college students having no prior experience in sprint techniques were tested over a three week period. All subjects completed six experimental conditions. The results of this study indicated the narrow

[redacted]

of a Type I error at 10 yards and a Type II error at 30 yards. If these errors were present, the narrow hand spacing would provide the best results. Duncans New Multiple Range Test as was applied to the means of sprint components

[redacted]

angle of 180 degrees was significantly slower than knee angles 90 and 135 degrees. The test also indicated that there was no significant difference between knee angles 90 and 135 degrees. Leg strength and movement time was examined through the use of a stepwise multiple regression analysis. This analysis suggested that leg strength might have been the factor that caused significant differences among rear knee angles. The findings of this study indicated the need for futher study of the relationship between leg strength and the sprinter's start.

The purpose of a study by Stock (26) was to analyse running speed resulting from four different sprint starting positions by comparing starting methods and speed for 20 yards, 50 yards, and between 20 and 50 yards. The timing device used in this study was a photoelectric cell timer recording to 1/1,000 second. Four starting form were employed, the bunch, medium, medium high hip, and elongated. The results of this study indicated that:

> The bunch and medium high hip starts accounted for the fastest time at 20 yards, the medium high hip at 50 yards, and the medium high hip starts between 20 and 50 yards. All results were significant at the .01 level (26).

Eighteen subjects were involved in a study by Henry (10) to investigate a theoretical description of the ideal start and the influence of foot placement upon it's effectiveness. To vary foot placement in the starting blocks toe-to-toe spacings of 11, 16, 21, and 26 inches were used. Force time graph of the leg thrust was taken on the

18 runners while completing their 4 runs. "Times were recorded automatically for the starting signal, the first movement in response, and the instant of passing markers placed 5, 10, and 50 yards from the starting line (10)." The results indicate that the spacing of the starting blocks had an effect on the runners reaction time, although not correlated with the runners speed in sprints. It was also revealed that medium foot spacings would produce the highest number of best runs.

Younger (32) completed a study on the comparison of reaction and movement times of women athletes and non-athletes. Forty-seven women athletes and seventy-five women non-athletes were compared using reaction time and movement time scores. The results of this study indicate that "women athletes are significantly faster than women non-athletes in speed of movement and reaction (32)." It was also revealed through this study that speed of movement could be effected by the type of sport speciality. An example of this would be, field hockey women athletes would tend to have a faster speed of movement than women athletes in volleyball. Sport speciality did not have an effect on reaction time.

The consistency of separate components of a timing response were measured by Schmidt (25) and the relationship of these consistancies to the changes in distance, speed, and resistance of the movement were determined. This study revealed that:

> The inconsistency of the total response was less than the sum of the inconsistencies of the response components. Factors which increase the movement time (e. g., greater distance or slower speed) tend to decrease consistency of both movement time and time of initiation of the response, tending to make the total response more inconsistent. There was a tendency for load to have a stabilizing effect on slower movement and to decrease the consistency of faster movements (25).

Colgate (5) conducted a study to add to the knowledge of reaction time, comparing the variation in reaction and response times of individuals subjected to visual, auditory, and tactile stimuli. The study involved 50 male physical education students. Each subject responded eight times to each of three stimuli. Time to the nearest .01 second was taken for speed of reaction and speed of response. The subject's responses were recorded to a mean time and would indicate that:

> For both speed of reaction and speed of response, the group means were lower when the subject responded to the auditory stimulus than when he responded to the visual or electroshock stimulus. Speed of reaction and speed of response were faster when subjects responded to electroshock stimulus (5).

SUMMARY

The research conducted in the area of training programs devoted to speed of movement and reaction time yield much of the same results. It could be safely predicted on the basis of research in the area that weight training or another form of exercise would increase the speed of movement, and in many cases increase reaction time. Since reaction time and movement time were part of response time,

it could be concluded that under the proper conditions response time would be increased through exercise. A sprinter should therefore increase his response time from the starting blocks through a training program.

The review of literature also revealed that the response time might depend upon the type of setting in terms of foot spacing in the starting blocks. From the review of literature it can be concluded that a sprinter would be the fastest out of the starting blocks for 50 yards using a start with wide foot placement, his back elevated to where his leg is bent about 130 degrees, and his thumbs about 8 inches apart.

Chapter 3

METHODS AND PROCEDURES

The purpose of this study was to determine which of three training programs under investigation would best increase a sprinter's response time out of the starting blocks. To conduct this study twenty freshmen and sophomore physical education students were selected from a group of volunteers. Twelve of these students were boys and eight were girls. The participants were placed in four groups of five. Each group contained one girl athlete, one girl non-athlete, two boy athletes, and one boy non-athlete. The participants were slected to prevent any group from containing any participants that had prior experience in using track starting blocks in high school or YMCA recreational competition.

Three groups were placed into a training program with the fourth group being the control group. The participants of these groups were placed according to their class schedule to prevent class conflicts on days when there was not a physical education class. Each participant in a training program conducted their workouts during the physical education period or after school three days a week for a six week period.

Prior to the beginning of the training programs all participants were called together and informed about the groups they were in, the nature of the study, and shown what they would be doing in their training program.

After the participants were informed about their part of the study, they were then instructed in and shown the medium start form. The subjects were then given three practice starts from the starting blocks using the starting device and the standard starting procedure. These practice starts were to acquaint each subject with the starting procedure and starting form.

TESTING PROCEDURE

After each subject had completed their three practice starts, they were taken to the Hartford High School dirt track. At the track the subjects were timed three times with a Dekan electric timing device from the starting position to a distance of ten yards.

Prior to the pre-program testing the subjects were reminded of the proper starting form. Beginning with the control group, the order of testing subjects was: 1) girl non-athlete, 2) girl athlete, 3) boy athlete, 4) boy non-athlete, and 5) boy athlete. This procedure was followed throughout the groups. The groups were tested starting with the control group and followed by the repetitious start group, the weight training group, and the exer-genie group

being the last group tested. This order of testing was used merely to establish uniformity throughout testing.

While a subject was being tested, the other subjects were watching quietly from behind the testing area on the track. It was stressed that the subjects, while observing remain quiet so that the individual being tested could concentrate on the proper starting form and the sound of the starting stimulus.

Upon hearing the sound of the starting device, the subject exploded from the starting blocks and ran a distance of at least fifteen yards before stopping. The timing device was placed on the ground directly behind the subject. A non-stretch cord was attached to an automatic stopping device on the Dekan timer. The other end of the non-stretch cord was attached to the subject's back at waistline level. The cord was measured with a steel tape so that when the subject reached the distance of ten yards, the cord pulled out a pen that stopped the timer.

The Dekan timer also had a push button starting device. This starting device was placed under one of the blocks of wood so that when the two blocks were clapped together the Dekan timer would start.

Each subject was tested three times in succession. The only rest time given was the walk back to the starting line. The subjects were allowed enough time to get themsleves situated properly in the starting blocks before they were started again. All times were recorded by an

assistant. There were five false starts. These false starts were not counted as a trial, but the subjects were given another trial. No one individual false started twice in the study. The best single time of the three trials was used for statistical analysis.

When one subject had completed his timed trials, the next subject would adjust the starting blocks to the proper setting for a medium start position. The testing continued with very little time elapsing between subjects. This procedure was followed until all twenty subjects had completed testing.

The subjects were not tested again until the conclusion of the six week training period. The same procedure was followed in the post-test as was used in the pre-test.

TRAINING PROGRAMS

The training programs selected for this study were: 1) non-active program, 2) the repetitious start program, 3) the weight training program, and 4) the exer-genie program.

None-active Program

The subjects of this program received the preliminary instruction on starting form, the three practice starts, and were then timed using the standard starting procedure. This procedure defined in the definition of terms is the accepted method of starting competitive track

sprint races. After the subjects of this group had recieved their three timed starts, they were not involved in any developmental program other than their daily routine and physical education class for a six week period. The subjects of this group were timed again upon the conclusion of the study. This group constituted the control group.

Repetitious Start Program (experimental group #1)

The subjects of this group received the preliminary instruction on starting form, the three practice starts, and were then timed using the standard starting procedure. Then, at the beginning of each physical education class the subjects of this group did ten starts for a distance of fifteen yards using the medium start form and the proper starting procedure. This program was conducted three days a week for the six week training period. When weather would not permit outside work outs, the ten repitious starts were completed inside on the gymnasium's hard wood floor. A subject would complete his ten starts before the next subject would reset the starting blocks and begin his starts. After the pre-test the subjects were not timed again until the end of the six week training period.

Weight Training Program (experimental group #2)

The weight training group received the preliminary instruction on starting form, the three practice starts, and were then timed using the standard starting procedure. The subjects of this group then followed the following weight

training program three days a week for the same six week period.

1. 1/2 squats, 10 repetitions, 3 sets. The beginning weight was 3/4 of the subjects weight. Ten pounds of weight was added each week. (See Appendix C)

2. Leg press, 10 repetitions, 3 sets. The beginning weight was 3/4 of the subjects weight. Ten pounds was added each week. (See Appendix C)

3. Toe raises, 10 repetitions, 3 sets. The beginning weight was 3/4 of the subjects weight. Ten pounds of weight was added each week. (See Appendix C)

4. Starts. After the completion of the weight training program, the subjects then completed ten starts for a distance of fifteen yards.

The weight training group completed their weight work in the weight room at Hartford High School. The subjects would complete ten repetitions at a time. The next subject would then complete one set. This procedure was continued until the weight program was completed. The subjects would continue on with the training program with the ten starts. Each subject would complete ten starts before the next subject would begin his starts.

The subjects of this group were timed again at the conclusion of the six week training period.

Exer-genie Program (experimental group #3)

The subjects in the exer-genie program received the preliminary instruction on starting form, the three practice starts, and were then timed using the standard starting procedure. The exer-genie was adjusted to an approximate weight of 1/4 the subjects weight. The exer-genie was then attached by rope to a metal pipe behind the starting blocks. A shoulder harness was put into the proper position around the shoulders of the subject. When the subject situated himself into the starting blocks, the exer-genie rope was tightened so the individual would be pulling poundage immediately upon starting. Upon hearing the starting device, the subject would drive out of the starting blocks, and run pulling the appropriate poundage a distance of fifteen yards. The poundage was increased approximately five pounds each week. (See Appendix C)

When the exer-genie training was completed, the subjects continued the training program with ten starts. When doing the starts, each subject completed his ten starts before changing the blocks for the next subject. This training program was completed three days a week for the six week training period. At the conclusion of this training period the subjects of this group were given the post-test.

Throughout the training period the subjects in all groups were under the supervision of the examiner, the women's physical education instructor, and a student aid.

FACILITIES AND INSTRUMENTS

This study was conducted on the Hartford High School dirt track. The subjects during the time of testing were wearing gym shorts, T-shirt or blouses, socks, and gym shoes.

The timing device used in this study was a Dekan electric timer. This timing device times to the nearest one-hundredth of a second. If a subjects time was between a hundredth of a second, the time recorded was to the nearest one-hundredth of the second.

WEATHER CONDITIONS

This study was conducted during the spring of the year. During this time of the year, weather conditions can change without notice. The first timed test (pre-test) was given in 45 degree temperature. The wind was gusting from the North-Northeast at 18 to 30 miles per hour. The final timed test (post-test) was given in 80 degree temperature. The wind was blowing from the North-Northeast at 12 miles per hour. All timed starts were run with the wind when the wind was not blowing it's maximum.

STATISTICAL ANALYSIS

The purpose of this study was to determine which of the training programs would have the greatest effect on the response time of a sprinter out of starting blocks. To determine the level of significance of the three experimental

programs two statistical procedures were employed. They were: 1) the t-test, and 2) an analysis of covariance.

t-test

Bartletts test for homogeneity of variance was used to determine what specific t-test formula to use.

$$F = \frac{s^2 g}{s^2 1}$$

where: s^2g = greater variance

s^21 = lesser variance

If the sample sizes are the same, and the variances are the same the pooled variance formula was used to determine the value of t. The pooled variance formula was:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{x^2_1 + x^2_2}{N_1 + N_2 - 2}\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

where: $X1$ = mean of the first group

X_2 = mean of the second group

n_1 = number of subjects in first group

n_2 = number of subjects in second group

In this study the pooled variance formula was used in all cases to determine the value of t.

The calculated t was compared to the t-table at the desired level of significance (.05) and the appropriate number (8) of degrees of freedom. If the calcualted statistic equaled or exceeded the tabled value, the null

hypothesis was rejected. If the calculated statistic was smaller than the tabled value, the null hypothesis was retained.

Analysis of Covariance

The statistical method used to determine if the combined experimental programs provided significant results was the analysis of covariance. Roscoe (24) states:

> The analysis of covariance was a blending of regression and the analysis of variance, which permitted statistical rather than experimental control of variables. The results was equivalent to matching the various experimental groups with respect to the variable or variables being controlled (24).

To find the analysis of covariance certain computational procedures were used. These computational procedures were as follows:

Total sum of products:

$$SP_t = \sum_{j=1}^{ki} \sum_{i=1}^{mj} X_{ij} Y_{ij} - \frac{T_x T_y}{N}$$

Sum of products between groups:

$$SP_b = \sum_{l=j}^{k} \frac{T_{xj} T_{xj}}{nj} - \frac{T_x T_y}{N}$$

Sum of products within groups:

$$SP_u = SP_t - SP_b$$

Adjusted total sum of squares:

$$SS^1_{wy} = SS_{wy} - \frac{(SP_u)^2}{SS_{wx}}$$

Adjusted sum of squares within groups:

$$SS^{1}_{wy} = SS_{by} - \frac{(SP_{w})^{2}}{SS_{wx}}$$

Adjusted sum of squares between groups:

$$SS^{1}_{by} = SS_{by} - SS^{1}_{wy}$$

F-ratio:

$$F = \frac{MS^{1}_{by}}{MS^{1}_{wy}}, \quad \text{with df} = (k-1), (N-k-1)$$

where:

k = total number of groups

j = any class or group

i = any individual in any group

n_j = number of individuals within a group

T_x = total sum of x

T_y = total sum of y

N = number of subjects in all groups

b = between groups

w = within groups

MS^{1} = adjusted mean square

df = degree of freedom

Roscoe (24) states:

> The calculated F was compared to the tabled F at the desired level of significance and the appropriate number of degrees of freedom. If the calculated statistic equaled or exceeded the tabled value, the null hypothesis was rejected, and a significant difference in the adjusted means of the various samples was determined to exist. If the calculated statistic was smaller than the tabled value, the null hypothesis was retained, and no significant difference in the adjusted means would be found (24).

SUMMARY

This study was designed to determine which one of the training programs would best increase a sprinter's response time out of the starting blocks. To conduct this study twenty high school physical education students were selected from a group of volunteers.

These subjects were divided into groups of five according to their class schedule, athletic participation, and sex.

The subjects were then placed into three training programs and one control group. The subjects were pre-tested, and were then involved in a training program three days a week for a six week period. The control group was not involved in training work. The programs used in this study were: 1) non-active, 2) the repetitious start, 3) the weight training, and 4) the exer-genie program.

Upon the conclusion of these training programs the post-test was given to determine the significance of the training programs. The best time of the three trials from each test was used for statistical purposes.

To determine the level of significance of the three experimental programs two statistical procedures were employed. They were: 1) the t-test, and 2) an analysis of covariance.

Chapter 4

ANALYSIS OF DATA

The statistical methods used to determine the level of significance in this study were the t-test and the analysis of covariance. The t-test was used to determine the level of significance between the experimental groups individually and the control group. The analysis of covariance was used to determine the level of significance between all experimental groups combined and the control group.

t-Test for Experimental Groups

Table 1 shows that the control group had a mean value of 2.41, while experimental group #1 after being involved in a six week repetitious start program had a mean value of 2126. The table also shows a standard deviation of 0.167 for the control group and a standard deviation of 0.082 for experimental group #1.

For 8 degrees of freedom ($df = n_1 + n_2 - 2$), a greater than t - 2.306 (.05 level of significance) was needed to reject the null hypothesis. Since the obtained value of t= 1.168 (refer to t formula p. 31) was not greater than t = 2.306, the null hypothesis was retained. It was concluded that there was no significant difference between the population means of the control group and experimental group #1.

Table 1

t-Table for the Control Group and Experimental Group #1

Group	Number	Standard Deviation	Mean Values	t
Control	5	0.167	2.41	1.618
Experimental Group #1	5	0.082	2.26	

Experimental group #2 with six weeks of weight training and the control group with no training are shown in Table 2. The experimental group #2 had a mean value of 2.32 and a standard deviation of 0.073. The control group had a mean value of 2.41 and a standard deviation of 0.167.

Table 2

t-Table for the Control Group and Experimental Group #2

Group	Number	Standard Deviation	Mean Values	t
Control	5	0.167	2.41	0.992
Experimental Group #2	5	0.073	2.32	

At 8 degrees of freedom (df = $n_1 + n_2 - 2$), a greater than t - 2.306 (.05 level of significance), was needed to reject the null hypothesis. Since the obtained value of t = 0.992 (refer to t formula p. 31) was not

greater than t = 2.306 the null hypothesis was retained. It was concluded that there was no significant difference between the population means of the control group and experimental group #2.

Table 3 shows experimental group #3 being involved in a exer-genie training program for six weeks and the control group. This table shows the mean value of 2.41 and a standard deviation of 0.167 for the control group, while the mean value and standard deviation for experimental group #3 was 2.34 and 0.186 respectively.

Table 3

t-Table for the Control Group and Experimental Group #3

Group	Number	Standard Deviation	Mean Values	t
Control	5	0.167	2.41	0.577
Experimental Group #3	5	0.186	2.34	

Using 8 degrees of freedom ($df = n_1 + n_2 - 2$) at the .05 level of significance, a score of t - 2.306 was needed to reject the null hypothesis. The null hypothesis was retained because t = .577 (see t formula p. 31) was not greater than t = 2.306. It was concluded that there was no significant difference between the population means of the control group and experimental group #3.

Analysis of Covariance for Groups

The statistical procedure for the analysis of covariance was shown in Chapter 3, page 32-33. The results of the pre-test and the post-test were used to determine if there was any significant difference between the control group and the three experimental groups combined. The best times out of three trials were used for the experimental groups.

Table 4 represents the results of the experimental groups over their six week training program. This test yielded an adjusted mean value of -1.02 between groups and a -75.25 adjusted mean value within groups. Using the covariates involved, an F value of 0.014 was obtained.

Table 4

Analysis of Covariance of Groups in the Testing Program

Source	df	SS_x	SP	SS_y	df'	SS'_y	MS'_y
Between	3	0.048	0.04	0.056	3	3.05	-1.02
Within	16	0.750	29.10	0.370	15	-1128.11	-75.25
Total	19	0.798	29.14	0.426	18	-1131.76	XXX

$$F = \frac{MS'_{by}}{MS'_{wy}} \quad \underline{0.014}$$

The critical F value for 1 and 15 degrees of freedom at the .05 level of significance was 3.29. The value of .014

was obtained. Therefore, it was concluded that there was no significant difference in the experimental programs used and the control group. The null hypothesis was retained.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine which of the training programs under investigation would best increase a sprinter's response time out of starting blocks. The subjects used in this study were freshmen and sophomore physical education students at Hartford High School.

The twenty subjects involved in this study were timed with a Dekan electronic timer three times prior to and three times following the training programs. The best times of each testing session was used for statistical purposes. Analysis of the data was by the t-test for significance between individual experimental groups and the control group, and the analysis of covariance was used to determine the level of significance of all groups combined.

Findings

1. The repetitious start group (experimental group #1) had a t-score of 1.618 at the .05 level of significance, which indicated no significant difference.

2. The weight training group (experimental group #2) at the .05 level of significance revealed no significant difference with a t-score of 0.992.

3. The exer-genie group (experimental group #3) with a t-score of 0.577 indicated no significant difference at the .05 level of significance.

4. At the .05 level of significance a F score of 0.014 was obtained for all experimental groups involved. This showed no significant difference.

CONCLUSIONS

Within the limitations of this study the following conclusions were reached.

1. There is no significant difference between the training programs studied and none of the training programs selected significantly increased a sprinter's response time out of starting blocks.

2. A sprinter's response time from the starting blocks cannot be increased through the use of any of the training techniques employed in this study.

Discussion

One of the conclusions drawn from the review of related literature was that response time could be increased through training. However, the results of this study did not support the conclusion drawn from the review of related literature. The purpose of this discussion was to present factors that might have had some effect on the results of this study. One of these factors was the environment during pre-test and post-test.

One of the disadvantages while conducting the study out of doors was the inability of the experimenter to control the environment. The environmental conditions varied considerably during pre-test and post-test. The temperature during pre-test was 45 degrees, while during post-testing the temperature was 80 degrees. Studies have indicated that muscle contraction is faster when the muscle is warm. This temperature difference of 35 degrees might have had some effect on the subject's muscle contraction and response time.

Since this study was conducted in-part during school time, the school's environment needs to be taken under consideration. This study was conducted around the class scheduling of students, the school's scheduling of assemblies, track meets, baseball games, music tours, play practices, class projects, the time limitation of class periods, illness of subjects, and classroom teachers. These factors caused interruptions in the training programs which could have effected the studies results. These factors were also responsible for the small number of subjects.

The small school situation made it difficult selecting subjects that were not athletes, or involved in other activities, or had conflicting class schedules. Therefore this study involved only twenty subjects placed into four groups of five. A larger population within groups would have provided a better representation and might have provided significant results in this study.

Another factor that could have had some effect on the results was the training programs. The training progrmas were conducted three days a week for six weeks. The weight poundage used in the training programs might not have been enough to increase muscle strength within a six week period, but due to the female subjects and non-athlete subjects involved within the study a strenuous weight program was not safe. A strenuous weight program conducted more days a week and over a longer period of time might have provided significant results.

Psychological factors could have been in-part responsible for the results not being significant. The study was conducted during the spring of the year when most students were becoming tired and anxious for school to be out. This anxiety and tiredness could have had an effect on the effort put into the training programs. The lack of an all out effort on the part of the subjects during training could have been responsible for the lack of increase in response time.

Another psychological factor involved in this study, was the anxiety of the subjects at the beginning and during pre-testing and the possible lack of anxiety during the post-test. This factor alone could have been responsible for the results not being significant.

Recommendations for Further Study

1. Further studies should be made using a larger number of subjects, a wider range of training programs, a variety of starting forms, and a variety of age groups.

2. Further studies should be made involving only girls and only boys.

3. Further studies should be made where the environment can be controlled during testing.

4. Further studies should be made where the training programs are done more days a week and over a longer period of time.

5. Further studies should be made to determine the psychological effect on response time of a sprinter's start.

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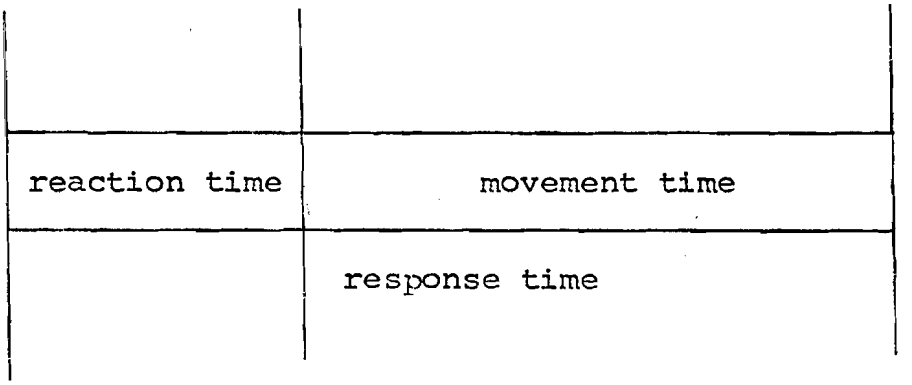
APPENDIX

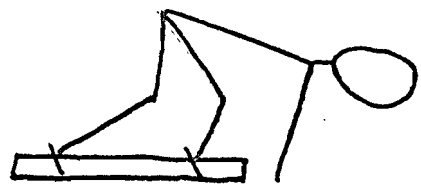
Appendix A

RESPONSE TIME CHART



Appendix B

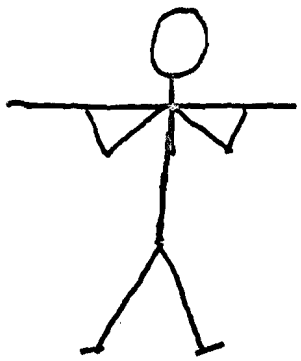
STARTING FORM



Medium Start Form

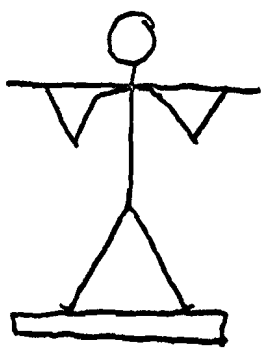
Appendix C

WEIGHT TRAINING DIAGRAMS



1/2 Squat (position #1)

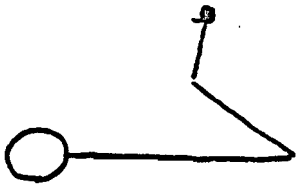
1/2 Squat (position #2)



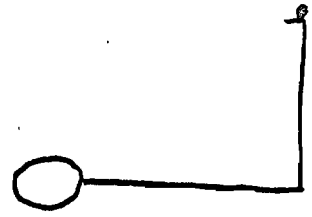
Toe Raises (position #1)

Toe Raises (position #2)

Appendix C (continued)

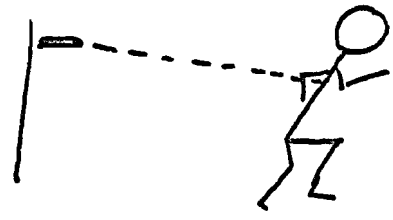


Leg Press (position #1)



Leg Press (position #2)

Exer-genie (position #1)



Exer-genie (running)