REACTION TIME AND MOVEMENT TIME RELATIONSHIPS AND COMPARISONS BY RACE, SEX, AND BODY TYPE

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES CONTINUED

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The primary incentive for pursuing this investigation lies in the observation that black athletes have achieved a position of relative dominance in many areas of athletics. Assuming that the better athletes in a particular sport will ultimately join the professional ranks of that sport, the observation of black dominance can be readily substantiated. Based on proportional expectations of the total number of blacks and whites that should attain professional status from their total population representation, it is readily evident that blacks are represented professionally to a highly disproportionate degree. This factor is more significantly demonstrated when the number of blacks represented on professional all-star teams is noted.

Recent evidence to support the contention of black dominance in the major professional sports of baseball, football, and basketball was compiled by Kane (1). The most valuable player selection for professional baseball has been a black athlete in sixteen of the last twenty-two seasons. In 1969, professional football gave four rookie-of-the-year awards for offense and defense. All of the selections for this honor were black athletes. In professional basketball, the 1970 All National Basketball Association rookie team consisted entirely of black athletes. The all-star team of that year was composed of black athletes by a sixty-three per cent majority, and the most valuable player in the National

Basketball Association has been a black athlete for twelve of the last thirteen seasons.

Another example of black dominance can be illustrated in the basically amateur sport of track and field where a wide variety of athletic skills are represented. Meade (2) has provided evidence of black dominance in track by pointing out results of the 1932, 1936, 1948, and 1952 Olympic Games. During these games, the United States won a total of thirteen races of less than one mile. The winners in ten of these thirteen instances were black. For the Olympics held during the period from 1908 to 1952, a look at the winners of all races between 100 and 800 meters shows that blacks won on thirty-two occasions and whites on only sixteen occasions. A check of all world and Olympic records further substantiates black predominance.

In the 1968 Olympics, all eight finalists in the 100 yard dash were black athletes. During these Olympics, the United States set a total of eight new Olympic records. In all instances, the new records were set by black athletes.

It is possible to mention several sports in which there is a negative indication of black dominance. In the majority of these cases, however, we find that the black athlete has experienced a significant lack of opportunity to participate and develop in these sports. Examples of this type of situation can be pointed to in the country club type sports of golf and tennis.

In searching for a possible explanation of black dominance in athletics, the factor of reaction time performance should be considered. Reaction time studies involving a comparison of athletes and non-athletes have established the fact that athletes are generally superior

to non-athletes in this capacity. Such a conclusion has held true for both male and female athletes as exhibited in a study of male athletes by Burley (3) and female athletes by Youngen (4).

With the existence of a valid link between reaction time and athletic performance, a more specified concern for the possibility of racial differences existing in this capacity is warranted. If the black race in general should exhibit a significantly superior capacity for reaction time, it would be a major point to consider in explaining black predominance in certain sporting events. Even though many types of reaction time studies have been done involving many different variables associated with reaction time, the possibility of racial differences existing in this capacity has not been pursued to any significant degree.

The writer performed a preliminary investigation pursuing the possibility of racial differences existing in the performance of reaction time (5). This investigation compared black and white athletes in the performance of reaction time with the results showing that the differences were not of a sufficient degree to claim significance at the .05 level. Since athletes have already demonstrated their place in the upper echelon of this measurement, working with this group would restrict the limits for possible significant differences. It seems that by utilizing the general population rather than athletes, a better chance for finding significant differences could be achieved.

Purpose of Investigation

The primary purpose of this investigation was to ascertain whether or not a significant difference existed between the black and white races in the innate capacity of reaction time performance. Several

other questions associated with reaction time served as secondary purposes for the study. One of the secondary purposes involved the question of whether or not a significant difference existed between males and females in the capacity for reaction time performance. Another question to be answered involved the relationship of reaction time to body type. Does it take longer for a response stimulus to travel the length of a longer limb? Does increased body mass impede the stimulus as it travels along the nerves? Such questions were treated in this investigation by including arm span, height, and weight measurements of each subject.

Further questions dealt with in this investigation included the relationship of reaction time to movement time and the relationship between two different methods of measuring reaction time. Considerable conflict in the results of prior studies has failed to establish a clear relationship between reaction time and movement time, and different researchers have utilized different methods of obtaining reaction time measures.

Hypotheses

The null hypothesis was utilized with regard to each of the variables tested in this investigation. Such hypotheses included the following:

(1) There is no significant difference in the performance of reaction time between blacks and whites when comparing males, females, or both as a group.

(2) There is no significant difference in the performance of reaction time between males and females when comparing blacks, whites,

or both as a group.

(3) There is no significant relationship between reaction time and individual body type.

(4) There is no significant relationship between reaction time and movement time.

(5) There is no significant relationship between reaction time as measured by the vertical jump method and reaction time as measured by the thumb response method.

Definitions

The term "reaction time" refers to the interval of time that elapses from the instant a stimulus is presented until the instant any measurable amount of movement is made in response to the stimulus. For this investigation, "simple reaction time" was the interval of time which elapsed from the sound of an auditory stimulus until the subject initiated movement in the thumb of the dominant hand to press a button. The "vertical jump reaction time" measurement consisted of the time required for the subject to break contact with a switch mat placed on the floor through a vertical jump, after receiving an auditory stimulus.

"Movement time" is normally referred to as the interval of time which elapses from the initial movement in response to a stimulus until the completion of the specified movement. Reaction time ends at the onset of movement time. For this investigation, movement time consisted of the time required for the foot to travel a distance of twelve inches.

The "reciprocal of the ponderal index" utilized in this investigation is a ratio of height to weight of the individual and is an indication of general body type in terms of ponderosity. Shorter and more

obese subjects produce a smaller index number than taller and thinner subjects who produce larger index numbers. The range of index numbers from most ponderous to least ponderous will be from 11.0 to 14.0. The index number is derived by dividing the height of the subject in inches by the cube root of the weight of the subject in pounds.

Delimitations

Timed measurements performed for this investigation included simple reaction time to an auditory stimulus, vertical jump reaction time to an auditory stimulus, and movement time. Anthropometrical measurements collected included arm span, height, and weight. The subjects were college males and females between the ages of eighteen and twenty-five.

Assumptions

Since motivation has been found to influence some reaction time performances, it was assumed in this investigation that any possible differences in this variable were cancelled out through a random effect between the groups.

CHAPTER II

REVIEW OF RELATED LITERATURE

Specific comparisons of reaction time by race as was performed in this investigation are seemingly non-existent in published research. There have been several studies which were related in a general fashion along racial lines. In 1935, Browne (6) performed an investigation for the purpose of determining whether or not the black race possessed neuro-muscular characteristics which could account for their outstanding performances in sprints. Utilizing patellar reflex times, he compared the results of eighty-two white subjects with the results of eighty-one black subjects. The white subjects produced a mean patellar reflex time of .0861± .0013, while the blacks produced a mean time of .0774± .0009. The difference between the groups was 5.43 times the probable error of difference, which served as a basis for a claim of significance.

A reaction time study comparing black and white athletes was made by Harsch (7) at the State University of Iowa. The study involved twenty-seven black subjects and forty-three white subjects. His conclusion was that black athletes do not react or respond more quickly than white athletes. It is possible that the preceding study may have been influenced by a dilemma similar to that encountered by the writer in a preliminary investigation that involved only athletes (5). Since athletes have proven to be in the upper echelon of this measurement, a statistically significant difference would be difficult to obtain using

this group.

Hipple (8) compared blacks and whites in a study involving the influence of motivation on muscular tension, reaction time, and speed of movement. Thirty subjects of each race were utilized and they ranged in age from twelve to fourteen years. The results showed no significant differences between the races during the unmotivated portion of the study. The portion of the study in which external motivating devices were used produced a significantly faster reaction time within the white group.

Schureman (9) and Kerr (10) studied the relationship of nerves as to number, size, and ability to produce a response. They made racial comparisons of these variables and found no significant differences between the races. A different possibility, however, was suggested by Ide (11). He implied a more rapid rate of nerve impulse existed in blacks because he found a larger cross-section area for principal peripheral nerves in blacks than in whites.

Research relating to the secondary purposes of this investigation was found to be more plentiful. Regarding the relationship between reaction time and movement time, Pierson (12) says that most of the studies that have found no correlation to exist between the two have been done on college age male students. He suggests that such results may be due to a peculiarity of this age and sex group since other studies involving different ages and sexes have produced significant correlations between reaction time and movement time.

Pierson set up a study involving 400 male subjects between the ages of eight and eighty-three to test the validity of his hypothesis. As a result of his study, he concluded that for males between the ages of

eight and eighty-three there is a statistically significant correlation between reaction time and movement time as measured in his study. The overall correlation was r = .56. He also stipulated that there is considerable chance for error when conclusions concerning the adult male population are drawn from a sample of college age male students. He further suggested that the relationship of reaction time and movement time may be a function of maturity or incidence of employment since the correlation for subjects over twenty-one was r = .63 while subjects between eight and twenty-one had a correlation of only r = .50. It seemed rather unfortunate that Pierson did not utilize females in his study since he did make reference to the possible existence of sex differences as well as age group differences.

Another study involving only females also found a correlation between reaction time and movement time. This study was conducted by Youngen (13) and involved 112 female subjects doing an arm movement task. Seventy-five of the subjects were classified as non-athletic and forty-seven were women athletes on the intercollegiate level. A low but statistically significant correlation was found to exist between reaction time and movement time for both the athletes and non-athletic groups. The athletes were significantly faster than the non-athletes in both reaction time and movement time. As a group, swimmers exhibited the slowest reaction and movement times of the athletes.

Westerlund and Tuttle (14) used twenty-two college track men in their investigation of reaction time and movement time. The subjects consisted of seven dash men, eight middle distance men, and seven distance men. Time for running the seventy-five yard dash was used as the movement time measure. The results of their reaction times progressed

in order according to the distance of their events with the dash men having the fastest reaction times. The relation of reaction time to speed in running the seventy-five yard dash resulted in a positive correlation of r = .86.

These results should not be generalized to the total population due to the select nature of the subjects and the type task used for movement time. It is quite possible that a combination of fast reaction and movement is necessary to become a college level dash man; therefore, we could not expect any other results to be obtained from such a group. It stands to reason that the shorter a race, the more important is an advantage gained through reaction to the starting gun.

Although some studies have reported a significant positive correlation between reaction time and movement time, as did the three previously mentioned studies, many others have reported that no correlation exists between these two variables. Lotter (15) conducted a study involving the interrelationships of reaction time and speed of movement in different limbs. His subjects consisted of 105 college students, and he concluded that quickness of movement are distinctly different and unrelated abilities. Hodgkins (16) reached a similar conclusion in her study involving males and females of various age groups by concluding that the results tended to support the theory that functions of reaction time and quickness of movement are largely independent.

In a study involving arm movement, Mendryk (17) compared reaction times and movement times of subjects in the age groups of twelve, twenty-two, and forty-eight. None of the groups produced significant correlations between reaction time and movement time, and the correlation for the combined groups was only r = .12.

Rarick (18) attempted to identify common elements associated with speed of muscular movement by analyzing a group of athletic and physiologic tests in a statistical manner. Part of the testing included obtaining reaction times of the triceps and gastrocnemius muscles. This was done by placing electrodes on the muscles which recorded the latency period between a visual stimulus (flashing light) and initial muscle response. It was concluded from the data that the latency period of the muscle response had little or no influence on speed of movement or speed of contraction of an intact, loaded, tetanized muscle. Generalized results of the study indicated that normal individuals with a high degree of motor ability or skill and an average amount of strength cannot increase their speed of muscular performance to any practical extent.

Henry (19) studied the relationship of reaction time and movement time, as well as the effects of motivation on each, utilizing sixty male college students as subjects. The task involved placing the hand on a treadle press key and upon presentation of the stimulus, which was the flash of a light, the subject would release the key and grab a tennis ball which was suspended on a string twelve inches above the key. Grabbing the ball stopped the timer and the recorded measurements included reaction time between stimulus and releasing the key, as well as movement time between releasing the key and grabbing the ball. The reaction and movement functions were found to be independent and uncorrelated with the highest correlation being $r = .15$.

In the same study, the effects of motivation produced significant results. Motivating devices consisted of flashing lights, electrical shock, and sound. All groups significantly improved in reaction time and most groups in movement time by whatever motivating stimulus they

received. Movement time was somewhat less influenced than reaction time, but statistical evidence did not clearly prove the point.

Slater-Hammel (20) questioned the findings of the previous study due to the possible deceleration in the movement that was used. He therefore devised a movement so that each half of the movement could be measured as a check for deceleration. His subjects consisted of twenty-five physical education majors between twenty and thirty-eight years of age with a median age of twenty-five. The results were interpreted as indicating that measurement of reaction time cannot readily be used to predict speed of movement. The correlational analysis revealed correlations ranging from $r = -.07$ to $r = .17$ on several measures of movement duration and reaction time. A generalization was made to the fact that some sprinters may be fast reactors, but there is still no significant correlation between reaction and movement.

In a similar study by Henry (21) involving 120 undergraduate students and an arm movement through ninety degrees, similar results were shown. It was concluded that individual differences in reaction time and movement time are independent and unrelated.

Ramirez (22) conducted a comparative study involving speed of running and reaction time. The subjects were all females eleven years of age. Three racial categories were represented as the subjects included one hundred blacks, fifty-five Mexican-Americans, and forty-five whites. Elements of the study included fifteen, thirty, and fifty yard dashes, starting time, acceleration speed, and maximum sprint velocity. Significant differences in favor of the blacks were found to exist in speed of running the dashes. Significant differences were not found to exist in the performance of reaction time. It was concluded that speed

as measured in the study did not appear to be closely related to reaction time.

Another study involving speed of running was conducted by Hutinger (23) utilizing black and white grade school children. In his study, a comparison of the races in performance of the thirty-five yard dash was made. Both boys and girls in the fourth, fifth, and sixth grades were tested with a total of 390 white subjects and 402 black subjects. The results indicated that the black children were faster in all six groups with the results being statistically significant in all groups except the sixth grade boys. The greatest mean difference was .61 seconds for the fourth grade boys, and the least mean difference was .20 seconds for the sixth grade boys. Reaction times were not included as part of the study.

Reaction times of athletes and non-athletes and the effects of simple and complex stimuli were compared in a study by Burley (24). The simple stimulus was a flash of light, while the complex stimulus involved reacting to the light only when preceded by a specified sequence of three other lights. He found that all individuals exhibited more variability in their reactions to complex stimuli. He also found a significant difference to exist between the reaction time of athletes and non-athletes, with the athletes being significantly faster.

A study by Keller (25) compared simple movement times of athletes and non-athletes as well as attempted to determine the value of quickness of body movement to athletic success. A total of 755 men were used as subjects with 359 of them classed as athletes. Quickness of movement was measured by stepping to the right, to the left, and forward. The athletes demonstrated significantly quicker movement times which served

as a basis for his conclusion that there is a positive relationship between ability to move quickly and athletic success. After comparing the times of the athletes according to their sport, it was further concluded that the requirement for quickness is not the same for all sports. He suggested that slower persons would have a better chance for success in sports where they would not be required to react to rapidly changing conditions and movements of several other teammates or opponents. Sports such as swimming, wrestling, and gymnastics were included in this category.

An in-depth study of physical fitness measures of champion athletes was made by T. K. Cureton (26). Subjects for his study included members of the 1948 U.S. men's swimming and diving team, U.S. track and field athletes, and the Danish gymnastics team. One of the measures utilized in this study was that of vertical jump reaction time. He suggested a relationship between reaction time scores and body size with the shorter and lighter men being faster than the taller and heavier men on the average. After comparing the reaction times of the athletes with a group of eighty non-athletes, the evidence was conclusive that athletes in general have faster reaction times than non-athletes. It was also concluded that reaction time is not dependent on muscular strength.

CHAPTER III

PROCEDURE

Subjects

A total of 120 subjects were utilized in this investigation. Four major classifications were represented in the total number of subjects for comparison purposes. These classifications included thirty white males, thirty black males, thirty white females, and thirty black females. The black subjects were randomly selected from physical education classes at Langston University in Langston, Oklahoma, which is a predominantly black institution. The white subjects were randomly selected from physical education classes at Southeastern State College in Durant, Oklahoma, which is a predominantly white institution.

Each of the institutions from which the subjects were selected require physical education as a part of their general education program. Therefore, physical education classes from which the subjects were selected included students representing a cross section of students rather than just physical education majors. This factor was considered important to the selection of subjects due to the known tendency of athletic individuals to possess better than average reaction times.

The random selection of subjects from the classes was accomplished by pooling the class rolls of three separate classes for each classification of subjects, and assigning consecutive numbers to each individual. These numbers were placed in a hat, and those subjects whose number was

drawn from the hat were utilized in the investigation. The subjects ranged in age from eighteen to twenty-five years.

Measuring Devices

Simple reaction times, vertical jump reaction times, and movement times were recorded with a Dekan Athletic Performance Analyzer (Figure 1). The dial facing on this device is marked at intervals of 1/100th of a second. Readings were recorded to the nearest .005 of a second by interpolation when the sweep hand stopped between 1/100th of a second markings.

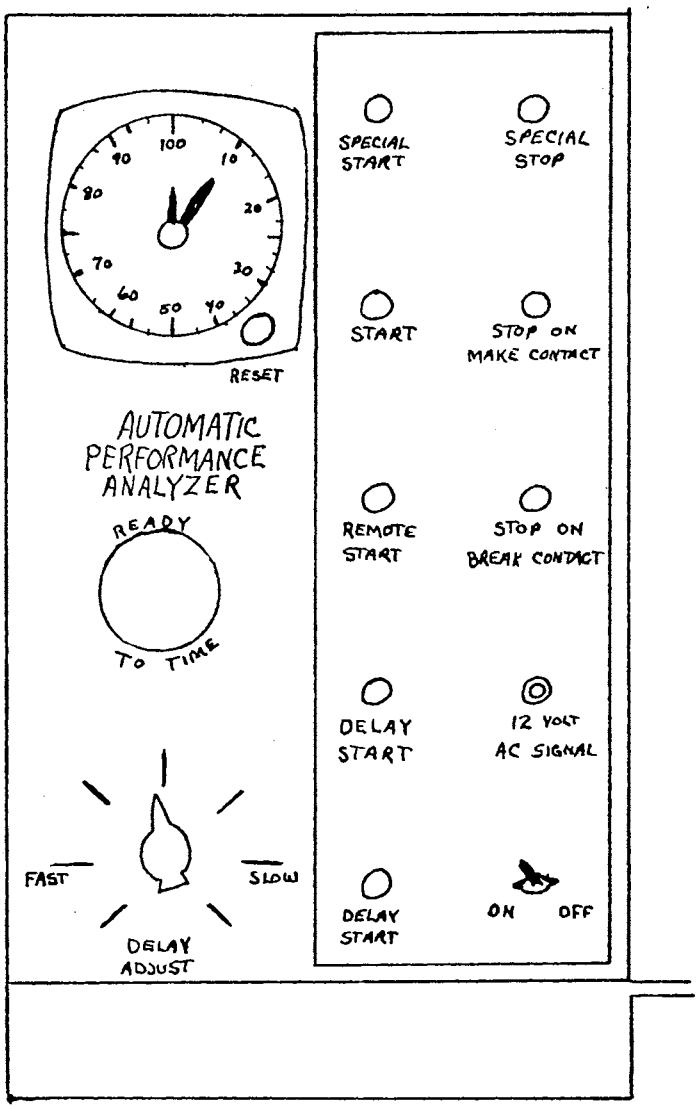
A small cylindrical shaped device with a button on the end was utilized in recording simple reaction times (Figure 2). This device fits comfortably in the hand with a closed fist, and the thumb stopped the timer after it had been activated at the sound of a buzzer.

Vertical jump reaction times were recorded by utilizing a switch mat device placed on the floor (Figure 3). After the timer was activated at the buzzer, the timer stopped as soon as the subject lost contact with the switch mat through a vertical jump.

The movement time device included a switch mat and a foot pedal (Figure 4). The timer was activated when the subject lifted his foot from the pedal, and was stopped when the foot made contact with the switch mat a distance of one foot away. In this manner, reaction time was omitted from the movement time measure. All of the special devices for time measures were connected by wires to the basic Dekan Athletic Performance Analyzer unit.

Arm span measurements were taken by utilizing a flat wall on which inches had been marked off horizontally to the nearest one-half inch.

igure 1. Dekan Athletic Performance Analyzer (Top View)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MAKE CONTACT
REMOTE
START
STOP ON
BREAK CONTACT
DELAY
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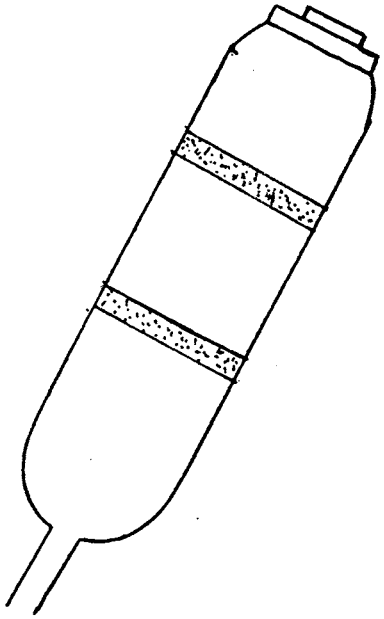
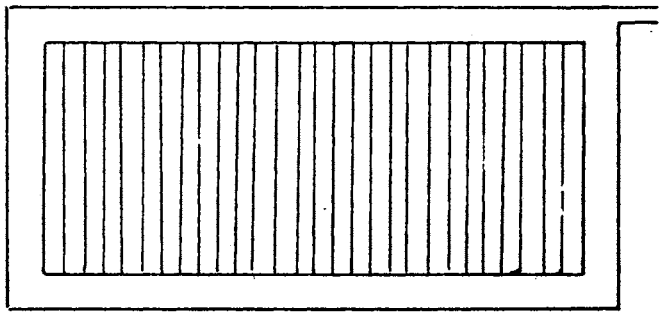
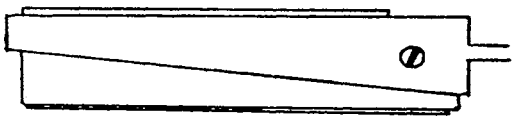
gure 2. Hand Device (Side View)

gure 3. Switch Mat (Top View)

re 4. Pedal Device (Side View)







The first inch was marked off from a corner. The subject stood facing the wall with the end of his longest finger touching the corner abutment, and the reading was taken at the farthest extension of his right hand.

Heights were recorded with gym shoes on, utilizing a flat wall on which inches had been marked off vertically to the nearest one-half inch. A foot ruler was placed level on the subject's head as he stood with his back to the wall and the measurement was recorded.

Weights were determined with the subjects wearing gym shoes and shorts, utilizing a set of Borg bathroom scales.

Collection of Data

Each subject was taken to an isolated corner of the gymnasium where the equipment had been set up. The subjects were first measured for height, followed by arm span and weight. After these measurements were recorded, the subject was seated in a chair with his back to the timer and the tester.

The first timed measure to be taken was that of simple reaction time. Specific instructions were given the subject regarding the functioning of the timing device, how to hold the hand device, and the preparatory command to be utilized. The preparatory command of "ready" was given prior to activating the device. After the "ready" signal was given, a delay of from one to five seconds occurred before the audio stimulus sounded and started the timer. This delay between the ready signal and the stimulus was varied at random by the tester and served the purpose of preventing anticipatory responses that would be possible with a continuous rhythm.

A series of five practice trials were then given to familiarize the subject with the equipment and testing procedure. These practice trials were then followed by ten recorded trials.

Vertical jump reaction time was recorded next. The subject was instructed to stand with both feet on the switch mat with knees slightly flexed and feet about shoulder width apart. It was explained that the same preparatory command and timing procedure as used in the previous simple reaction time test would be utilized. The subject was further instructed that the object was to break contact with the switch mat as quickly as possible, and that dipping the knees during the jump resulted in a longer reaction time measure. A series of five practice trials were then given, followed by a series of ten recorded trials.

The final measurement taken was that of movement time which consisted of the time required to move the foot from the pedal device to the switch mat placed a distance of twelve inches away. The subject was instructed to stand with one foot on the pedal device and the other on the floor directly opposite, about shoulder width apart. The subject was further instructed to use the same foot laterally for the movement as the hand used in the simple reaction time measurement. The same preparatory command and audio stimulus as used in the previous measures were utilized, except that the audio stimulus was initiated manually, and the timer did not start until the subject broke contact with the pedal device as he began his movement task. Again, a series of five practice trials were given followed by a series of ten recorded trials.

Statistical Analysis

Two basic procedures were utilized in analyzing the data collected.

The Pearson r was used to find correlations of variables with reaction times and movements times. A t - test was utilized to determine significance of differences between group means where applicable. A confidence level of .05 was used as the criteria for establishing significance.

The first hypothesis stated that there is no significant difference in the performance of reaction time between blacks and whites when comparing males, females, or both as a group. This hypothesis was tested by utilizing a two-tailed t - test for independence of unpaired samples for significance of differences in group means.

The second hypothesis stated that there is no significant difference in the performance of reaction time between males and females when comparing blacks, whites, or both as a group. This hypothesis was also tested by utilizing a two-tailed t - test for independence of unpaired samples for significance of differences in group means.

The third hypothesis of no significant relationship between reaction time and individual body type was tested by utilizing the Pearson r.

The fourth hypothesis of no relationship between reaction time and movement time was tested by utilizing the Pearson r, as was the fifth hypothesis of no significant relationship between reaction time as measured by the vertical jump method and as measured by the thumb response.

All correlations were found for each separate group as well as for groups combined by race and by sex.

CHAPTER IV

RESULTS AND DISCUSSION

TABLE I

TABLE OF ABBREVIATIONS

AS.	arm span in inches
HT.	height in inches
WT.	weight in pounds
RPI	reciprocal of ponderal index
SRT	simple reaction time to nearest 1/1000th of a second
VJRT.	vertical jump reaction time to nearest 1/1000th of a second
MT.	movement to nearest 1/1000th of a second
BM.	black male
BF.	black female
WM.	white male
WF.	white female
df.	degrees of freedom
N	number of subjects
STD. DEV.	standard deviation
STD. ERR.	standard error of the mean
CRIT. VAL. .05.	critical value for .05 level of confidence

TABLE II

DATA FOR SRT

Group	N	SRT Mean	Variance	Std. Dev.	Std. Err.
BM	30	.142 sec.	.217	.015	.269
BF	30	.158 sec.	.441	.021	.384
WM	30	.158 sec.	.571	.024	.436
WF	30	.163 sec.	.349	.019	.341
BM+BF	60	.150 sec.	.385	.020	.253
WM+WF	60	.161 sec.	.458	.021	.276
BM+WM	60	.150 sec.	.453	.021	.275
BF+WF	60	.161 sec.	.396	.020	.257

TABLE III

COMPARISON OF MEANS FOR SRT

Group Means Compared	Mean Difference	df	Crit. Val. .05	t - statistic
BM-WM	.016 sec.	58	2.002	3.151
BF-WF	.005 sec.	58	2.002	1.082
BM-BF	.016 sec.	58	2.002	3.315
WM-WF	.005 sec.	58	2.002	0.891
BM+BF-WM+WF	.011 sec.	118	1.980	2.895
BM+WM-BF+WF	.011 sec.	118	1.980	2.720

TABLE IV

DATA FOR VJRT

Group	N	VJRT Mean	Variance	Std. Dev.	Std. Err.
BM	30	.253 sec.	.964	.031	.567
BF	30	.260 sec.	.114	.034	.616
WM	30	.240 sec.	.795	.028	.515
WF	30	.278 sec.	.810	.029	.520
BM+BF	60	.257 sec.	.105	.032	.418
WM+WF	60	.259 sec.	.116	.034	.440
BM+WM	60	.246 sec.	.906	.030	.389
BF+WF	60	.269 sec.	.104	.032	.416

TABLE V

COMPARISON OF MEANS FOR VJRT

Group Means Compared	Mean Difference	df	Crit. Val. .05	t - statistic
BM-WM	.013 sec.	58	2.002	1.676
BF-WF	.018 sec.	58	2.002	2.206
BM-BF	.007 sec.	58	2.002	.908
WM-WF	.038 sec.	58	2.002	5.225
BM+BF-WM+WF	.002 sec.	118	1.980	.408
BM+WM-BF+WF	.022 sec.	118	1.980	4.024

Results Related to Hypothesis #1

(Tables II, III, IV, V)

The first hypothesis stated that no significant difference exists in the performance of reaction time between blacks and whites whether comparing males, females, or both combined by race. They have previously been identified as simple reaction time (SRT) and vertical jump reaction time (VJRT). Results for SRT are found in Tables II and III, and the results for VJRT are found in Tables IV and V.

Black males produced a mean SRT of .142 sec. while white males produced a mean SRT of .158 sec. Comparison of these means produced a t - statistic of 3.131 which was significant beyond the .05 level of confidence. If this were a valid racial difference, one would expect to find similar results in the comparison of females of each race. This, however, was not the case as the black female SRT of .158 sec. and the white female SRT of .163 sec. failed to show statistical significance when compared.

Combining males and females and comparing the means by race produced significant results. The mean of all black subjects of .150 sec. compared to the mean of all white subjects of .161 sec. produced a t - statistic of 2.895 which was statistically significant beyond the .05 level. This result, however, was influenced largely by the black male mean SRT which was much faster than the other three groups.

Results obtained utilizing the vertical jump method of measuring reaction time varied greatly from the SRT method. Significance was not found in the performance VJRT when black and white males were compared. In fact, the white male mean VJRT of .240 sec. was faster than the black male mean VJRT of .253 sec. and the t - statistic of 1.676 approached

significance in favor of the white male. This result tends to raise a question as to the validity of the significant results obtained with the SRT measure. Reason for such a question is further substantiated by the fact that a highly significant correlation was found to exist between the SRT measure and the VJRT measure.

Another conflict between SRT and VJRT is exhibited in the comparison of black and white females. While no significant difference was found in comparing SRT means, significance was found in the comparison of VJRT means. The black female VJRT mean of .260 sec. compared to the white female VJRT mean of .278 sec. produced a t - statistic of 2.206 which was significant beyond the .05 level in favor of the black females.

A racial comparison with males and females combined also produced conflicting results between SRT and VJRT measures. A significant difference was not found with the VJRT measure, while it was found with the SRT measure

In all of the comparisons relating to hypothesis number one, none of the significant differences in SRT were substantiated by a finding of a significant difference in the corresponding VJRT or vice versa. Such a situation gives reason to accept the null hypothesis in general terms regarding a racial difference in the performance of reaction time, even though specific elements of the investigation suggest a rejection of the null hypothesis should be made in favor of the blacks.

Results Related to Hypothesis #2

(Tables II, III, IV, V)

The second hypothesis in this investigation stated that no significant difference existed in the performance of reaction time between

males and females, whether comparing blacks, whites, or both combined by sex. A comparison of black male and female means for SRT produced a t - statistic of 3.315 in favor of the black males, which was significant beyond the .05 level of confidence. The same finding did not hold true, however, when black males produced a slightly faster VJRT, the mean difference of only .007 sec. produced a t - statistic of .908 which was far below the critical value of 2.002 required for significance at the .05 level.

A similar situation in reverse order existed in the comparison of white male and female means for reaction time. Although the white male mean of .158 sec. for SRT was faster than the white female mean of .163 sec., the difference produced a t - statistic of only .891 where the critical value for significance was 2.002. A highly significant difference was found to exist, however, when means were compared for VJRT. The white male mean VJRT of .240 sec. compared to the white female mean of .278 sec. produced a t - statistic of 5.225 which was significant far beyond the .05 level.

A comparison of all males with all females produced significant results substantiated by both SRT and VJRT. The male mean of .150 sec. for SRT compared to the female mean of .161 sec. produced a t - statistic of 2.720 with a critical value of 1.980 required for significance at the .05 level. The differences were even greater in favor of the males when VJRT means were compared. The male mean of .246 sec. compared to the female mean of .269 sec. produced a t - statistic of 4.024.

The overall results of male and female comparisons for SRT and VJRT tend to suggest a valid rejection of the null hypothesis in favor of the males as was found by Hodgkins (16). This conclusion is complicated,

TABLE VI

RELATIONSHIP OF SRT AND RPI

Group	SRT Mean	RPI Mean	Crit. Val. .05	df	Pearson r
BM	.142 sec.	12.667	.362	28	-.119
BF	.158 sec.	12.667	.362	28	.158
WM	.158 sec.	12.773	.362	28	.060
WF	.163 sec.	12.953	.362	28	.084
BM+BF	.150 sec.	12.752	.255	58	.101
WM+WF	.161 sec.	12.863	.255	58	.086
BM+WM	.150 sec.	12.720	.255	58	.034
BF+WF	.161 sec.	12.895	.255	58	.134

TABLE VII

RELATIONSHIP OF VJRT AND RPI

Group	VJRT Mean	RPI Mean	Crit. Val. .05	df	Pearson r
BM	.253 sec.	12.667	.362	28	-.114
BF	.260 sec.	12.837	.362	28	.096
WM	.240 sec.	12.773	.362	28	-.039
WF	.278 sec.	12.953	.362	28	.123
BM+BF	.257 sec.	12.752	.255	58	.014
WM+WF	.259 sec.	12.863	.255	58	.118
BM+WM	.246 sec.	12.720	.255	58	-0.92
BF+WF	.269 sec.	12.895	.255	58	.134

however, by the lack of significance in differences in both SRT and VJRT for both races. A general acceptance of the null hypothesis regarding sex differences in the performance of reaction time is therefore suggested for the purposes of this investigation, even though a tendency for males to exhibit superiority is noted.

Results Related to Hypothesis #3

(Tables VI, VII)

The third hypothesis in this investigation stated that no significant relationship existed between the performance of reaction time and individual body type. Individual body type was determined by utilizing the reciprocal of the ponderal index (RPI), which is the height of the subject in inches divided by the cube root of the subject in pounds. Shorter and stockier individuals produce a smaller RPI while taller and slimmer individuals produce a larger RPI. The extremes for this calculation are generally from 11.0 to 14.0.

The most ponderous of the groups measured proved to be the black males who produced a mean RPI of 12.667. They were followed by the white males who produced a mean RPI of 12.773. Next were the black females with a mean RPI of 12.837, and finally, the white females proved to be the least ponderous with a mean RPI of 12.953.

According to the results of this investigation, any attempt to relate reaction time performance to individual body type would be completely invalid. None of the groups tested produced a significant relationship between RPI and reaction time. This finding held true for both SRT and VJRT. The closest relationship was produced by the all female group who produced the same Pearson r for both SRT and VJRT. The

Pearson r produced in those cases were .134 with the critical value at the .05 level being .255.

Such a finding did not substantiate the findings of Cureton (25) in his study of male athletes utilizing the VJRT method. He suggested that shorter and lighter individual body types tended to produce faster reaction times.

The results produced by the males in this investigation gave no reason to suggest any type of relationship between body type and reaction time. The black males produced a correlation of -.114 for VJRT and RPI, and -.119 for SRT and RPI. The white males produced a correlation of -.039 for VJRT and RPI, and .060 for SRT and RPI. The critical value for significance at the .05 level in these cases was .362. A combination of black and white males produced a correlation of -.092 for VJRT and .034 for SRT. In these cases the critical value for significance at the .05 level was .255.

It is quite evident that the results of this investigation clearly substantiate an acceptance of the null hypothesis with regard to the existence of a relationship between reaction time performance and individual body type, regardless of the method utilized for reaction time measurement.

Another issue related to reaction time and body type that was possible to pursue utilizing the data in this investigation was that of limb length and reaction time. It would seem logical to assume that it would take a nerve impulse longer to travel through a longer limb than a shorter limb. Such an assumption was examined in this investigation by looking at the relationship of AS to SRT and also the relationship of HT to VJRT.

With regard to the relationship of AS and SRT, the only significant finding was produced by the group which included black males and females. In this case, the Pearson r was -.281 with the critical value for significance at the .05 level being .255. This would suggest that the subjects with shorter arms tended to produce the faster reaction times. Such a finding did not hold true when the group was separated by sex and was not substantiated in any other instance.

A similar situation was found in examining the relationship of HT and VJRT. In this case, it was the group of combined white males and females that produced a significant correlation of -.372. This finding did not hold true when the group was separated by sex and was not substantiated in any other instance.

Based on the results of this investigation, it would not be valid to assume that people with longer limbs will tend to have slower reactions due to an increased length of time necessary for the nerve impulse to travel the length of the longer limb.

Results Related to Hypothesis #4

(Tables VIII,IX)

Hypothesis number four in this investigation stated that no significant relationship exists between reaction time and movement time. As was stated in the review of literature, there have been conflicting results obtained in previous investigations of this relationship by different investigators. The general conclusion based on all of the evidence of previous investigations has been one of no significant relationship. The overall results of this investigation tend to support such a conclusion.

TABLE VIII

RELATIONSHIP OF SRT AND MT

Group	SRT Mean	MT Mean	Crit. Val. .05	df	Pearson r
BM	.142 sec.	.147 sec.	.362	28	.272
BF	.158 sec.	.173 sec.	.362	28	.218
WM	.158 sec.	.140 sec.	.362	28	.329
WF	.163 sec.	.162 sec.	.362	28	.356
BM+BF	.150 sec.	.160 sec.	.255	58	.375
WM+WF	.161 sec.	.151 sec.	.255	58	.351
BM+WM	.150 sec.	.144 sec.	.255	58	.211
BF+WF	.161 sec.	.168 sec.	.255	58	.227

TABLE IX

RELATIONSHIP OF VJRT AND MT

Group	VJRT Mean	MT Mean	Crit. Val. .05	df	Pearson r
BM	.253 sec.	.147 sec.	.362	28	.345
BF	.260 sec.	.173 sec.	.362	28	.248
WM	.240 sec.	.140 sec.	.362	28	.289
WF	.278 sec.	.162 sec.	.362	28	.337
BM+BF	.257 sec.	.160 sec.	.255	58	.300
WM+WF	.259 sec.	.151 sec.	.255	58	.498
BM+WM	.246 sec.	.144 sec.	.255	58	.340
BF+WF	.269 sec.	.168 sec.	.255	58	.203

The relationship of reaction time and movement time was determined by the two methods of measuring reaction time utilized in this investigation. With regard to SRT and MT, only two of the eight possible groups produced a relationship between SRT and MT that was significant at the .05 level. Those groups were the ones that included both sexes of each race. The group of black males and females produced a Pearson r of .375, while the group of white males and females produced a Pearson r of .351. The critical value for significance at the .05 level in these cases was .255.

When the groups were separated by sex, significance was not shown. Significance was most closely approached, however, by the white female groups and the white male group. The white females produced a Pearson r of .356 where a critical value of .362 was needed for the .05 level of significance. The white male group produced a Pearson r of .329 in the same situation.

Similar results were produced when the relationship of VJRT and MT was determined. Three of the possible eight groups produced a significant relationship between the VJRT and MT variables. These groups included the same ones that produced significance with SRT and MT with the addition of the all male group that included both blacks and whites. The all black group of males and females produced a Pearson r of .300, while the all white group of males and females produced a Pearson r of .498, and the all male group of blacks and whites produced a Pearson r of .340. The critical value for significance at the .05 level in all of these cases was .255.

The increased degrees of freedom and the corresponding decrease in significance value gained by combining the groups was instrumental in

producing significance. This is evidenced by the fact that none of the groups segregated by race and sex produced significant results in the relationships of reaction time and movement time. Based on the results of this investigation, a general acceptance of the null hypothesis was made with respect to the relationship of reaction time and movement time. This conclusion is in agreement with previous investigations reported by Lotter (15), Hodgkins(16), and Mendryk (17), and in disagreement with results obtained by Pierson (12), Youngen (13), and Westerlund and Tuttle (14).

TABLE X

RELATIONSHIP OF SRT AND VJRT

Group	SRT Mean	VJRT Mean	Crit. Val. .05	df	Pearson r
BM	.142 sec.	.253 sec.	.362	28	.507
BF	.158 sec.	.260 sec.	.362	28	.466
WM	.158 sec.	.240 sec.	.362	28	.572
WF	.163 sec.	.278 sec.	.362	28	.600
BM+BF	.150 sec.	.257 sec.	.255	58	.482
WM+WF	.161 sec.	.259 sec.	.255	58	.540
BM+WM	.150 sec.	.246 sec.	.255	58	.391
BF+WF	.161 sec.	.269 sec.	.255	58	.536

Results Related to Hypothesis #5

(Table X)

Hypothesis number five in this investigation stated that there is no significant relationship between measuring reaction time by the vertical jump method and by the thumb response method. It was the feeling of the investigator that the vertical jump method (VJRT) of measuring reaction time which was used exclusively by Cureton (25) in his study of champion athletes possibly was not as valid as the thumb response method (SRT). This questioning of the VJRT was based on the fact that more body movement was involved in performing a vertical jump, and it would therefore be more likely to include movement time as well as reaction time than a method such as the thumb response. An examination of this question was made in this investigation by determining the relationship of VJRT and SRT.

All groups and combinations of groups produced Pearson r's which were significant beyond the .05 level for the relationship of VJRT and SRT. Such findings require that a rejection of the null hypothesis be made with respect to a relationship between VJRT and SRT, and an assertion that a relationship does in fact exist.

Other aspects of the investigation, however, produce questions as to what this relationship is and how it operates. For instance, in comparing mean differences a comparison of black males with white males produced a significant t for SRT and no significance for VJRT. Black females compared to white females produced a significant t for VJRT and no significance for SRT. Black males compared to black females produced a significant t for SRT and no significance for VJRT. White males compared to white females produced a significant t for VJRT and no

significance for SRT. The all black group compared to the all white group produced a significant t for SRT and no significance for VJRT. In the case of the comparison of black males and white males, the blacks produced a superior SRT which was statistically significant while the whites produced a superior VJRT which approached significance.

Another reason for question was shown in the correlation results when the all male group produced a significant relationship between VJRT and MT, while no significance was shown by the same group for SRT and MT. It would seem that if a true relationship did exist between SRT and VJRT, this relationship would be substantiated in the other statistical procedures. The discrepancies noted tend to suggest that reaction time measurement is specific to body part and method of measure. Since the simple reaction time measure in this study involved the hand and the movement time measure involved the foot and leg, we would not expect to find a high correlation of the two if they are in fact specific to body part.

General Discussion

The major incentive for pursuing this investigation emerged from an observation of black dominance in several athletic events, and a feeling that some physiological factor might play a role in explaining such a dominance. The element of reaction time was chosen as a point of investigation since it has been established that athletes exhibit superior reaction times compared to non-athletes and is therefore assumed to be a factor in successful athletic performance. If the black population should in fact exhibit superiority to whites in reaction time performance, such a factor could be instrumental in explaining black dominance

in specific athletic endeavors.

The results of this investigation tend to be inconclusive with regard to black superiority in the performance of reaction time. The black male group clearly demonstrated a superior reaction time capacity to the white male group in the simple reaction time measurement. Drawing a conclusion from this result, however, was complicated by the fact that almost opposite results were obtained utilizing the vertical jump method of measuring reaction time. Utilizing the vertical jump method, the white males produced faster times than the black males. Inconsistencies were noted throughout as significance was not substantiated by both methods of measuring reaction time.

Another factor which clouds the issue lies in the fact that a definite relationship between reaction time and movement time was not shown. It stands to reason that any athletic advantage gained by a superior reaction time would be useless if it could not be maintained through a movement phase of athletic performance. This type of reasoning, however, does not allow for the fact that any advantage gained from a specific factor such as reaction time must be an aid in some degree to the overall performance. The ideal situation would be one in which an individual athlete possessed a superior reaction time combined with a superior movement time. The results of this investigation simply indicate that this combination does not exist with enough frequency in the general population to produce a statistically significant relationship.

Based on the results of this investigation, the proposal of superiority of reaction time performance as a factor contributing to black dominance of specific athletic events was rejected.

The mean reaction time produced in this investigation tended to be

faster than the times produced by athletes in other investigations. The mean VJRT with an auditory stimulus produced by the track athletes in Cureton's study (26) was .276 seconds. All groups in this investigation produced faster VJRT means than those found in Cureton's study with the exception of the white females. Faster means in SRT were also found in this investigation when compared to the writer's preliminary investigation involving only athletes (5), where the black subjects produced a mean SRT of .169 seconds and the white subjects produced a mean SRT of .176 seconds. It is suggested that a possible explanation for such an occurrence lies in the possibility of differences existing in the calibration of timing devices.

CHAPTER V

CONCLUSIONS

The results of this investigation warrant the following conclusions:

1. Black males produced a superior simple reaction time mean to a significant degree when compared to white males.

2. Black males produced a superior simple reaction time mean to a significant degree when compared to black females.

3. Black males and females as a group produced a superior simple reaction time mean to a significant degree when compared to white males and females as a group.

4. Black and white males as a group produced a superior simple reaction time mean to a significant degree when compared to black and white females as a group.

5. Black females produced a superior vertical jump reaction time mean to a significant degree when compared to white females.

6. White males produced a superior vertical jump reaction time mean to a significant degree when compared to white females.

7. Black and white males as a group produced a superior vertical jump reaction time mean to a significant degree when compared to black and white females as a group.

8. A general superiority of blacks over whites in reaction time performance was rejected due to a variability of results between simple reaction time and vertical jump reaction time.

9. Black males produced a superior movement time mean to a significant degree when compared to black females.

10. White males produced a superior movement time mean to a significant degree when compared to white females.

11. Black and white males as a group produced a superior movement time mean to a significant degree when compared to black and white females as a group.

12. The consistency of results indicate that males tend to exhibit superior movement time when compared to females.

13. Black males and females as a group produced a significant relationship between simple reaction time and movement time.

14. White males and females as a group produced a significant relationship between simple reaction time and movement time.

15. A general relationship between simple reaction time and movement time was rejected since only two of eight possible groups produced a significant relationship.

16. Black males and females as a group produced a significant relationship between vertical jump reaction time and movement time.

17. White males and females as a group produced a significant relationship between vertical jump reaction time and movement time.

18. Black and white males as a group produced a significant relationship between vertical jump reaction time and movement time.

19. A general relationship between vertical jump reaction time and movement time was rejected since only three of eight possible groups produced a significant relationship.

20. A significant relationship between simple reaction time and vertical jump reaction time was asserted since all groups produced a

significant relationship.

21. A proposal of superiority of reaction time performance as a factor contributing to black dominance of specific athletic events was rejected.

Recommendations

Perhaps the most critical factor affecting conclusions drawn from this investigation was the lack of consistency of results obtained from the two methods of measuring reaction time. It is therefore recommended that some form of measuring reaction time be validated and standardized for use in this type of comparative investigation.

Although many varied types of reaction time investigations have been made, very few have dealt with the possibility of racial differences existing in this capacity. Due to its possible significance in explaining an observed dominance of black athletes in several sports, it is recommended that further investigations be made into this possibility.

Since Ide (11) and Ricci (27) have shown relationships to exist between the diameter of nerves and their ability to transmit an impulse, perhaps it would be worthy to investigate the possibility of racial differences existing in nerve size to a more conclusive degree. Other variables with possible implications to reaction time include the latent period of muscle contraction and the effects of internal muscle temperature on the latent period.

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APPENDIXES

TABLE XI

RAW DATA - BLACK MALES

Subject	Age	AS	HT	WT	RPI	Mean SRT	Mean VJRT	Mean MT
1	21	75"	75"	217	12.48	.1785	.2540	.1385
2	21	74¼"	72"	194	12.44	.1805	.3590	.1560
3	20	72"	70"	208	11.81	.1280	.2125	.1535
4	21	75"	71½"	188	12.48	.1490	.2660	.1835
5	20	70½"	69"	172	12.41	.1515	.2775	.1530
6	20	71"	72"	172	12.95	.1440	.2925	.1805
7	21	73"	72½"	219	12.03	.1750	.2750	.1715
8	22	66½"	67"	176	11.96	.1360	.2300	.1110
9	20	74"	73½"	222	12.14	.1450	.2665	.1275
10	22	73"	74"	208	12.49	.1380	.2790	.1185
11	19	77"	74"	196	12.74	.1405	.2585	.1320
12	19	77"	72"	165	13.13	.1285	.2545	.1485
13	21	72"	71"	170	12.81	.1280	.2580	.1330
14	25	73½"	73"	202	12.44	.1320	.2160	.1620
15	25	77"	75½"	218	12.55	.1315	.2260	.1300
16	21	75½"	70"	169	12.66	.1360	.2125	.1335
17	21	72"	71"	185	12.46	.1385	.2405	.1310
18	20	68"	69"	190	12.00	.1375	.2715	.1530
19	21	71½"	70"	210	11.78	.1390	.2735	.1565
20	20	76"	73½"	185	12.90	.1385	.2675	.1440

TABLE XI (CONTINUED)

Subject	Age	AS	HT	WT	RPI	Mean SRT	Mean VJRT	Mean MT
21	22	76"	75"	193	12.98	.1170	.2665	.1675
22	20	72"	75"	185	13.16	.1535	.2795	.1795
23	20	77"	75½"	160	13.91	.1375	.2270	.1360
24	20	73"	72"	179	12.78	.1340	.2275	.1425
25	24	77"	74½"	160	13.72	.1540	.2435	.1620
26	21	76"	76½"	174	13.70	.1415	.2450	.1540
27	19	77½"	73"	207	12.34	.1505	.2120	.1430
28	21	76"	71½"	170	12.91	.1355	.2205	.1255
29	19	80"	75"	212	12.58	.1275	.2475	.1310
30	20	76½"	74"	175	13.23	.1395	.2245	.1565

TABLE XII

RAW DATA - BLACK FEMALES

Subject	Age	AS	HT	WT	RPI	Mean SRT	Mean VJRT	Mean MT
1	18	68"	66½"	125	13.30	.1570	.2700	.2085
2	19	61"	63½"	118	12.95	.1725	.2655	.1415
3	19	68½"	64½"	140	12.42	.1785	.3175	.1940
4	19	63½"	61½"	160	11.33	.1535	.2340	.2040
5	22	71½"	69"	160	12.71	.1485	.2385	.1485
6	17	67½"	65"	125	13.00	.1430	.2290	.1300
7	19	63"	60"	120	12.17	.1395	.2780	.1575
8	23	63½"	64"	115	13.16	.1630	.2700	.1760
9	17	61"	62"	130	12.24	.1400	.2460	.1770
10	18	66"	65"	125	13.00	.1915	.3130	.2115
11	18	72"	70"	145	13.32	.1580	.2570	.1465
12	19	63½"	62"	116	12.71	.1365	.2300	.1745
13	19	67½"	66"	120	13.38	.1565	.2485	.1290
14	18	63"	63"	125	12.60	.1690	.1910	.1655
15	19	63"	62"	110	12.94	.1435	.2800	.1525
16	20	69"	66"	135	12.87	.1660	.2295	.1905
17	20	68"	65"	133	12.74	.1880	.2770	.1925
18	20	60"	63"	128	12.50	.1365	.2010	.1750
19	20	66"	67"	135	13.06	.2080	.1985	.1775
20	25	65"	66½"	112	13.80	.1795	.2715	.1665

TABLE XII (CONTINUED)

Subject	Age	AS	HT	WT	RPI	Mean SRT	Mean VJRT	Mean MT
21	18	63"	62"	104	13.18	.1700	.2795	.1355
22	21	66"	65"	132	12.77	.1905	.2750	.2580
23	20	62"	64"	140	12.33	.1570	.2215	.1465
24	25	69"	67"	127	13.33	.1320	.2050	.1415
25	22	67"	63"	115	12.95	.1385	.2825	.2235
26	20	66"	65"	130	12.83	.1300	.2525	.1880
27	21	65½"	65"	145	12.37	.1335	.2835	.1805
28	21	72"	71"	135	13.84	.1675	.2810	.1525
29	25	66½"	67"	165	12.22	.1735	.3300	.1535
30	20	65"	62"	106	13.10	.1380	.2560	.1855

TABLE XIII

RAW DATA - WHITE MALES

Subject	Age	AS	HT	WT	RPI	Mean SRT	Mean VJRT	Mean MT
1	22	71½"	71"	164	12.97	.1375	.2220	.1255
2	25	71½"	72"	168	13.05	.1595	.2545	.1370
3	18	73½"	71"	160	13.08	.1350	.2060	.0970
4	20	80"	78½"	194	13.56	.1515	.2615	.1340
5	19	71½"	70"	180	12.40	.1665	.2615	.1210
6	21	74"	72"	209	12.13	.1415	.2370	.2040
7	20	72½"	72"	240	11.59	.1760	.2565	.1600
8	25	70½"	70	200	11.97	.1660	.2200	.1400
9	26	78"	76"	230	12.40	.1840	.2390	.1600
10	22	70½"	72"	145	13.70	.1585	.2365	.1600
11	20	74"	74"	215	12.35	.1505	.2020	.1400
12	18	73"	71"	160	13.08	.1780	.2540	.1430
13	19	70"	71"	165	12.94	.1450	.2220	.1385
14	24	69"	69"	140	13.29	.2145	.3070	.1295
15	18	78"	76"	250	12.06	.1815	.3075	.1485
16	20	77"	74"	180	13.11	.1965	.2635	.1660
17	18	71"	71"	160	13.08	.1475	.2590	.1635
18	17	67"	67"	125	13.40	.1745	.2260	.1200
19	19	76"	74"	170	13.36	.2160	.2355	.1750
20	18	66½"	68"	150	12.80	.1455	.2395	.1580

TABLE XIII (CONTINUED)

Subject	Age	AS	HT	WT	RPI	Mean SRT	Mean VJRT	Mean MT
21	19	74½"	71"	152	13.30	.1280	.1755	.1270
22	21	72"	71½"	265	11.19	.1625	.2340	.1205
23	18	74"	71½"	153	13.37	.1600	.2320	.1285
24	20	72"	73"	195	12.59	.1505	.2620	.1385
25	19	74½"	70"	195	12.07	.1315	.2400	.1280
26	21	69½"	71"	200	12.14	.1360	.2185	.1095
27	24	74"	70½"	180	12.49	.1500	.2210	.1280
28	26	69½"	69"	140	13.29	.1300	.2025	.1190
29	21	72"	73"	170	13.18	.1555	.2650	.1445
30	22	72"	70½"	165	12.85	.1210	.2380	.1385

TABLE XIV

RAW DATA - WHITE FEMALES

Subject	Age	AS	HT	WT	RPI	Mean SRT	Mean VJRT	Mean MT
1	20	67"	66"	128	13.10	.1665	.2680	.1345
2	18	66"	67"	110	13.98	.1625	.2915	.1675
3	18	66½"	63"	127	12.53	.1440	.2300	.1410
4	18	68"	67"	165	12.22	.1725	.3205	.1570
5	18	61"	61½"	107	12.96	.1385	.2445	.1325
6	18	66"	66"	130	13.03	.1305	.2575	.1565
7	19	65"	64"	125	12.80	.1310	.2280	.1700
8	18	71"	68½"	145	13.04	.1785	.2970	.1340
9	18	65½"	62"	120	12.57	.1380	.3130	.1430
10	18	64"	64"	127	12.73	.1580	.2815	.1450
11	19	62"	61½"	106	12.99	.1560	.2315	.1805
12	20	67"	63½"	137	12.32	.1590	.2900	.1990
13	21	66"	65"	160	11.97	.1520	.2360	.1555
14	20	56"	60"	118	12.23	.1750	.2920	.1890
15	21	66½"	62"	120	12.57	.1750	.2700	.1535
16	20	67½"	62"	95	13.59	.2080	.3465	.2000
17	22	65"	64"	115	13.16	.1810	.2810	.1720
18	25	67½"	67"	125	13.40	.1910	.2580	.1665
19	18	68½"	67½"	145	12.85	.1805	.2915	.1690
20	25	64½"	65"	120	13.18	.1660	.2790	.1700

TABLE XIV (CONTINUED)

Subject	Age	AS	HT	WT	RPI	Mean SRT	Mean VJRT	Mean MT
21	20	70½"	68"	135	13.26	.1810	.3130	.1605
22	20	69"	66½"	133	13.03	.1395	.2625	.1640
23	21	67"	68½"	125	13.70	.1530	.2560	.1405
24	19	65½"	67"	123	13.47	.1580	.2625	.1535
25	21	65½"	66½"	120	13.48	.1605	.2950	.1495
26	19	67½"	67"	155	12.47	.1505	.2770	.1620
27	19	65½"	67"	120	13.58	.1780	.2970	.1945
28	20	66½"	65"	180	11.51	.1900	.2945	.1625
29	19	68"	65½"	127	13.03	.1665	.2760	.1515
30	22	66"	64"	103	13.65	.1580	.3050	.1945

TABLE XV

GROUP MEANS AND STANDARD DEVIATIONS

Variable	Group	N	Mean	Std. Dev.
AS	BM	30	74.167 in.	2.984
AS	WM	30	72.633 in.	3.129
AS	BF	30	65.750 in.	3.202
AS	WF	30	66.050 in.	2.812
AS	BM+BF	60	69.958 in.	5.237
AS	WM+WF	60	69.342 in.	4.440
AS	BM+WM	60	73.400 in.	3.128
AS	BF+WF	60	65.900 in.	2.991
HT	BM	30	72.583 in.	2.297
HT	WM	30	71.683 in.	2.409
HT	BF	30	64.750 in.	2.576
HT	WF	30	65.050 in.	2.329
HT	BM+BF	60	68.667 in.	4.632
HT	WM+WF	60	68.367 in.	4.087
HT	BM+WM	60	72.133 in.	2.378
HT	BF+WF	60	64.900 in.	2.439
WT	BM	30	189.367 lbs.	19.104
WT	WM	30	180.667 lbs.	34.158
WT	BF	30	129.200 lbs.	15.339
WT	WF	30	128.200 lbs.	18.726

TABLE XV (CONTINUED)

Variable	Group	N	Mean	Std. Dev.
WT	BM+BF	60	159.283 lbs.	34.862
WT	WM+WF	60	154.433 lbs.	38.023
WT	BM+WM	60	185.017 lbs.	27.787
WT	BF+WF	60	128.700 lbs.	16.978
RPI	BM	30	12.667	.539
RPI	WM	30	12.773	.620
RPI	BF	30	12.837	.520
RPI	WF	30	12.953	.571
RPI	BM+BF	60	12.752	.532
RPI	WM+WF	60	12.863	.598
RPI	BM+WM	60	12.720	.579
RPI	BF+WF	60	12.895	.545
SRT	BM	30	.142 sec.	.015
SRT	WM	30	.158 sec.	.024
SRT	BF	30	.158 sec.	.021
SRT	WF	30	.163 sec.	.019
SRT	BM+BF	60	.150 sec.	.020
SRT	WM+WF	60	.161 sec.	.021
SRT	BM+WM	60	.150 sec.	.021
SRT	BF+WF	60	.161 sec.	.020
VJRT	BM	30	.253 sec.	.031
VJRT	WM	30	.240 sec.	.028
VJRT	BF	30	.260 sec.	.034
VJRT	WF	30	.278 sec.	.029

TABLE XV (CONTINUED)

Variable	Group	N	Mean	Std. Dev.
VJRT	BM+BF	60	.257 sec.	.032
VJRT	WM+WF	60	.259 sec.	.034
VJRT	BM+WM	60	.257 sec.	.030
VJRT	BF+WF	60	.269 sec.	.032
MT	BM	30	.147 sec.	.019
MT	WM	30	.140 sec.	.022
MT	BF	30	.173 sec.	.030
MT	WF	30	.162 sec.	.019
MT	BM+BF	60	.160 sec.	.028
MT	WM+WF	60	.151 sec.	.023
MT	BM+WM	60	.144 sec.	.020
MT	BF+WF	60	.168 sec.	.026

TABLE XVI

CORRELATION MATRIX FOR BLACK MALES

df = 28

Crit. Val. .05 = .362

	AS	HT	WT	RPI	SRT	VJRT	MT
AS	X	.728	.047	.507	-.056	-.219	-.048
HT	.728	X	.178	.616	.075	-.015	.110
WT	.047	.178	X	-.663	.216	.115	-.075
RPI	.507	.616	-.663	X	-.119	-.114	.139
SRT	-.056	.075	.216	-.119	X	.507	.272
VJRT	-.219	-.015	.115	-.114	.507	X	.345
MT	-.048	.110	-.075	.139	.272	.345	X

TABLE XVII

CORRELATION MATRIX FOR WHITE MALES

df = 28

Crit. Val. .05 = .362

	AS	HT	WT	RPI	SRT	VJRT	MT
AS	X	.858	.483	-.043	.197	.159	.249
HT	.858	X	.541	-.014	.235	.282	.330
WT	.483	.541	X	-.840	.112	.198	.194
RPI	-.043	-.014	-.840	X	.060	-.039	-.043
SRT	.197	.235	.112	.060	X	.572	.329
VJRT	.159	.198	-.198	-.039	.572	X	.289
MT	.249	.330	.194	-.043	.329	.289	X

TABLE XVIII

CORRELATION MATRIX FOR BLACK FEMALES

df = 28
Crit. Val. .05 = .362

	AS	HT	WT	RPI	SRT	VJRT	MT
AS	X	.816	.374	.416	.170	.194	-.004
HT	.816	X	.447	.523	.305	.140	-.167
WT	.374	.447	X	-.522	.154	.067	.055
RPI	.416	.523	-.522	X	.158	.096	-.211
SRT	.170	.305	.154	.158	X	.466	.218
VJRT	.194	.140	.067	.096	.466	X	.248
MT	-.004	-.167	.055	-.211	.218	.248	X

TABLE XIX

CORRELATION MATRIX FOR WHITE FEMALES

df = 28
Crit. Val. .05 = .362

	AS	HT	WT	RPI	SRT	VJRT	MT
AS	X	.700	.391	.149	.201	.248	-.195
HT	.700	X	-.433	.329	.112	.100	-.255
WT	.391	.433	X	-.700	.055	.007	-.252
RPI	.149	.329	-.700	X	.084	.123	.107
SRT	.201	.112	.055	.084	X	.600	.356
VJRT	.248	.100	.007	.123	.600	X	.337
MT	-.195	-.255	-.252	.107	.356	.337	X

TABLE XX

CORRELATION MATRIX FOR ALL BLACKS

df = 58

Crit. Val. .05 = .255

	AS	HT	WT	RPI	SRT	VJRT	MT
AS	X	.928	.762	.136	-.281	-.094	-.387
HT	.928	X	.820	.155	-.238	-.065	-.427
WT	.762	.820	X	-.432	-.268	-.058	-.405
RPI	.136	.155	-.432	X	.101	.014	.013
SRT	-.281	-.238	-.268	.101	X	.482	.375
VJRT	-.094	-.065	-.058	.014	.482	X	.300
MT	-.387	-.427	-.405	.013	.375	.300	X

TABLE XXI

CORRELATION MATRIX FOR ALL WHITES

df = 58

Crit. Val. .05 = .255

	AS	HT	WT	RPI	SRT	VJRT	MT
AS	X	.911	.730	-.084	.043	-.313	-.332
HT	.911	X	.770	-.040	.008	-.372	-.367
WT	.730	.770	X	-.652	-.014	-.320	-.308
RPI	-.084	-.040	-.652	X	.086	.118	.095
SRT	.043	.008	-.014	.086	X	.540	.351
VJRT	-.313	-.372	-.320	.118	.540	X	.498
MT	-.332	-.367	-.308	.095	.351	.498	X

TABLE XXII

CORRELATION MATRIX FOR ALL MALES

df = 58
Crit. Val. .05 = .255

	AS	HT	WT	RPI	SRT	VJRT	MT
AS	X	.804	.346	.177	-.005	.020	.152
HT	.804	X	.419	.249	.082	.165	.256
WT	.346	.419	X	-.768	.066	.186	.129
RPI	.177	.249	-.768	X	.034	-.092	.019
SRT	-.005	.082	.066	.034	X	.391	.211
VJRT	.020	.165	.186	-.092	.391	X	.340
MT	.152	.256	.129	.019	.211	.340	X

TABLE XXIII

CORRELATION MATRIX FOR ALL FEMALES

df = 58
Crit. Val. .05 = .255

	AS	HT	WT	RPI	SRT	VJRT	MT
AS	X	.765	.376	.287	.188	.222	-.082
HT	.765	X	.432	.429	.224	.134	-.206
WT	.376	.432	X	-.623	.096	.026	-.070
RPI	.287	.429	-.623	X	.134	.134	.097
SRT	.188	.224	.096	.134	X	.536	.227
VJRT	.222	.134	.026	.134	.536	X	.203
MT	-.082	-.206	-.070	.097	.227	.203	X

TABLE XXIV

DATA FOR MT

Group	N	MT Mean	Variance	Std. Dev.	Std. Err.
BM	30	.147 sec.	.345	.019	.339
BF	30	.173 sec.	.891	.030	.545
WM	30	.140 sec.	.465	.022	.394
WF	30	.162 sec.	.373	.019	.352
BM+BF	60	.160 sec.	.774	.028	.359
WM+WF	60	.151 sec.	.537	.023	.299
BM+WM	60	.144 sec.	.422	.020	.262
BF+WF	60	.168 sec.	.649	.026	.329

TABLE XXV

COMPARISON OF MEANS FOR MT

Group Means Compared	Mean Difference	df	Crit. Val. .05	t - Statistic
BM-WM	.007 sec.	58	2.002	1.360
BF-WF	.011 sec.	58	2.002	1.615
BM-BF	.016 sec.	58	2.002	3.994
WM-WF	.022 sec.	58	2.002	4.204
BM+BF-WM+WF	.011 sec.	118	1.980	1.877
BM+WM-BF+WF	.024 sec.	118	1.980	5.693

VITA

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Doctor of Education

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