A STUDY OF THE REACTION TIME OF SPRINTERS AND DISTANCE RUNNERS AT THE SECONDARY SCHOOL LEVEL

A Thesis

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Recreation, and Athletics

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by

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS USED

In all phases of education, as well as in almost all phases of life, the value of testing and the application of the results of that testing has led to tremendous progress and developments.

In the field of physical education, as in perhaps no other field, we can see these results illustrated as records which once looked unattainable are replaced by new records which will soon be replaced by new.

This writer feels that the utilization of testing should be an integral part of a physical education program, and that the more simple the device used, the more likely that this testing will be accomplished.

I. THE PROBLEM

Statement of the problem. The purpose of this study was to investigate the relationship between hand reaction time and speed of movement of sprinters and distance runners at the secondary school level at Wichita High School North.

Importance of the study. In this study this writer

hoped to contribute some data which would help in determining if hand reaction time is a factor which might be used when deciding whether a track man should participate as a sprinter or as a distance runner. This might be used as a guide to help the undeveloped track aspirant to find the events in which he will probably develop best.

Limitations of the study. This study was limited to the sophomore, junior and senior track boys at Wichita High School North in Wichita, Kansas.

This study was concerned with testing of only two qualities: (1) speed of movement, and (2) hand reaction time.

II. DEFINITIONS OF TERMS USED

Sprinter. One who runs a race of 440 yards of less.[1]

Distance runner. One who runs a race greater than 440 yards in distance.[2]

Reaction time. The time elapse between a stimulus and a response.

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[1]Brother G. Luke, F.S.C., Coaching High School Track and Field (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958), p. 21.

[2]Ibid., p. 40.

Secondary School level. In this study the secondary school level pertains to sophomore, junior and senior classes, rather than to a four year secondary school.

CHAPTER II

REVIEW OF RELATED LITERATURE

The exploration of the relationship, if any, between reaction time and speed of movement has involved the time and talents of many men who have done studies in these fields. It is the purpose of this chapter to present a summary of those studies which are related to (1) speed of movement, (2) reaction time, and (3) the relationship between reaction time and speed of movement.

I. RESEARCH RELATED TO SPEED OF MOVEMENT

Various theories as to what causes speed of movement may be found. Luke stated that either a boy is fast or he is not. Although one tends to associate the slimmer type of athlete with distance running where excess poundage would be a handicap, body build should not be the primary guide in making the selection of sprinters or distance runners.[3]

Miller, using data on a 60 yard dash, concurred that speed is an innate factor which is not significantly related to body size or build. He selected at random 1,559

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[3] Ibid., p. 40.

pretest records from some 6,000 which were collected during the academic year of 1942-43. He felt that perhaps the heavier individuals accommodate increased weight by an increase in strength.[4]

Rasch studied the relationship of arm strength, weight, and length to the speed of arm movement. His test was administered to twenty-five males between the ages of 17 and 47. With a single exception, these men had histories of extensive athletic experience. His findings showed no significant correlation between the speed of movement of an arm in relation to the strength of that arm. These results substantiated the theory that strength in action is controlled by neuromotor coordination centers of the nervous system and exhibits the high specificity that is found in other activities of this nature.[5]

The speed of a lateral arm movement and the strength mass ratio were measured by Clarke in forty-eight university student volunteers enrolled in elementary physical education

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[4]K. D. Miller, "A Critique on the Use of the Height-Weight Factors in the Performance Classification of College Men," Research Quarterly, 23: 402, 1952.

[5]Philip J. Rasch, "Relationship of Arm Strength, Weight, and Length to Speed of Arm Movement," Research Quarterly, 25: 328-332, 1945.

classes. Clarke found, also, that the ability to exert muscular strength in a coordinated manner is determined by a specific neuromuscular pattern. Knowledge of the muscular strength cannot be used to predict successfully the speed of an arm movement. He found the correlation in movement time and reaction time to be low (r=.045).[6]

Chui, stating that little attention had been focused on determining which training method was most influential in causing a significant increase in limb speed, compared the effects of isometric and dynamic weight training exercises on strength and speed of single discreet movements. He used seventy-two male subjects who elected to enroll in a weight training activity section and twenty-four subjects enrolled in another activity section who performed no weight training exercises of any sort. He found that significant gains in limb strength, resulting from performing resistive and non-resistive exercises in a specific range of movement, were accompanied by significant gains in speed of the same movement. Since the difference in strength and speed gain between exercise regimens was nonsignificant, both training methods appeared to be equally effective.[7]

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[6]David H. Clarke, "Correlation Between the Strength Mass Ratio and the Speed of an Arm Movement," Research Quarterly, 31: 570-574, 1960.

[7]Edward F. Chui, "Effects of Isometric and Dynamic Weight Training Exercises Upon Strength and Speed of Movement," Research Quarterly, 35: 246-257, 1964.

In a study of the effect of weight training on the speed of movement, Wilkens compiled data from testing nine chronic weight lifters, nineteen beginning weight lifters, and eighteen beginning swimmers and golfers who had weight trained over a period of one semester. This training had no slowing effect on speed of arm movement. Wilkens stated that the chronic weight lifter is not "muscle bound" in the sense that his speed of movement is impaired. His speed is as great as that of other students and improves as much or more during a semester of training.[8]

Henry, in a study of increase of speed of movement by motivation and by transfer of motivated improvement, used ten experimental and ten control subjects. The experimental group exhibited a transfer effect of 12 per cent on a retest of a relatively complicated movement after a period of materialization by applying a mild electric shock during the slower responses of a simple movement. The control group showed no statistically significant transfer from unmotivated practice with the simple movement. The resulting improvement of the experimental group was

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[8]Bruce M. Wilkens, "The Effect of Weight Training on Speed of Movement," Research Quarterly, 23: 361, 1952.

considered more likely to be due to transfer of the motivation effect rather than to transfer of learning.[9]

Electric shock motivation was studied, also, by Munro, using sixty male university students randomly assigned to six groups of ten each. The ball-snatch test was followed by an electric shock if response was slow. This motivation speeded the reaction of the subjects. In order to see if motivation was retained, a second ball-snatch test was given. It was found, using a control group which did receive shock motivation, that the major part of the improvement was due to the electric shock motivation. Munro concluded that a period of seven weeks is required for the increase in speed transferred from motivated simpler response to significantly retrogress toward the initial speed of movement. Munro also concluded that foreperiods of two, three, and four seconds do not influence the speed of response, although a one second foreperiod results in slower responses.[10]

Thompson, Nagle, and Dobias conducted studies to measure movement time of forty-three Boston University varsity football players and forty New Hampshire High School

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[9]Franklin M. Henry, "Increase in Speed of Movement by Motivation and by Transfer of Motivated Improvement," Research Quarterly, 22: 219-228, 1951.

[10]Sanford J. Munro, "The Retention of Increase in Speed of Movement Transferred from Motivated Simpler Response," Research Quarterly, 22: 229-233, 1951.

football lettermen in response to selected starting signals. Each group was tested on two starting counts, rhythmic and non-rhythmic. Both groups reacted more quickly to the starting signals which allowed the subjects to concentrate on the response rather than the stimulus. The rhythmic digit starting signals permitted the fastest movements, .51 second for college players and .54 second for high school football players. Non-rhythmic word digit and non-rhythmic color signals were investigated and found to result in slower reaction and speed of movement times.[11]

II. RESEARCH RELATED TO REACTION TIME

Pierson conducted a study of twenty-one untrained subjects selected on the basis of body build. These subjects were measured for height, weight and speed of a sprint start. Pierson concluded that the speed with which one can get into action has little relation to his height, weight, calculated body fat or lean body mass.[12] This study supports an earlier one by Miller in which he determined that speed with

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[11]E. W. Thompson, F. J. Nagle, and R. Dobias, "Football Starting Signals and Movement Times of High School and College Football Players," Research Quarterly, 29: 222-230, 1958.

[12]William R. Pierson, "Body Size and Speed," Research Quarterly, 32: 197, 1961.

which the untrained individual can react may have little relationship to his body size.[13]

In a study of reaction time measures to a visual stimulus and arm displacement, Slater-Hammel tested eighty volunteer male university students ranging in age from 18 to 27. The groups consisted of twenty varsity athletes, twenty physical education majors who were not varsity athletes, twenty music majors who were not varsity athletes and twenty liberal art majors who were not varsity athletes. He concluded that only a small relationship existed between reaction time to arm displacement and visual stimulus. He found significant differences in reaction time among the several groups for both reaction time measures.[14]

Henry and Trafton secured data from twenty-five young men in a physical education major curriculum. Each subject was physically active, but was not an experienced track man. In testing the subjects on a 50 yard dash, timing stations were placed at five yard intervals and each subject made two runs each. An automatic timing apparatus attached to the starting block was used to determine the reaction time.

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[13]Miller, loc. cit.

[14]A. T. Slater-Hammel, "Comparisons of Reaction Time Measures to Visual Stimulus and Arm Movement," Research Quarterly, 26: 470-479, 1955.

The subjects also rode a bicycle ergometer twice at different speeds and with different loads. During the ergometer work, oxygen consumption was measured continuously. It was found that maximum velocity was important in determining speed for the first five or ten yards, but not thereafter. Reaction time was also an important factor for a five yard dash, but of no importance if the run was twenty yards or longer.[15]

Henry tested to see what part the starting position played in human speed in dashes. The study included six men with two or more years of successful competitive college experience in the dashes, six with only freshman experience and six with high school experience, but who had never run in college. He found that reaction time is uninfluenced by block spacing and is unrelated to speed in the sprints. The highest proportion of best runs and the smallest proportion of poorest runs result from starting with a sixteen inch stance.[16]

In investigating how long a baseball player could

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[15]Franklin M. Henry and Irving R. Trafton, "The Velocity Curve of Sprint Running with some Observation on the Muscle Viscosity Factor," Research Quarterly, 22: 409-422, 1951.

[16]Franklin M. Henry, "Force-time Characteristics of the Sprint Start," Research Quarterly, 23: 301, 1952.

wait before he started the swing of his bat, Slater-Hammel and Stumpner investigated starting reaction time and movement reaction time. Their subjects were twenty-five male physical education majors at Indiana University. The subjects ranging in age from 20 to 29, were all right handed and all had had many years of baseball experience. Mean starting reaction time was found to be .21 and mean movement reaction time was .27.[17] Andrews had found that a simple hand response to a visual stimulus ranged from .150 to .225.[18] Scott stated that a fast ball travels from pitcher to home base in approximately .43 to .58 seconds.[19] Using these statistics, a batter would have to start his swing twenty-two to thirty feet from home base starting reaction time and twenty-eight to thirty-eight feet in movement reaction time. Slater-Hammel and Stumpner stated that some implication in batting under game conditions were noted.[20]

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[17]A. T. Slater-Hammel and R. L. Stumpner, "Batting Reaction Time," Research Quarterly, 21: 353-356, 1950.

[18]T. G. Andrews, Methods of Psychology (New York: John Wiley and Sons, Inc., 1948) p. 463.

[19]M. Gladys Scott, Analysis of Human Motion (New York: F. S. Crafts and Co., 1945) pp. 145-46.

[20]Slater-Hammel and Stumpner, op. cit., pp. 353-356.

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[19]M. Gladys Scott, Analysis of Human Motion (New York: F. S. Crafts and Co., 1945) pp. 145-46.

[20]Slater-Hammel and Stumpner, op. cit., pp. 353-356.

Reaction time of the batter in softball is important because of short pitching distance and the speed of the pitcher. Nine volunteer right handed pitchers were tested for speed by Miller and Shay and were found to have an average velocity of 59.95 mph. A mean reaction time of .215 seconds was found for 258 male freshmen students tested. With these averages, the ball would be 29.33 feet from home plate before 116 of these students began their swings. In forty-one cases, the ball would be less than twenty feet from the plate. Pitchers with greater velocity would decrease the success of the batter if the reaction time remained the same.[21]

In a study of the reaction time of male high school students, Atwell and Elbel random selected 247 subjects ranging in age 14 to 17. These subjects were tested in hand and body response to an auditory stimulus. The hand response correlation coefficient was found to be .9637 and the body response correlation coefficient was .9875. These results were compared with the results which had been obtained in a similar study which was done on university students in which the same apparatus was used. Correlation coefficients

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[21]Robert G. Miller and Clayton T. Shay, "Relationship of Reaction Time to the Speed of a Softball," Research Quarterly, 35: 433-437, 1964.

between hand and body response for each group were significant but low. This study tends to show that maximum reaction time is not reached fully at the high school level.[22]

III. RESEARCH RELATED TO THE RELATIONSHIP BETWEEN REACTION TIME AND SPEED OF MOVEMENT

Westerlund and Tuttle, in some of the earliest work in studying the relationship between running events and reaction time, felt that in shorter distances it was evident that the time required for leaving the mark is more important than where the greater distances are to be covered. With that being the case, and other factors such as skill and physical condition being equal, the individual with the shortest reaction time has an advantage in sprint events. Their investigation was undertaken in order to determine whether there is a difference between reaction times of those running the short distances and of those who specialize in the distance events. They were attempting to find if there is any correlation between speed in running and reaction time. They concluded that there is a high degree of

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[22]William O. Atwell and Edwin E. Elbel, "Reaction Time of Male High School Students in 14-17 Year Age Groups," Research Quarterly, 19: 22-29, 1948.

relationship between reaction time and speed in sprinting. They found a coefficient of correlation of .863.[23]

Later studies often presented a contradictory point of view. Fairclaugh arbitrarily selected forty male students from a group of forty-four students of university physical education classes which had been given a foot test. These students, half as an experimental group and half as a control group, were tested as to speed on a hand co-ordination movement and on a foot co-ordination movement. There was a low negative correlation (r=-.278) between reaction time and movement time in the transfer of motivated improvement. The subject who improves in reaction time tends to slow up in movement time and vice versa.[24]

Henry conducted a study wherein sixty college men were measured on a ball snatch co-ordination test. Their responses were fractioned into reaction time and movement phases through the use of two chronoscopes. Another group of forty-three men were similarly measured on a treadle press test. The reaction time phase was improved only when

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[23]J. H. Westerlund and W. W. Tuttle, "Relationship Between Running Events in Track and Reaction Time," Research Quarterly, 2: 95-100, 1931.

[24]Richard H. Fairclaugh, Jr., "Transfer of Motivated Improvement in Speed of Reaction and Movement," Research Quarterly, 23: 20-27, 1952.

the motivation was informational. The reaction and movement functions were found to be independent and non significant. Correlation was from -.07 to +.15 between reaction time and movement time.[25]

Speed of arm and leg movements and the reaction time for these movements were measured for a modified baseball throw and a football kick in a study conducted by Lotter. Two groups of adult males, all volunteers, were tested. One group consisted of eighty college students. The other group was made up of twenty-five graduate students and staff members. He found individual differences in ability to move an arm or leg quickly to be non-significant to the reaction time for these movements.[26]

Two groups were involved in testing by Henry and Whitley in a study of relationships between individual differences in arm mass, static arm strength and strength in action. In the first experiment, there were thirty-five male subjects, heterogeneous as to age, all physically

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[25]Franklin M. Henry, "Independence of Reaction and Movement Times and Equivalence of Sensory Motivators of Faster Response," Research Quarterly, 23: 45-53, 1952.

[26]Willard S. Lotter, "Interrelationships Among Reaction Times and Speeds of Movement in Different Limbs," Research Quarterly, 31: 147-155, 1960.

active in their habits since they were physical education major students and instructors. The second experiment used thirty male students who were volunteers from activity classes. No significant correlation was found, even though the reliability was high for all variables. Henry and Whitley correlated reaction time and movement time using only the measurements of the second group. The observed correlation was r=.0594, which is not significant.[27]

Factor analyses were made of reaction time and maximal limb speed measurements of six movements using eighty volunteer college men. Measurements of reaction time, speed, strength, and the ratio of limb strength to limb mass in four movements were also analyzed, using another seventy volunteer college men. A factor labeled quickness of reaction was found to be characterized by relatively high loadings in reaction time items. A second factor labeled speed of limb movement was identified. It was characterized by low saturation. About two-thirds of the individual difference variance in speed was specific to a particular limb and/or movement. A third factor, limb strength in proportion to limb mass, had moderate saturation

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[27]Franklin M. Henry and J. D. Whitley, "Relationship Between Individual Differences in Strength, Speed and Mass in an Arm Movement," Research Quarterly, 31: 24-33, 1960.

with about half of the variance in the specificity category. This factor was orthogonal to limb reaction and limb speed, and had a correlation of .52 with the factor simple limb strength.[28]

Using fifty male volunteer university students, 80% physical education majors and 20% student volunteers from activity classes, Wilson conducted a test in which reaction time and movement time were measured with both rhythmic and non-rhythmic stimulus present. The average reaction time was .198 seconds with rhythmic signal presentation. It increased significantly to the extent of 5.95 percentile when non-rhythmic presentation was used. The average movement time, .208 seconds, was not significantly influenced by the method of signal presentation. The correlation between individual differences in reaction and movement times was quite low.[29]

In a study of the differences in quickness of fencers and non-fencers, Pierson worked with a group of twenty-five

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[28]Franklin M. Henry, W. S. Lotter and L. E. Smith, "Factorial Structure of Individual Differences in Limb Speed, Reaction, and Strength," Research Quarterly, 33:70-84, 1962.

[29]Donald J. Wilson, "Quickness of Reaction and Movement Related to Rhythmicity or Non-Rhythmicity of Signal Presentation," Research Quarterly, 30: 101-109, 1959.

fencers and twenty-five nonfencers. Among his conclusions he found that neither fencers nor nonfencers demonstrated any correlation between speed of arm movement and reaction time, speed of arm movement and arm length or reaction time and arm length.[30]

Forty-seven volunteer male college students were tested for speed of reaction and movement in a knee extension movement of 68°. One week later, only thirty-nine of the same subjects were retested on the same parameters. In both tests, reaction time was found to correlate with speed of movement (r=.536 and .629 respectively). The two correlation coefficients were not found to differ significantly from each other.[31]

Howell conducted a study wherein fifty volunteer male athletes, who were, or had been, participating in sports, were tested for reaction time and movement time before and after motivation. Howell described this as "informational motivation." The motivation used was an electric shock.

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[30]William R. Pierson, "Comparison of Fencers and Nonfencers by Psychomotor, Space Perception and Anthropometric Measures," Research Quarterly, 37: 55-60, 1966.

[31]Barry A. Kerr, "Relationship between Speed of Reaction and Movement in a Knee Extension Movement," Research Quarterly, 37: 55-60, 1966.

It was shown that movement time of a coordinated response was improved by either non-informational or informational motivation, but reaction time was improved only when the motivation was informational. Comparing total time scores in a series of coordinated movements, a psychologically tense group improved significantly more than a less tense group under the influence of informational motivation. Both groups also improved when the motivation was non-informational, but did not differ significantly in the amount of increase.[32]

In studying the influence of fatiguing warm-up exercises on speed of movement, Phillips used three groups, each consisting of twenty-five volunteer male college students, which were measured under both test and control conditions. Phillips found that related warm-up exercise of moderate intensity failed to improve arm speed in a large muscle criterion movement. However, heavy, but non-related warm-up exercise did improve the speed by sixteen per cent. Neither of the warm-up exercises influenced reaction latency. The correlation between reaction time and movement time scores was non-significant ($r=.17$).[33]

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[32]Maxwell L. Howell, "Influence of Emotional Tension on Speed of Reaction and Movement," Research Quarterly, 24: 22-32, 1953.

[33]William H. Phillips, "Influence of Fatiguing Warm-up Exercises on Speed of Movement and Reaction Latency," Research Quarterly, 34: 370-378, 1963.

Data was collected by Youngen from 122 volunteer women subjects at Michigan State University constituting two groups, the athletes and the nonathletes. The non-athletic group was composed of seventy-five women and the athletic group was composed of forty-seven women. It was concluded that women athletes were significantly faster than women nonathletes in speed of movement and reaction. Youngen indicated that individual differences in reaction time and movement time are frequently independent and uncorrelated in a variety of motor performances, although a low but statistically significant relationship was found (.270).[34]

Hodgkins, in a study of reaction time and movement time in males and females of all ages, analyzed data collected from 930 subjects ranging in age 6 to 84. Classes in the first, seventh and tenth grades in public schools were randomly selected and all students in each of these classes were used as subjects. The other subjects were volunteer college students ranging in age from 18 to 21 and volunteers from a recreation club. The results of reaction

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[34]Lair Youngen, "A Comparison of Reaction and Movement Time of Women Athletes and Nonathletes," Research Quarterly, 30: 349-355, 1959.

time and movement time analysis indicated that (1) males are faster than females in both reaction and movement, (2) speed of both reaction time and movement time increases up to early adulthood and then decreases, (3) peak speed is maintained longer by males in movement and longer by females in reaction, and (4) in the majority of groups studied, no relationship existed between speed of reaction and speed of movement.[35]

Reaction time latency and time required for basic limb movement made at maximum speed were measured by Henry in 402 volunteer subjects including both sexes and ranging in age from 8 to 30 years. Variations of stimulus type and complexity, had no influence on the amount of correlation between reaction time and movement time. Neither age nor sex influenced the amount of correlation, which was zero under all conditions. Women reacted slower than men, but the difference was less than .01 seconds. Women averaged 22% slower in movement time than men. Henry also found that subjects less than 18 years of age reacted and moved slower than subjects 19 to 30 years of age.[36]

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[35]Jean Hodgkins, "Reaction Time and Speed of Movement in Males and Females of Various Age," Research Quarterly, 34: 335-343, 1963.

[36]Franklin M. Henry, "Stimulus Complexity, Movement Complexity, Age and Sex in Relation to Reaction Latency and Speed in Limb Movement," Research Quarterly, 32: 353-366, 1961.

In a study of racial differences in this field, Hipple tested sixty boys aged 12 to 14 years. Half were Negroes and the remainder white, with half of each racial group in the motivated or "experimental" group. The groups were matched according to age and race. The subjects were measured on muscular tension by the pneumatic bulb technique. In the second part of the test, the experimental group was subjected to informational motivation produced by a loud sound that came on at the average individual response time. The result showed no statistically significant difference between the whites and the Negroes in reaction time, movement time or muscular tension during the first and unmotivated part of the experiment. The white motivated experimental group showed a significant improvement over the white control group in reaction time and movement time and had a larger increase in muscular tension. While the Negro experimental group also improved, there was no clearly significant change in any reaction time, movement time or muscular tension compared with the Negro control group. In both racial groups, the percentage improvement due to motivation was two to three times greater for net movement time than it was for reaction time. Hipple found that an increase in speed of reaction time and/or movement time due to informational motivation was accompanied by a rise in

muscular tension for the whites by a correlation of .38. The results were inconclusive for the Negroes since the correlation was .23.[37]

Pierson conducted a study with four hundred male subjects between the ages of 8 and 83. These subjects were measured for reaction time and movement time by a fractioning process. A statistical analysis of the data indicated that when subjects other than just male college students are used, there is a statistically significant correlation (.33) between reaction time and movement time.[38]

Whereas Pierson had employed an eleven inch foreward arm-thrust movement in his study,[39] Mendryk included another movement in his study of male subjects at ages of 12, 22 and 48 years. This movement was a twenty-five inch circular clockwise orbit of the hand in the horizontal plane, with continuation of the movement on a tangent in the forward direction of thirty-six inches. The reaction time and movement time of 150 subjects divided into the three equal

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[37]Joseph E. Hipple, "Racial Difference in the Influence of Motivation of Muscular Tension, Reaction Time and Speed of Movement," Research Quarterly, 25: 297-306, 1954.

[38]William R. Pierson, "The Relationship of Movement Time and Reaction Time from Childhood to Senility," Research Quarterly, 30: 227-231, 1959.

[39]Ibid., p. 228.

age groups returned an average intercorrelation of only .127 for the shorter arm movement and .138 in the longer movement. The correlation was nonsignificant and unrelated to age although the absolute speeds of reaction time and movement time were both approximately twelve percent faster in college men age 22 than in 12 year old boys or 48 year old men.[40]

Smith suggests also that the significant correlation found by Pierson was due to the kind of movement, the forward arm thrust, which was used. Smith studied four types of movements of the limbs, the arm forward and backward and the leg forward and backward. His subjects were seventy male undergraduate volunteers from physical education and R.O.T.C. classes. No specialized athletes were used and the mean age was 23.7 years. Smith concluded that individual differences in ability to react quickly and ability to move quickly are almost entirely unrelated.[41]

In a later study Smith investigated whether it is more advantageous for an athlete to initiate and to complete

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[40]Stephen Mendryk, "Reaction Time, Movement Time and Task Specificity Relationships at Ages 12, 22, and 48 Years," Research Quarterly, 31: 156-162, 1960.

[41]Leon E. Smith, "Reaction Time and Movement Time in Four Large Muscle Movements," Research Quarterly, 32: 88-92, 1961.

a fast movement when his muscles are in a relaxed or a tensed condition. He tested forty college men under experimental conditions of stretch, tension and relaxation. An analysis of variance revealed that reaction time and velocity of the arm during the state of stretch was not significantly faster than either condition when the arm was relaxed or tensed. An analysis of the final third of the arm movement revealed a significantly faster movement when the prime movers of the limb were stretched. During the condition of tension, reaction and movement times were faster than when the arm was relaxed. A high degree of specificity of relationship was found between reaction time and movement time.[42]

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[42]Leon E. Smith, "Effect of Muscular Stretch, Tension and Relaxation upon the Reaction Time and Speed of Movement of a Supported Limb," Research Quarterly, 35: 546-543, 1964.

CHAPTER III

PROCEDURES

I. OVERVIEW OF PROCEDURES

The purpose of this study was to investigate the relationship between hand reaction time and speed of movement of sprinters and distance runners at the secondary level at Wichita High School North. The Nelson-Reaction Timer Test was administered to forty-four subjects as a measure of reaction time of hand to sight. A running speed test of fifty yards was used to test the same subjects for speed. The results of the two tests were analyzed following the completion of both the Nelson-Reaction Timer Test and the running speed test of fifty yards.

II. NATURE OF THE VARSITY TRACK PROGRAM

The forty-four subjects of this study were sophomore, junior, and senior members of the 1967 spring track squad of Wichita High School North, Wichita, Kansas, all male, and all between the ages of 15 to 18. The students chose track as an elective varsity sport, and were participating as sprinters or as distance runners (greater than 440 yards) by their own choice. The subjects trained both morning and afternoon,

six days a week, for the twelve-week track season. Of fifty-four boys who registered for track at the beginning of the season, forty-four remained by the sixth week when the fifty yard running speed test of this study was given and all of the forty-four served as subjects. The Nelson-Reaction Timer Test was administered during the sixth and seventh week of the season.

III. ORIENTATION PROCEDURES

The fifty yard running speed test was administered during a track practice session. The investigator, serving as one of the coaches of the squad and familiar to all the subjects, explained and demonstrated the nature and the purpose of the test. The subjects were given a fifteen minute warm up period prior to the administration of the test.

The Nelson-Reaction Timer Test was explained and demonstrated to each subject at the time the test was given. Each subject was permitted fifteen practice trials with the timer before scores were recorded.

IV. FACILITIES AND INSTRUMENTATION

The fifty yard running speed test was administered on the cinder track at the track facilities of Wichita High School North. It was timed with a stop watch to the nearest

one-tenth of a second. The subjects were dressed in practice equipment of shorts and T-shirts and were wearing spike track shoes. The reaction time was tested in the gymnasium class room by the Nelson-Reaction Timer, Model RT-2. The researcher, was assisted by a cadet teacher as a recorder and by another coach who served as the starter in the fifty yard speed test.

V. TESTING PROCEDURES

Speed test. The speed test was administered on a cinder track of fifty yards distance. The subjects had a running start of twenty yards before crossing the chalk line which designated the beginning of the fifty yard course. The timer stood on a six foot tower at a distance of twenty-five yards perpendicular from the mid-point of the fifty yard course. This placed him at a diagonal distance of 35.35 yards from the beginning and from the end of the course (see appendix A). The timer started and stopped the watch by sight as the subject crossed the chalk line at the beginning and at the end of the course. Each subject ran this course three times, and the average time was recorded.

Hand Reaction Time Test. The Nelson-Reaction Timer was used in the hand reaction test. The subject rested his forearm and hand comfortably on the top of a desk while

sitting down. The tips of the thumb and the index finger were held one inch apart in a pinching position and extended beyond the edge of the desk three or four inches. The upper edge of both the thumb and index fingers were held in a horizontal position.

The tester held the reaction timer near the top and suspended it between the subject's thumb and index finger. The "base line" was held level with the upper edge of the subject's thumb.

The subject was instructed to look at the "concentration zone", the black lined zone between the .120 and .130 lines, and to react as quickly as possible by pinching his thumb and index finger together when the tester released the reaction timer. The subject was instructed not to look at the tester's hand, nor to move his hand up or down when he made his response.

After the subject understood the procedure, he was tested fifteen consecutive times. The five fastest of the fifteen scores were discarded as being the result of possible anticipation. The five slowest scores were discarded as being the result of possibly being caught in a trough of attention. The five middle scores were averaged in order to determine the subject's average reaction time.

CHAPTER IV

ANALYSIS OF DATA

Analysis of the data which resulted from this investigation was by the product moment coefficient of correlation method. The method of testing the significance of r, the correlation coefficient, was to convert it into a Fisher's Z function. This conversion was used primarily for two reasons: (1) its sampling distribution is approximately normal, and (2) its standard error depends only upon the size of the sample N, and is independent of the size of the correlation coefficient.[43] The second statistical procedure was a t test for significance between the groups on correlation of the two variables.

I. HAND REACTION TIME AND MOVEMENT TIME OF SPRINTERS

The sprinters were ranked according to their hand reaction times from the fastest times to slowest times and were then divided equally into two groups. The top half of the scale was classified as the faster group and the slower group was the bottom half of the scale.

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[43] William L. Hays, Statistics for Psychologists (New York: Holt, Rinehart and Winston, Inc., 1965), pp. 530-533.

The correlation between reaction time and movement time for the faster half of the sprinters had a -.04 value. This correlation converted into the Fisher Z is .04. The .95 confidence interval showed a wide range of -.69 to .61. Reconverting these scores back into the product method correlation, the interval was -.60 to .54. This correlation was nonsignificant at the .95 confidence interval.

The correlation between reaction time and movement time for the slower half of the sprinters had a .085 value. This correlation converted into the Fisher Z is .085. The .95 confidence interval showed a wide range of -.61 to .78. Reconverting these scores back into the product method of correlation, the interval was -.54 to .65. This correlation also was nonsignificant at the .95 confidence interval.

The total correlation between hand reaction time and movement time for the entire group of sprinters had a -.014 value. This correlation converted into the Fisher Z was -.014. The .95 confidence interval showed a range of -.45 to .43. Reconverting these scores back into the product method of correlation, the interval was -.42 to .40. This correlation, as the two previous correlations of the sprinters was nonsignificant.

II. HAND REACTION TIME AND MOVEMENT TIME OF DISTANCE RUNNERS

The distance runners were ranked according to their hand reaction times from fastest times to slowest and were then divided equally into two groups, the faster and the slower as determined by the resulting scale.

The correlation between hand reaction time and movement time for the faster half of the distance runners had a -.529 value. This correlation converted into the Fisher Z is -.59. The .95 confidence interval showed a wide range of -.128 to .10. Reconverting these scores back into the product method correlation, the interval was -.86. to 10. This value of -.59 was nonsignificant at the .95 confidence interval.

The correlation between hand reaction time and movement time for the slower half of the distance runners had a -.015 value. This correlation converted into the Fisher Z is -.015. The .95 confidence interval showed a wide range of -.67 to .63. Reconverting these scores back into the product method correlation, the interval was -.58 to .56. The score of .015 was nonsignificant at the .95 confidence interval.

The total correlation between hand reaction time and movement time for the entire group of distance runners had a value of .20. The correlation converted to the Fisher Z

was .20. The .95 confidence interval showed a range of -.25 to .65. Reconverting to true r's, the interval was -.25 to 57. The correlation value in this study was meaningless.

III. HAND REACTION TIME AND MOVEMENT TIME OF THE GROUP AS A WHOLE

When all subjects, including both sprinters and distance runners, were analyzed as a group the correlation between hand reaction time and movement time had a .133 value. When this correlation was converted into the Fisher Z, a correlation of .133 resulted. When the .95 confidence interval was tabulated, a very wide range of -.17 to .44 resulted. Reconverting these Z's scores back into the product method correlation produced a confidence interval of -.17 to .41. This score means that there are 95 chances in 100 that the obtained r does not miss the true r by more than +.31. Therefore, it can be said that the existence of hand reaction time and movement time of sprinters and distance runners as measured by this study was nonsignificant.

IV. COMPARISON OF SPRINTERS AND DISTANCE RUNNERS BY TWO VARIABLES

When sprinters were compared to distance runners to locate any significance in differences that might exist between hand reaction time and speed of movement, a *t* test for significance was used.

Hand Reaction Time. The distance runners, those subjects who participate in running events of greater than 440 yards, had a mean hand reaction time of .185 compared to the sprinter's .181. A mean difference of .004 yielded a standard error (SE) difference of .0043. When the *t* of .94 was found with 42 degrees of freedom, this *t* did not reach the .05 level. Therefore, the obtained mean difference of .004 was nonsignificant. The results are shown in Table I.

TABLE I

THE SIGNIFICANCE OF THE DIFFERENCE OF HAND REACTION TIME BETWEEN SPRINTERS AND DISTANCE RUNNERS

Group	N	Mean Reaction Time	Mean Diff.	SE Diff.	*t*	P
Distance Runners	21	.185	.004	.004	.94	--
Sprinters	23	.181				

t needed for .05 level of significance = 2.02

t needed for .01 level of significance = 2.71

Movement Time. In the test of speed of 50 yards, the distance runner had a mean movement time of 6.01 seconds compared to the sprinter's 5.63 seconds. A mean difference of .38 yielded a SE difference of .143 and resulted in the *t* of 2.66 with 42 degrees of freedom. The obtained *t* of 2.66 is significant at the .05 level, but not at the .01 level. Only once in twenty comparisons of distance runners and sprinters on this test would we expect to find a difference as large as or larger than 2.66 under the null hypothesis. We may be reasonably confident, therefore, that in general sprinters do better than distance runners on the speed of movement test.

TABLE II

THE SIGNIFICANCE OF THE DIFFERENCE OF MEAN SPEED OF RUNNING BETWEEN SPRINTERS AND DISTANCE RUNNERS

Group	N	Mean Speed	Mean Diff.	SE Diff.	*t*	P
Distance Runners	21	6.01	.38	.143	2.66	.05
Sprinters	23	5.63				

t needed for .05 level of significance = 2.02

t needed for .05 level of significance = 2.71

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to investigate the relationship between hand reaction time and speed of movement of male sprinters and distance runners at the secondary school level. The subjects used in this study were the sophomore, junior, and senior track boys at Wichita High School North in Wichita, Kansas.

The Nelson-Reaction Timer Test was administered to forty-four subjects as a measure of reaction time of hand to sight. A running speed test of fifty yards was used to test the same subjects for speed. Analysis of the data was by the product moment coefficient of correlation for reaction time to speed of movement and a t test for significance between the groups for correlation of the two variables.

I. FINDINGS

The analysis of the data revealed the following findings:

1. The correlation between hand reaction time and movement time for the faster half of the sprinters was -.04 and nonsignificant at the .05 level.

2. The correlation between hand reaction time and movement time for the slower half of the sprinters was .085 and nonsignificant.

3. The total correlation between hand reaction time and movement time for the entire group of sprinters was -.014 and nonsignificant.

4. The correlation between hand reaction time and movement time for the faster half of the distance runners was -.529 and nonsignificant.

5. The correlation between hand reaction time and movement time for the slower half of the distance runners was -.015 and nonsignificant.

6. The correlation between hand reaction time and movement time for the entire group of distance runners was .20 and nonsignificant.

7. When all subjects were totaled, the correlation between hand reaction time and movement time was .133 and nonsignificant.

8. Distance runners had a hand reaction time mean difference of .004 which was not significant difference at the .05 level when compared to sprinters.

9. Sprinters and distance runners had a movement time mean difference of .38 which was significant at the .05 level favoring the sprinters.

II. CONCLUSIONS

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

1. There is little if any relationship between hand reaction time and movement time as exhibited by male varsity track members.

2. There is no significant difference in the hand reaction time between distance runners and sprinters.

3. In general, sprinters have more speed of movement than do distance runners.

III. IMPLICATIONS

Most boys who participate in track hope to do so initially as sprinters because there is much less endurance and conditioning required. However, in a track program involving a large number of participants, such as at Wichita High School North where this study was made, the supply of sprinters exceeds the demand. Some of the boys who have almost identical abilities to those who remain as sprinters, become distance runners so as to be able to participate in more events. Perhaps this is a contributing factor to the low significance of difference found between the two groups in this investigation.

It was observed during the testing that a boy could have fast reaction time and be slow in speed of movement. The converse was also shown to be true. However, boys who have slow reaction time and who possess good speed of movement can be very valuable to a track team in relay racing where a running start is utilized.

It was observed also that the sprinters who had the highest degree of success in the Wichita High School North track program were those who were high in both qualities of hand reaction time and speed of movement in this investigation.

IV. RECOMMENDATIONS FOR FURTHER STUDY

1. Further investigations should be made using a larger number of subjects and using a wider range of ages, college and beyond.

2. Further investigations should be made with subjects who have acquired a high degree of efficiency in distance running and in sprinting.

3. Further investigations should be made using distance swimmers and sprint swimmers as subjects.

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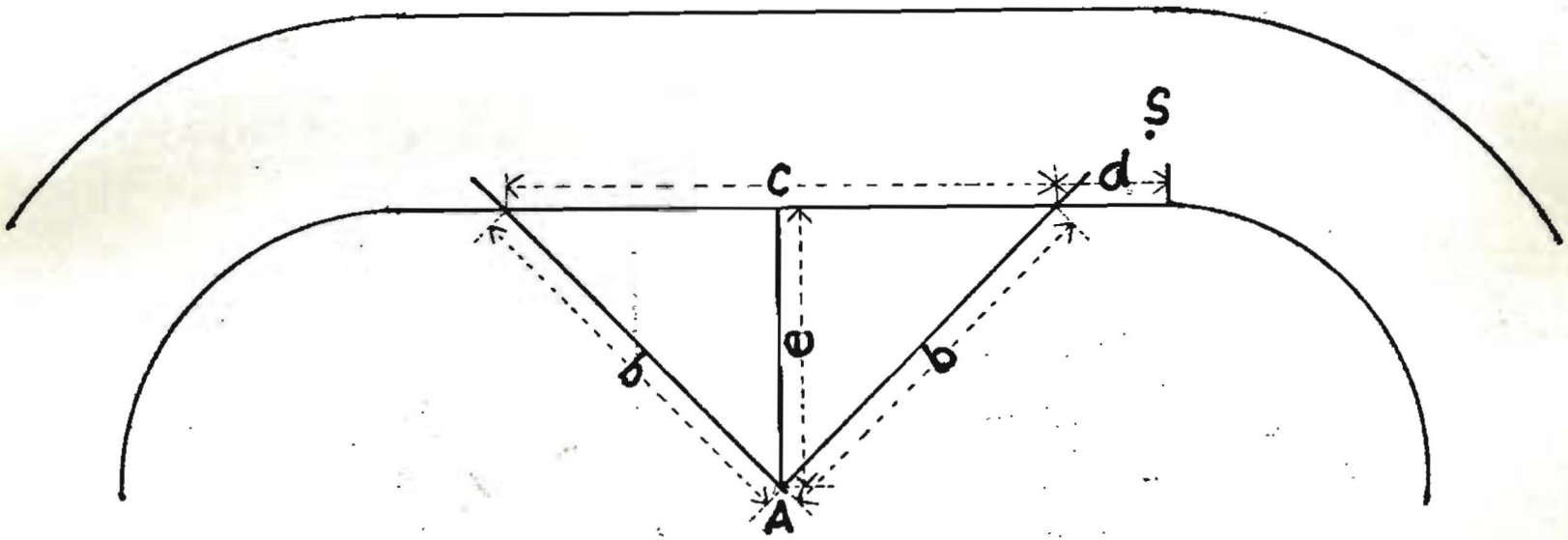
APPENDIX A



A. Six foot stand of the testor

b. 35.35 yard diagonal distance between testor and the starting and finish lines of the 50 yard test run.

c. 50 yard speed of movement test distance.

d. 20 yard approach start of the speed of movement test.

S. Position of the starter