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A Comparison of Reaction Times to a Kinesthetic and a Tactual Stimulus for Groups of Athletes and Non-athletes

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A COMPARISON OF REACTION TIMES TO A KINESTHETIC AND A TACTUAL STIMULUS FOR GROUPS OF ATHLETES AND NON-ATHLETES

BY

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A COMPARISON OF REACTION TIMES TO A KINESTHETIC AND A TACTUAL STIMULUS FOR GROUPS OF ATHLETES AND NON-ATHLETES

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and acceptable as meeting the thesis requirements for this degree; but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor

Head of the Major Department

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CHAPTER I

INTRODUCTION

Research in the prediction of athletic ability has for some years been of major interest in the minds of athletic coaches. This has been particularly true in the field of reaction-time studies. The element of time it takes to discover talent through practice sessions has given importance to the finding of methods to predict sports ability. Information of a scientific nature should prove valuable in objectively evaluating and selecting athletic team members and greatly improve upon the subjective method of selection. Movement and reaction to tactual stimuli are important attributes of the good athlete, and reaction time to various stimuli, such as visual, tactual, and auditory, have been used as a basis of prediction.

This research attempted to study reaction-time measures to muscle sense by use of tactual and kinesthetic stimuli. Wilkinson, in 1958, completed research in this field using visual and kinesthetic stimuli and recommended further study using tactual stimuli.[1] In keeping with this recommendation and using new and advanced equipment, this study was completed.[2]

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[1]James J. Wilkinson, A Study of Reaction-Time Measures to a Kinesthetic and a Visual Stimulus For Selected Groups of Athletes and Non-Athletes, Unpublished Doctor's Dissertation, University of Indiana, Lafayette, Indiana, 1958.

[2]Ibid., p. 84.

Statement of the Problem

It is the purpose of this study to compare reaction time to kinesthetic and tactual stimuli of athletes to that of non-athletes. It was felt that this knowledge could act as a determining factor in the prediction of athletic ability. Results could also be of importance to the field of physical education as a predictor of needed physical activities for the non-athlete, act as a guide in the teaching of new motor skills, and to take care of individual differences of the student.

Subproblems

1. To select 50 athletes from the varsity football, track, basketball, and wrestling squads and 50 physical education students who had not earned a major letter for athletic competition in either high school or college.
2. To compare reaction times of athletes of the various sports to non-athletes using tactual and kinesthetic stimuli.
3. To analyze the results statistically by calculating the means, the differences between the means, the significance of the difference, and the t values.

Delimitations

1. This study was limited to 100 male students at South Dakota State College.
2. The non-athletes were limited to 50 students enrolled in

the service physical education classes.

3. The athletes were limited to 50 subjects from the following sports: football, wrestling, track and basketball.

4. It was not possible to regulate fatigue, sleep, diet or mental attitude.

5. The investigation was limited to kinesthetic and tactual reaction-time measures.

6. Only one initial test was given.

7. Age, height and weight were not factors in the study.

Definitions

1. Kinesthetic Sense--the definition of Best and Taylor will be used: "The sense by which we are made conscious of the extent and the force of muscular contraction and the position of the parts of our bodies."[3]

2. Reaction-Time--the definition of Karpovich will be used: "Reaction-time means the time elapsing between the moment of application of a stimulus and the moment of response."[4]

3. Kinesthetic Stimulus is defined as the sudden dropping of the subject's arm which is held by a leather sleeve and a solenoid magnet.

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[3]C. H. Best and N. B. Taylor, "The Physiological Basis of Medical Practice," pp. 804-805.

[4]Peter V. Karpovich, "Nerve Control of Muscular Activity," Physiology of Muscular Activity, p. 45, W. B. Saunders Company: Philadelphia, Pennsylvania, 1959.

4. Tactual Stimulus is defined as "pertaining to touch."[5]

5. Athlete is defined as a regular member of a varsity athletic team at South Dakota State College.

6. Non-Athlete is defined as a member of a physical education service class at South Dakota State College who had not earned a major letter in high school or college athletic competition.

7. Service Class is defined as physical education classes required for graduation at South Dakota State College.

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[5]Webster's New Collegiate Dictionary, G. and C. Merrian Co., Springfield, Massachusetts, 1945.

CHAPTER II

REVIEW OF LITERATURE

For the purpose of this study, the review of literature has been limited to two divisions: Reaction Time, and Kinesthesis and Kinesthetic Reaction Time.

Reaction Time

Winkler made a study of reaction time of large muscle groups in 30 football players for the purpose of selecting line-backers. He used a movie projector and screen on which he flashed a scrimmage play and four inclined plane switches -- one in front of the subject to represent a run up the middle, one on each side of the subject to represent the end sweep, and one behind the subject to represent the forward pass. From his study, Winkler made the following conclusions: (1) candidates with good reaction time are good in other sports as well as football; (2) experience and maturity have a direct effect on reaction time; and (3) testing the large muscles of football players aid the coaches in selecting their line-backers, halfbacks, and safety men. Also, from this study, several coaches found they were playing boys in the wrong position and should have used boys who had not been playing.[6]

Miles measured the charging reaction time of a group of 87 Stanford University football players and found the starting eleven had a

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[6]George Winkler, A Study of the Reaction Time of High School Defensive Football Players, Unpublished Master of Education Thesis, University of Boston, Boston, Massachusetts, 1956.

significantly lower average charging time than did the remainder of the squad. Of the 53 men who were kept on the varsity squad, the backs had the fastest charging reaction time, with the ends, guards, tackles, and centers following in the order named.[7]

The reaction time of 247 male high school students between 14 and 17 years of age was investigated by Atwell. He recorded two response measures: a hand response, which involved lunging forward a distance equal to the height of the subjects, and striking a paddle contact. Low, but significant, correlations ranging from r = 0.24 to r = 0.43 were found between the two responses measured.[8]

A study made by Wilkinson measured the reaction time to a visual and a kinesthetic stimulus for 50 non-athletes and 100 athletes, of whom 25 were baseball players, 25 were wrestlers, 25 were football players, and 25 were basketball players. The times from the kinesthetic stimulus indicated that (1) wrestlers had the fastest reaction time; (2) baseball players and football players were not significantly different from each other; and (3) no significant difference existed between basketball players and non-athletes, but both groups were significantly lower than all of the other groups. The results of the visual stimulus indicated that (1) wrestlers and baseball players had significantly quicker

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[7]W. R. Miles, "Studies in Physical Education: II, Individual and Group Reaction Time in Football Charging," Research Quarterly, vol. 2, 5-13, AAHPER: Washington, D. C., October, 1931.

[8]W. O. Atwell and E. R. Elbel, "Reaction Time of Male High School Students in 14-17 Age Groups," Research Quarterly, vol. 19, 22-29, AAHPER: Washington, D. C., March, 1948.

reaction times than the other groups, but were not significantly different from each other; (2) football players were significantly faster than basketball players and non-athletes; and (3) basketball players and non-athletes were significantly slower than all other groups, but were not significantly different from each other.[9]

Patrick concluded from his study into the reaction time of basketball players that a reaction time of 1.25 seconds to a visual stimulus is a good indication of potential ability in basketball, and boys with the quickest reaction time are good in other activities. He stated also that reaction time can be improved by practice.[10]

Kroll investigated the relationships among total response times for two wrestling take-down maneuvers, a strength test, and initial take-down ability on 100 varsity high school wrestlers who had finished first or second in a meet or placed in a state meet. He found that strength and experience played the most important part in success in wrestling, with reaction time having very little effect on success.[11]

Burpee and Stroll designed an experiment to test an individual's quick and accurate response to situations in sports. Small and large muscles of four groups of subjects were measured, each group having a different level of success as a participant in physical activities. It

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[9]Wilkinson, op. cit.

[10]John Patrick, "Quick Reaction Time Means Athletic Ability," Athletic Journal, vol. 30, 68, September, 1949.

[11]Walter Kroll, "Selected Factors Associated with Wrestling Success," Research Quarterly, vol. 29, 396-406, AAHPER: Washington, D. C., December, 1958.

was concluded that there appeared to be a significant negative relationship between small-muscle reaction time and successful participation in physical education activities. Fast small-muscle reaction time appeared to be an important factor in attaining success in these activities, and there appeared to be a significant negative correlation between large-muscle reaction time and successful participation in physical activities.[12]

Westerlund and Tuttle conducted a study of 22 varsity track men of short, middle distance, and distance events to determine relationship between running events and reaction time. The reaction time of champions was shorter than any other group regardless of distance, and there was a high degree of relationship between speed in running 75 yards and reaction time.[13]

Attempting to find the relationship of certain sports skills and reaction time, speed of running, and speed when action requiring dexterity of moving the entire body is necessary, Beise and Peaseley found that the skilled group showed a significant difference over the unskilled in reaction time of large muscles, speed of running, and agility. The skilled group also had greater stability in reaction time regardless of

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[12]Royal H. Burpee and Wellington Stroll, "Measuring Reaction Time of Athletes," Research Quarterly, vol. 7, 110-118, AAHPER: Washington, D. C., March, 1936.

[13]J. A. Westerlund and W. W. Tuttle, "Relationship Between Running Events in Track and Reaction Time," Research Quarterly, vol. 2, 95-100, AAHPER: Washington, D. C., October, 1931.

the condition under which the stimulus was given.[14]

Elbel, in a study to determine the effects of various forms of strenuous exercise upon the response time of men, used stool stepping and push-ups for one group of subjects. Other groups participated in basketball, boxing, and fencing. He defined response time as the interval between the sound of a bell and movement of the body. He tested the groups for response time before and after exercise and found no significant change in the response time for the group performing the stool stepping and push-ups. Groups in athletic competition showed a shortened response time which was significant. Elbel suggested that in competitive exercises an emotional component arises which may be an influencing factor in the quickening of response time.[15]

Keller made a study comparing the relation of quickness of bodily movement and success in athletics. He defined quickness as the ability of the body to overcome the effect of inertia. Subjects included 359 athletes and 277 non-athletes attending college and high school. He found a positive relationship between ability to move the body quickly and success in athletic activities. Athletes participating in baseball, football, track, and basketball had faster reaction times than athletes in wrestling, swimming, and gymnastics. Keller

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[14]Dorothy Beiss and Virginia Peaseley, "The Relation of Reaction Time, Speed, and Agility of Big Muscle Groups to Certain Sport Skills," Research Quarterly, vol. 8, 133-142, AAHPER: Washington, D. C., March, 1937.

[15]E. R. Elbel, "A Study of Response Time Before and After Strenuous Exercise," Research Quarterly, vol. 11, 86-95, AAHPER: Washington, D. C., March, 1940.

suggested in his conclusions that athletes with a reaction time too slow for success in team sports, might find success in individual activities.[16]

Yatchmanoff compared reaction times of high school basketball players and high school non-athletes and observed significant differences between the two groups for both hand-eye and foot-eye reaction times. There was a moderate correlation between simple foot-eye and hand-eye reaction times for both groups. In both cases, the basketball players were faster.[17]

Earlier research supported the thought that reaction time and movement were related. Cooper found evidence to indicate that reaction time and movement time were independent and that no relationship existed. Whether or not there was participation in athletics had no effect on relationship between reaction time and various movement times. Reaction time and movement time remained independent when groups from successful backgrounds of participation in either basketball or baseball were investigated. Athletes, in general, appeared to be superior to non-athletes in ability to react quickly. College and high school athletes appeared to be of equal ability in reaction time. No evidence was obtained to show the superiority of either the basketball or baseball

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[16]Louis F. Keller, "The Relation of 'Quickness of Bodily Movement' to Success in Athletics," Research Quarterly, vol. 13, 147-154, AAHPER: Washington, D. C., May, 1942.

[17]Norman Yatchmanoff, A Comparison of Certain Reaction Times of Basketball Players and Non-Athletes Sixteen to Eighteen Years of Age, Unpublished Master of Science Thesis, University of Oregon, Eugene, Oregon, 1951.

players in reaction time or the velocity of movement measures. Both high school and college athletes were superior to non-athletes in ability to react quickly, but all were equal in the ability to negotiate the arm excursion which was the movement used to test the reaction and movement times.[18]

Henry conducted a study to find the basic degree of relationship or absence of relationship between individual differences in reaction time and in speed of movement. The subjects reached for a ball after receiving a stimulus, and a second stimulus was applied as a means of motivation. All groups were significantly improved in reaction time, and most of them in movement time depending upon the motivating stimuli they received.[19]

In a study of 400 males, ages 8 to 83, Pierson found evidence indicating considerable chance for error when conclusions concerning the adult male population are drawn from a sample of male college students. He stated that the relationship of reaction time may be a function of maturity or incidence or employment, since the correlation for subjects more than 21 years of age (r = 0.63) differs from that for subjects between ages 8 and 21 (r = 0.50). He also correlated reaction

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[18]John Cooper, An Investigation of the Relationship Between Reaction Time and Speed of Movement, Unpublished Doctor of Physical Education Dissertation, University of Indiana, Bloomington, Indiana, 1956.

[19]Franklin M. Henry, "Independence of Reaction and Movement Times and Equivalence of Sensory Motivators of Faster Response," Research Quarterly, vol. 23-24, 43-52, AAHPER: Washington, D. C., January, 1952.

time and movement times, as measured in the study, and observed a statistically significant correlation.[20]

Anderson attempted to evaluate the effects of a 14-week weight training program on the total body reaction time of 28 young men. The reaction time was tested by visual, auditory, and a combination of auditory-visual stimuli. The subjects responded to the stimulus with a vertical jump. He divided the group equally into weight-training and developmental exercise classes. Each class met three times a week for one-half hour. The developmental group improved in all of the reaction measures, but only the responses resulting from auditory stimuli were significant. He also concluded that the developmental exercise program improved reaction time only and that weight training would not lengthen the reaction time of an individual. Neither group indicated significant improvement over the other in any of the reaction-time tests.[21]

Morehouse stated that the time required to react to a stimulus is greatly affected by the nature of the stimulus. He added that response to a sound or a touch is quicker than the response to a visual signal, but reaction to all types of stimuli will be lengthened if the

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[20]William R. Pierson, "The Relationship of Movement Time and Reaction Time from Childhood to Senility," Research Quarterly, vol. 30, 227-230, AAHPER: Washington, D. C., May, 1959.

[21]Robert Anderson, The Effect of Weight Training on Total Body Reaction Time, Unpublished Master of Science Thesis, University of Illinois, Urbana, Illinois, 1957.

stimuli are complicated. The data indicated that men react faster than women and that the shortest reaction times in both sexes are during the age period between 21 and 30 years.[22]

Employing athletes and non-athletes to find differences in reaction time, Burley found that all individuals reacted more slowly to complex stimuli than to a simple stimulus. A greater variation in reaction times was scored by all individuals to the complex stimuli than to the more simple stimulus.[23]

Kinesthesis and Kinesthetic Reaction Time

Search of literature pertaining to kinesthesis and kinesthetic reaction time revealed that little research has been done in the field of physical education and athletics.

In a study of tests of kinesthesis by Wiebe, 30 male university students were used as subjects. The students were divided into two groups, athletes and non-athletes. The athletes were chosen by their coaches as being the best all-around on their teams, and the non-athletes were students who had not won a letter for varsity athletic competition in college. A low intercorrelation between kinesthetic tests was found, and it was felt that there is no general kinesthetic

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[22]Laurence E. Morehouse, Physiology of Exercise, p. 67, C. V. Mosby Company: St. Louis, 1959.

[23]Lloyd R. Burley, "A Study of the Reaction Time of Physically Trained Men," Research Quarterly, vol. 15-16, 232-239, AAHPER: Washington, D. C., October, 1944.

sensitivity. He thought there were numerous specific factors involved.[24]

Mumby made a study of the relationship between wrestling ability and kinesthetic acuity. A wrestling class of 21 students was divided into groups of good and poor ability. The subjects' ability to maintain constant pressure and position under a changing and moving position was tested. The results indicated that maintaining constant pressure was related significantly to wrestling ability and that maintaining a constant position was not.[25]

Discrepancy was reported in early tests of kinesthetic reaction time. Vince and Hick made studies concerning the time required for subjects to correct the movement of a lever when sudden changes in pressure were applied. The speed with which the subject could react was measured. Hick found a time of 0.30 seconds was needed.[26] Vince found a time of 0.16 seconds.[27]

Wilkinson, in his review of literature, cited a study by Chernikoff and Taylor in which reaction time was measured after a sudden displacement of the arm held up by an electromagnet.

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[24]V. R. Weibe, "A Study of Tests of Kinesthesis," Research Quarterly, vol. 25, 222-230, AAHPER: Washington, D. C., 1953.

[25]H. H. Mumby, "Kinesthetic Acuity and Balance Related to Wrestling Ability," Research Quarterly, vol. 24, 327-334, AAHPER: Washington, D. C., 1953.

[26]M. A. Vince, "Corrective Movements in a Pursuit Task," Quarterly Journal of Experimental Psychology, vol. 1, 85-103, 175-179, Psychological Laboratory, Cambridge, England, 1949.

[27]W. E. Hick, "Reaction Time for the Amendment of a Response," Quarterly Journal of Experimental Psychology, vol. 1, 175-179, Psychological Laboratory, Cambridge, England, 1949.

> Two different responses were measured: (1) the subject indicated his response by stopping the falling arm. The onset of the change in the acceleration of the arm as he was accomplishing the act was measured for reaction time; (2) the key release response was also measured for reaction to a falling arm. For the purpose of comparison, reaction time to auditory and tactual stimuli were also determined. The times for the mean scores for each of the stimuli were: stopping the falling arm 129.4 ms., key release response to falling arm 149.6 ms., auditory stimulus 151.5 ms., and tactual stimulus 160.3 ms. The experimenters found that when the subject used the displaced arm to stop the timer, there was a significant difference between that time and the other types of response.[28]

Slater - Hammel compared reaction-time measures to a visual and a kinesthetic stimulus. Used as subjects were university students including 20 physical education majors, 20 music majors, 20 liberal arts majors, and 20 athletes. It was indicated that (1) arm movement reaction time was significantly quicker than visual reaction time, (2) athletes were significantly quicker than other groups of subjects, (3) music majors, athletes, and physical education majors were significantly quicker than the liberal arts majors in the arm movement, (4) athletes were significantly quicker than the other groups of subjects for the visual reaction time, and (5) that a positive correlation of 0.502 was revealed in a comparison of the two reaction time measures.[29]

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[28]Wilkinson, op. cit., pp. 27-28.

[29]A. T. Slater - Hammel, "Comparison of Reaction-Time Measures to a Visual Stimulus and Arm Movement, Research Quarterly, vol. 26, 470-479, AAHPER: Washington, D. C., December, 1955.

CHAPTER III

PROCEDURE

The subjects in this study were divided into two major groups, athletes and non-athletes. The athletes were further divided into the various athletic teams of which the subject was a member. The group of athletes contained 50 male students who were regular members of varsity football, basketball, track, and wrestling squads. The group of non-athletes consisted of 50 male students from the service classes in physical education. These students had not earned a major letter for athletic competition in either high school or college. In the two groups, no attempt was made to classify the subjects as to age, height, or weight.

Testing Equipment

The instrument used to record reaction time was the Hale Reaction Timer (Figure I). The device had two clocks for the measurement of reaction and performance time. Only the clock on the left side of the front panel was used. This clock recorded the reaction time for both the kinesthetic and tactual tests.

The unit for testing kinesthetic reaction time consisted of the Hale Reaction Timer with two switch mats and a metal frame device, containing an electromagnet, used to hold the arm at a 90 degree angle to the body (Figure II). The arm was held at a 90 degree angle by a sleeve containing the core of the electromagnet and secured to the wrist of the subject. Both the switch mats and the solenoid electromagnet were

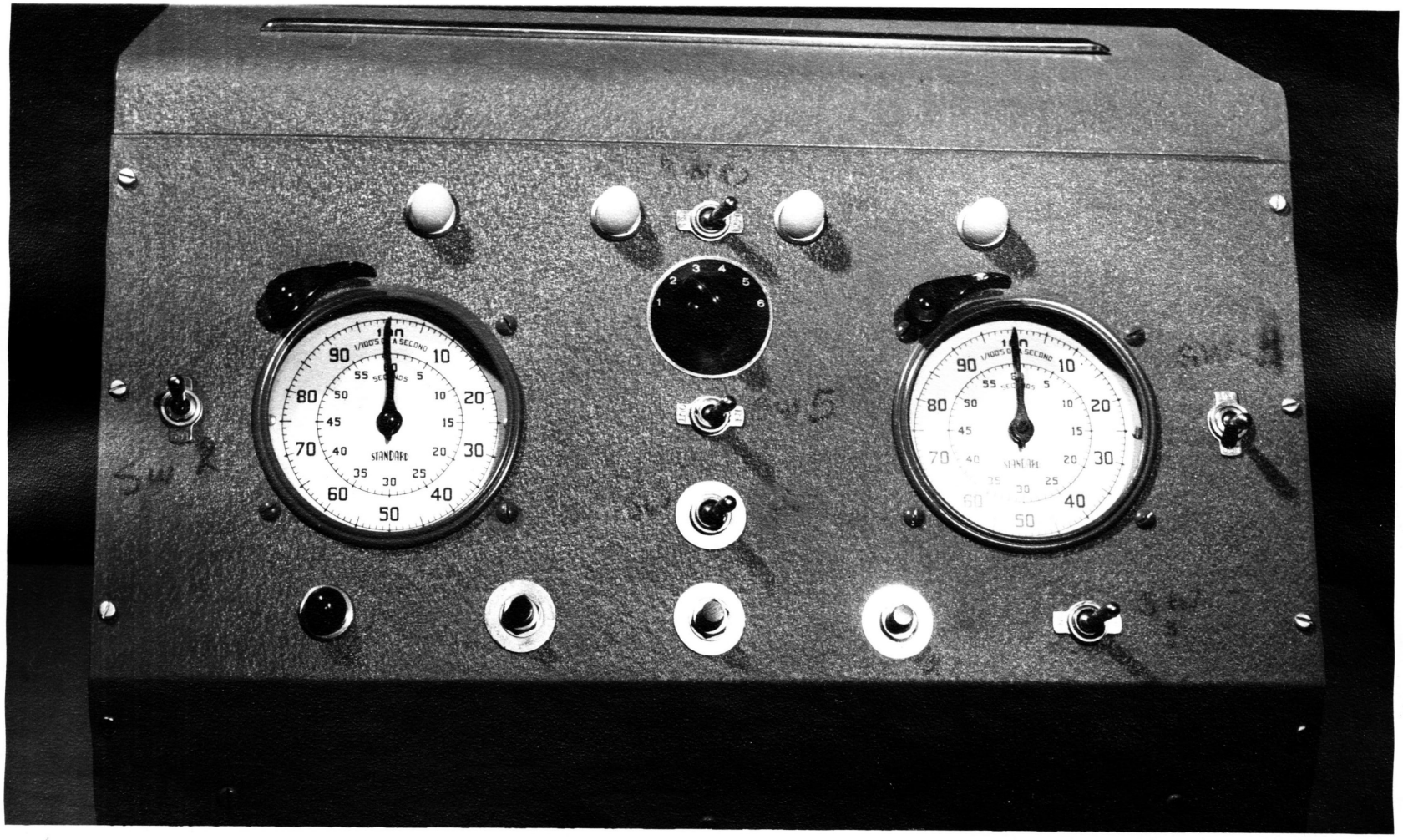

Figure I. The Hale Reaction Timer

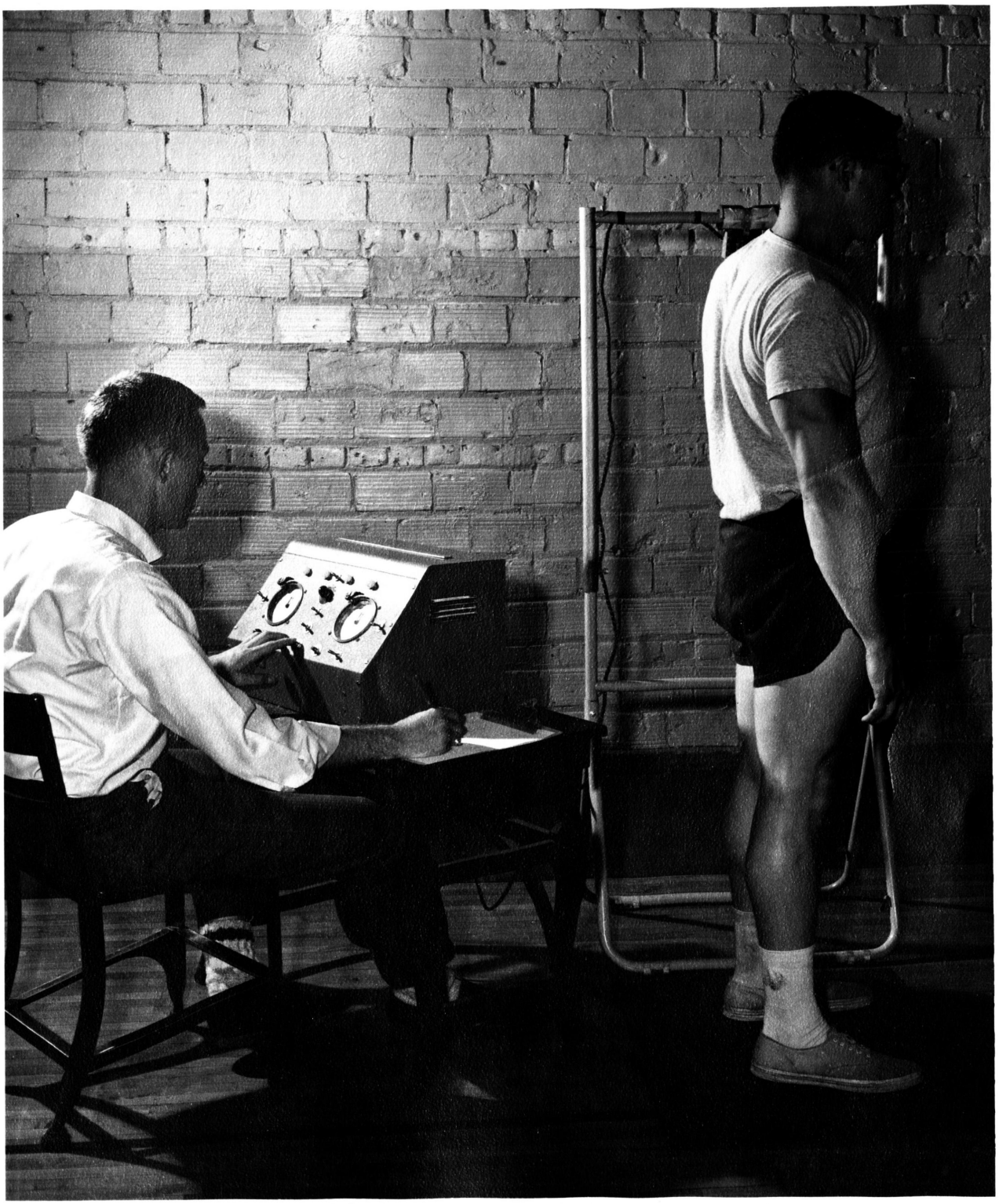

Figure II. The Kinesthetic Reaction-Time Test Unit

connected to the reaction timer by electrical circuits. When the subject stood on the switch mats, the circuit was complete. By means of a relay, one push of the stimulus button would energize the solenoid and the arm held at the 90 degree position. The second push would de-energize the solenoid producing a drop of the arm, start the reaction-time clock, and energize the circuit. This was all done simultaneously. The first movement of the foot in leaving the switch mat caused the circuit to be broken and the reaction-time clock to stop. The Hale Reaction Timer had a neutral position so that the magnet could be energized without starting the clock. The times were recorded in hundredths of seconds.

The unit for testing tactual reaction time consisted of the Hale Reaction Timer, two switch mats, and two electric wires from the machine to the subject's back (Figure III). By pushing the stimulus button, an electric shock was sent through the wires to the subject. The amount of electricity was regulated by a volt adjuster to give only enough shock to make the subject react. Standing on the switch mats by the subject completed the circuit. The first movement of the foot from the switch mat caused the circuit to be broken and the reaction-time clock to stop.

Testing Procedure

Only one initial test of 15 trials was given each subject. These 15 times were recorded and an average time was taken for the statistical analysis. Two types of reaction-time tests, the electrical shock for tactual and the arm drop for kinesthetic, were employed in

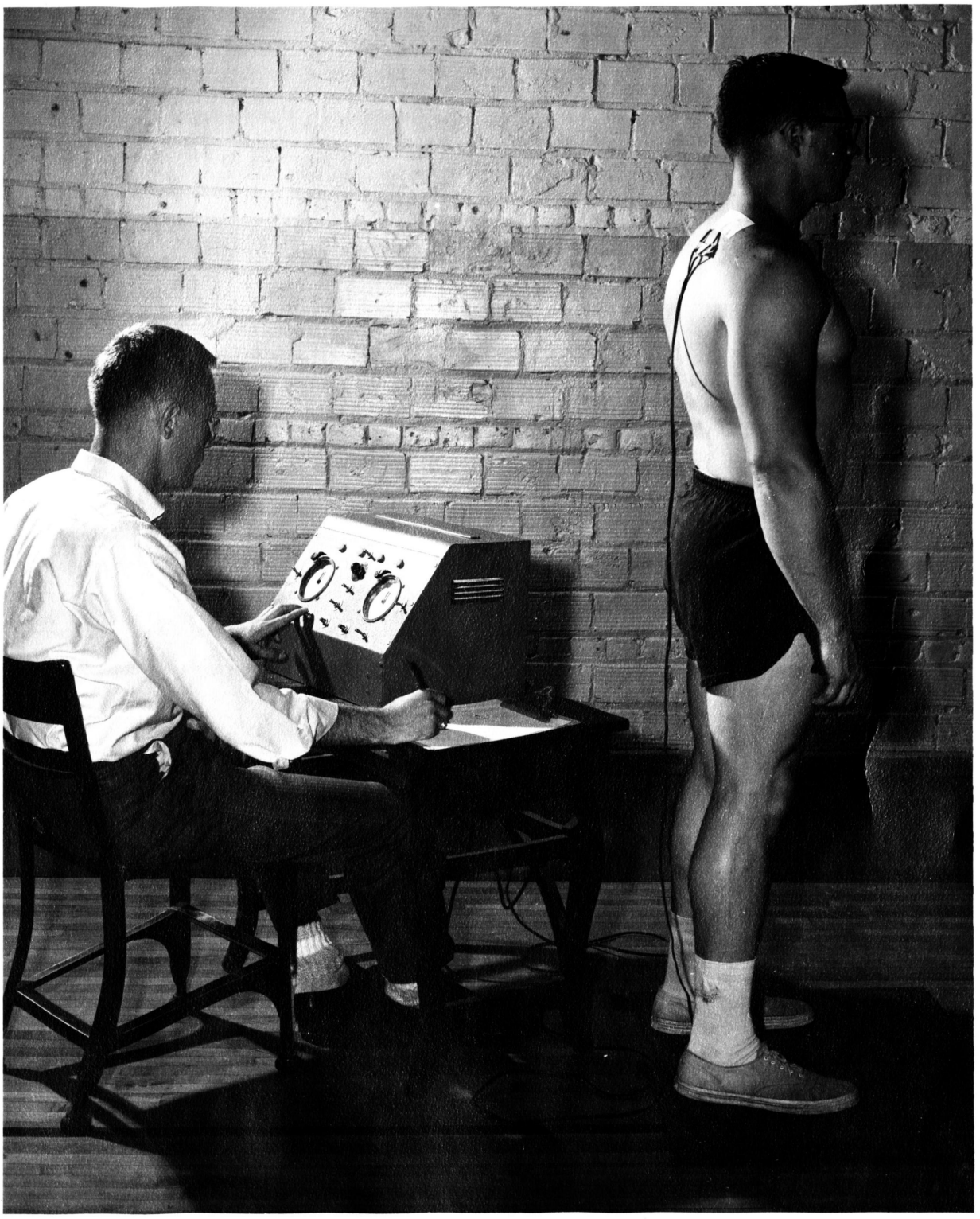

Figure III. The Tactual Reaction-Time Unit

the study. The subject's reaction times for leg displacement were taken on the Hale Reaction Timer. The tactual stimulus was given by taping on the back of the subject two bare wires through which electricity passed. The amount of electricity was regulated to give only enough shock to make the performer react. The kinesthetic stimulus was given by the dropping of the subject's arm, which was held at a 90 degree angle to his body, by means of a solenoid electromagnet. A sleeve containing the core of the solenoid was placed securely on the wrist of the subject, and the core was inserted into the solenoid by an assistant to the experimenter. Both stimuli were controlled by buttons on the front of the reaction-time machine. Pressing the button gave the stimulus and started the clock simultaneously. Fifteen trials for each stimulus were given. These 15 times were recorded and an average time taken for the statistical analysis. The directions of the test were thoroughly explained to the subject in an earlier briefing session before the tests were given. The subject was in a separate room from the experimenter during both tests. This was done so that operating noise from the reaction timer could not be heard by the subject. For the kinesthetic test the subject was blindfolded. This blocked out all possibility of visual reaction entering into the test. The experimenter was aided by an assistant who replaced the metal core of the solenoid after each trial and checked the alignment of the equipment during the test.

The following instructions for the Kinesthetic Test were given to each of the subjects in a briefing period prior to the actual testing

and repeated once again before the testing began:

1. You will stand facing this direction with one foot on each switch mat. (At this point, the sleeve containing the core of the electromagnet was secured to the subject's wrist.)
2. Your arm will be placed at a 90 degree angle to your body and will be held there by a solenoid electromagnet. When the current is turned on, let your arm relax completely. (The arm is here placed at the proper angle to the body and the metal core is inserted into the solenoid.)
3. Let your arm relax.
4. When you feel your arm fall, lift either foot from the switch mat and place it to the side as quickly as possible. If you lift your right foot, place it to the right. If you lift your left foot, place it to the left.
5. Fifteen trials will be given after 5 to 10 practice trials are given. All trials will be given with no set arrangement of occurrence. Be ready as soon as your arm is placed in the horizontal position.

The following instructions for the Tactual Test were given to each of the subjects in a briefing period prior to the actual testing and repeated once again before the testing began:

1. You will stand facing this direction with one foot upon each switch mat.
2. When you feel the shock, tactual stimulus, lift either foot

from the mat and place it to the side as quickly as possible. If you lift your right foot, place it to the right. If you lift your left foot, place it to your left.

3. You will be given a warning before each trial, but the trials will be given with no set arrangement of occurrence.

CHAPTER IV

TREATMENT AND ANALYSIS OF THE DATA

Treatment of the Data

The basic purpose of this study was to compare the reaction times of athletes to non-athletes to kinesthetic and tactual stimuli.

From the raw scores of two groups, athletes and non-athletes, a frequency distribution was set up from which the means and the standard deviations were derived. Since the two groups were uncorrelated, the following formula was used to find the standard deviation:[30]

$$\sigma = i\sqrt{\frac{\Sigma fx'^2}{N} - c^2}$$

The athletes were further grouped into their respective sports. After grouping the subjects into four sports, the standard deviations were found by applications of the following formula:[31]

$$\sigma = \sqrt{\frac{\Sigma x^2}{N} - M^2}$$

The difference between the means was found by subtracting the mean of the athletes (M_1) from the mean of the non-athletes (M_2).

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[30]Henry E. Garrett, Statistics in Psychology and Education, p. 52, Longmans, Green and Company: New York, 1958.

[31]Ibid., p. 53.

In order to find the standard error of the difference between the means, the following formula was used:[32]

$$\sigma_D = \sqrt{\frac{\sigma^2_1}{N_1} + \frac{\sigma^2_2}{N_2}}$$

The t values were found by the following formula:[33]

$$t = \frac{M_1 - M_2}{SE_D}$$

The degrees of freedom as stated by Garrett were determined at 98 for athletes and non-athletes, 68 for football players and non-athletes, 58 for track men and non-athletes, 58 for basketball players and non-athletes, (N-1)+ (N-1). The five per cent level of significance was accepted for this study.

Analysis of the Data

The statistical applications of the kinesthetic and tactual reaction times for athletes and non-athletes are shown in Table 1.

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[32] Ibid., p. 214.

[33] Ibid., p. 231.

Table 1. Differences Between the Means, Standard Error of the Differences, Critical Ratios, and Level of Significance Computed from the Kinesthetic and Tactual Reaction Times of Athletes and Non-Athletes

	M_1 Athletes	M_2 Non-Athletes	Diff. (M_1-M_2)	Diff.	t Value	Level
Kinesthetic	.232	.252	.020	.0055	3.68	1%
Tactual	.278	.304	.025	.0086	2.88	1%

The t values for both the kinesthetic and tactual tests were found to be significant at the one per cent level since both exceeded 2.63. The null hypothesis was rejected in both cases.

The statistical applications of the kinesthetic and tactual reaction times for wrestlers and non-athletes are shown in Table 2.

Table 2. Differences Between the Means, Standard Error of the Differences, Critical Ratios, and Level of Significance Computed from the Kinesthetic and Tactual Reaction Times of Wrestlers and Non-Athletes

	M_1 Wrestlers	M_2 Non-Athletes	Diff. (M_1-M_2)	Diff.	t Value	Level
Kinesthetic	.224	.252	.028	.0107	2.61	5%
Tactual	.264	.304	.040	.0157	2.54	5%

In both the kinesthetic and tactual tests, the t value was found to be significant at the five per cent level as both t values exceeded 2.01. The null hypothesis was rejected and the gains were

meaningful.

Table 3 shows the statistical application applied to the kinesthetic and tactual reaction times for track men and non-athletes.

Table 3. Differences Between the Means, Standard Error of the Differences, Critical Ratios, and Level of Significance Computed from the Kinesthetic and Tactual Reaction Times of Track Men and Non-Athletes

	M_1 Track Men	Non-Athletes	Diff. (M_1-M_2)	Diff.	t Value	Level
Kinesthetic	.227	.252	.025	.0104	2.40	5%
Tactual	.284	.304	.020	.0151	1.32	None

In comparing the reaction time of track men to non-athletes for the kinesthetic stimulus, a significant difference at the five per cent level was found and the null hypothesis was rejected. In comparing the tactual reaction times for track men and non-athletes, no significant difference was found and the null hypothesis was accepted, and any existing differences would be attributed to chance.

Table 4 shows the statistical applications applied to the kinesthetic and tactual reaction times for basketball players and non-athletes.

Table 4. Differences Between the Means, Standard Error of the Differences, Critical Ratios, and Level of Significance Computed from the Kinesthetic and Tactual Reaction Times of Basketball Players and Non-Athletes

	M_1 Basketball Players	M_2 Non-Athletes	Diff. (M_1-M_2)	Diff.	t Value	Level
Kinesthetic	.229	.252	.023	.0104	2.21	5%
Tactual	.284	.304	.020	.0099	2.02	5%

In both the kinesthetic and tactual tests, the t value was found to be significant at the five per cent level and the null hypothesis was rejected.

The statistical applications for the kinesthetic and tactual reaction times for football players and non-athletes are found in Table 5.

Table 5. Differences Between the Means, Standard Error of the Differences, Critical Ratios, and Level of Significance Computed from the Kinesthetic and Tactual Reaction Times of Football Players and Non-Athletes

	M_1 Football Players	M_2 Non-Athletes	Diff. (M_1-M_2)	Diff.	t Value	Level
Kinesthetic	.242	.252	.010	.0100	1.00	None
Tactual	.279	.304	.025	.0126	1.98	None

In comparing football players to non-athletes for the kinesthetic and tactual stimuli, there was no significant difference at the five per cent level and the null hypothesis was accepted.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to compare reaction-time measures to a kinesthetic and tactual stimulus for groups of athletes and non-athletes. The total athlete group numbered 50, of which 20 were football players, 10 were track men, 10 were basketball players, and 10 were wrestlers. The non-athlete group numbered 50 students who were members of general physical education classes and had not won a major letter for athletic competition in either high school or college. No attempt was made to classify the subjects according to age, weight, and height.

The subjects were tested once for reaction time on the Hale Reaction Timer using kinesthetic and tactual stimuli. The subjects were given the two stimuli 15 times from which an average time was calculated. The kinesthetic and tactual tests were given and the times were recorded. There was no set time interval between the occurrence of the stimuli and the times were recorded in hundredths of seconds.

The means of each group, the difference between the means, standard error of the differences, t values, and the level of significance were found. The null hypothesis was applied to each t value of the statistical work.

Conclusions

The following conclusions were drawn from this study:

In both the kinesthetic and tactual reaction-time tests, the athletes were significantly quicker than the non-athletes. The null hypothesis was rejected as the test of significance was at the one per cent level.

Wrestlers proved to be significantly quicker than non-athletes in both the kinesthetic and tactual reaction-time tests. The null hypothesis was again rejected as the test of significance was at the five per cent level.

In kinesthetic reaction time, the track men proved to be significantly quicker than non-athletes. The test was significant at the five per cent level and the null hypothesis was rejected. In the tactual reaction-time test, the difference between track men and non-athletes was not significant at the five per cent level and the null hypothesis was accepted. This is perhaps due to the fact that in track competition, there is very little, if any, tactual stimulus involved.

In both kinesthetic and tactual reaction time, basketball players were significantly quicker than the non-athletes. The difference was significant at the five per cent level and the null hypothesis was rejected.

In comparing football players to non-athletes, the result were not significant for either the kinesthetic or tactual tests. The difference fell short of the five per cent level of significance and the null hypothesis was accepted. This is probably true due to football players being trained to move into stimuli and not reacting away from such stimuli.

The study indicates that athletes as a group do have quicker reaction times to both movement and touch stimuli. However, necessary testing equipment and time involved in the testing would tend to make this method of prediction of athletic ability impractical.

Recommendations

The following recommendations were drawn from this study:

1. A similar study should be made using another method of kinesthetic stimulation, such as lifting the arm rather than dropping the arm.

2. A study of the same nature should be done with more restriction placed upon the choosing of the subjects, such as age, height, and weight classification.

3. A similar study should be done using members of golf and tennis teams as subjects.

4. A similar study should be made at the pre-high school age level.

5. A follow-up study using the same subjects over a period of high school or college competition should be done to determine loss or gain in reaction-time quickness due to athletic competition.

6. Construction of less intricate testing equipment to reduce the time element involved in testing procedures should be investigated.

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APPENDICES

APPENDIX A

Raw Data of the Non-Athletes Reaction Time

Subject no.	Kinesthetic mean	Tactual mean
1	.213	.299
2	.316	.314
3	.236	.245
4	.214	.216
5	.230	.284
6	.264	.247
7	.308	.364
8	.242	.223
9	.299	.347
10	.281	.269
11	.283	.359
12	.262	.254
13	.219	.292
14	.336	.401
15	.282	.380
16	.213	.341
17	.228	.294
18	.219	.366
19	.220	.279
20	.296	.374
21	.235	.222
22	.225	.243
23	.264	.317
24	.239	.311
25	.229	.309
26	.225	.311
27	.209	.215
28	.255	.303
29	.227	.280
30	.231	.326
31	.294	.291
32	.290	.435
33	.261	.306
34	.234	.328
35	.210	.320
36	.239	.296
37	.236	.248
38	.258	.273
39	.248	.293
40	.255	.461

Subject no.	Kinesthetic mean	Tactual mean
41	.244	.266
42	.229	.266
43	.272	.331
44	.266	.346
45	.249	.248
46	.250	.331
47	.291	.286
48	.249	.299
49	.271	.322
50	.252	.314

APPENDIX B

Raw Data of the Football Players Reaction Time

Subject no.	Kinesthetic mean	Tactual mean
1	.246	.239
2	.237	.288
3	.217	.257
4	.243	.335
5	.263	.262
6	.208	.210
7	.216	.262
8	.304	.314
9	.227	.241
10	.242	.294
11	.214	.240
12	.230	.236
13	.234	.309
14	.218	.296
15	.281	.292
16	.256	.278
17	.271	.268
18	.235	.292
19	.270	.379
20	.232	.296

APPENDIX C

Raw Data of the Wrestlers Reaction Time

Subject no.	Kinesthetic mean	Tactual mean
1	.225	.264
2	.221	.298
3	.222	.263
4	.278	.345
5	.223	.261
6	.188	.216
7	.197	.225
8	.220	.242
9	.242	.294
10	.227	.241

APPENDIX D

Raw Data of the Track Men Reaction Time

Subject no.	Kinesthetic mean	Tactual mean
1	.222	.280
2	.248	.310
3	.268	.313
4	.255	.364
5	.193	.241
6	.210	.265
7	.208	.292
8	.223	.303
9	.214	.240
10	.230	.236

APPENDIX E

Raw Data of the Basketball Players Reaction Time

Subject no.	Kinesthetic mean	Tactual mean
1	.267	.332
2	.254	.319
3	.240	.310
4	.235	.302
5	.232	.273
6	.223	.273
7	.221	.266
8	.220	.262
9	.202	.252
10	.195	.251