The relationship of reaction time and movement time to racquetball success
by Gregory Dale Olson

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Physical Education
Montana State University

Abstract:
A study was conducted to compare racquetball success with reaction time (RT), movement time (MT), and the composit of the two—total time (TT). These variables were compared between two groups of eleven players. The groups were established according to the results of a double elimination tournament. The top eleven finishers formed the high ability group, while the bottom eleven players formed the low ability group. Total time and RT data were collected while speed of movement was computed. t-tests and F-ratios were used to determine if any significant difference existed between the means and/or variability of the two groups in any of the three variables. The findings were as follows:
1. The mean TT was significantly lower in the high ability group as compared with the low ability group.

2. The mean RT was significantly lower in the high ability group as compared with the low ability group.

3. The mean MT and the MT variability were not significantly different between the high ability group and the low ability group.

4. Reaction time variability was significantly less in the high ability group as compared with the low ability group.

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A thesis submitted in partial fulfillment
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ABSTRACT

A study was conducted to compare racquetball success with reaction time (RT), movement time (MT), and the composit of the two--total time (TT). These variables were compared between two groups of eleven players. The groups were established according to the results of a double elimination tournament. The top eleven finishers formed the high ability group, while the bottom eleven players formed the low ability group. Total time and RT data were collected while speed of movement was computed. t-tests and F-ratios were used to determine if any significant difference existed between the means and/or variability of the two groups in any of the three variables. The findings were as follows:

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Chapter 1

INTRODUCTION

Reaction time, speed of movement time, and the composit of the two--total time, have been of interest in the field of Physical Education since before the turn of the century. With the development of better instrumentation, scientists have been able to make more precise measures of reaction and speed of movement times. Using advanced electronics, we can measure in milliseconds. Using advanced technology, scientists can better explore the relationships of reaction and movement times and their effects on athletic performance. In the following study, the researcher will explore the areas of reaction time and speed of movement time.

Statement of the Problem

The purpose of this investigation was to examine the relationships among reaction time, speed of movement time, the total time and success in racquetball. Selected subjects consisted of twenty-two male racquetball players. Specific problems for exploration were:

1. to identify the relationship between reaction time and success in racquetball,

2. to identify the relationship between speed of movement and success in racquetball,
3. to identify the relationship between total time and success in racquetball,
4. to identify the relationship between consistency and success in racquetball,
5. to identify which of the three variables, total time, reaction time, and speed of movement, is of the greatest importance in relationship to success in racquetball,
6. to identify and describe the characteristics of total time, reaction time, and movement time, and the relationships which may exist between them.

Hypothesis

It was hypothesized that total time, reaction time, and movement time have no significant effect on racquetball success.

Alternate. It was hypothesized that total time, reaction time, and movement time do have significant effect on racquetball success.

Delimitations

The investigation was limited to twenty-two male racquetball players between the ages of 19 and 45. All of the subjects met the eligibility requirements of the Montana State University intramural department, which limited racquetball participation to university students and faculty. Subjects were playing racquetball and were participants in a double elimination tournament at the time of the study. Subjects were given no motivation to attempt to increase their reaction time or movement time speeds.

Limitations

Each subject was tested at a random time during the day. There was no attempt to control variations in eating and sleeping habits or fatigue. Secondly, various limbs and sections of limbs have different reaction times and movement times. The specific combination tested was an expeditious clapping motion with the hands at the level of the illiactic crest.

Another limiting factor may be that the H-O reaction test was a simple task and may not compare to the complex visual stimuli of a racquetball game. Furthermore, speed of movement is changeable according to the direction

of force applied to the limb. Only one specific direction was tested--the direction of the hands moving horizontally toward one another. This direction was chosen since it stimulates a motion commonly made in a racquetball game.

Reaction time is faster when subjects are given a simple stimulus rather than a complex stimulus. Uncontrolled factors which may have limited racquetball success included inate coordination, amount of practice, psychological and physical condition.

The assumption was made that the simple reaction and movement time in the experiment represented the characteristic reaction and movement time of the individual, and could be compared to other subjects performing the same task.

Definitions

The following terms as used in this study are confined to the following definitions:

Chase stick - a 3/4" dowel, 36" long on which the subject placed his hand at the beginning of each trial. The purpose of the chase stick was to keep the subject's hands traveling in a horizontal plane.

Foreperiod. The time elapsed between the "ready" signal, given by the subject, and the time of the throwing of the switch. The time was counted from a random number table between zero and nine.

Reaction time. (RT) The time elapsed in milliseconds between the visual stimulus and the time at which the circuit was broken, i.e., first movement.

Speed of movement. (MT) The time in milliseconds which elapsed between the subject's (S) movement and the catch of the Nelson Reaction Timer.

Chapter 2

REVIEW OF RELATED LITERATURE

Many studies have been completed that deal with RT, MT, and TT which are relevant to the following study. Studies of this nature deal with a variety of subjects. Therefore, a division was made into the following categories:

1. Practice and learning,
2. Psychological and Motivational conditions affecting RT and MT,
3. Effects of gender and age upon RT and MT,
4. Physiological effects,
5. Relationship of RT and MT to athletic success.

The Memory Drum Theory

The Memory Drum Theory of Neuromotor Reaction, according to Christina (9), suggests that the redundant motor elements of a fast, complicated, learned movement are governed by a non-conscious motor memory mechanism. The mechanism controls and channels the flow of impulses into the appropriate neuromotor coordination centers and nerves --thus affecting movement in a somewhat automated fashion. Increased RT and MT would result when one thought more

about a movement. In the same manner, RT and MT would increase because of an interference with the memory mechanism.

Practice and Learning

Researchers have shown, that the learning effect in RT trials takes place within the first five trials of a task (9,16,28). Henry (16) showed that RT and movement task learning occurs very rapidly and stated that reaction task learning occurs at a quicker pace than does movement task learning.

Luachei (24) approximated that forty milliseconds of RT interval was necessary for the subcortical and spinal motor processing required for coordination of the normal reaction movement. One hundred and twenty milliseconds were needed for a full RT response to a visual stimulus. Henry (16), Clark (12), and Smith (33) found RT and MT to be independent and uncorrelated.

Norrie (29) found practice does not appreciably affect the amount of variability in RT or MT within the individual, except for RT in the first five trials. Reaction time during the first five trials was variable because of a learning factor.

Aiken and Lichtenstein (1) found that the mean RT to a visual stimuli would increase proportionately with the length of foreperiod--the foreperiod time ranging from one to ten seconds.

Botwinick (5) found that the shorter the foreperiod, the faster the RT under six different auditory stimulus intensities.

Over a four day period Carson (7) found that RT response consistency was high in thirty right-handed college males. The reliability coefficients for four different RT measures over four days were .797, .830, .780, and .793, respectively.

Psychological and Motivational Conditions Affecting RT and MT

Nash (26), studying the effects of manifest and induced anxiety, found that under stress induced by electrical shock, simple RT is slower than under no stress. However, he did find that there was no relationship between the level of anxiety as measured by the Taylor Manifest Anxiety Scale, and simple RT. In other words, simple RT was not affected by the level of manifest anxiety according to the Taylor Manifest Anxiety Scale.

Henry (15) showed that both RT and MT can be improved by motivation. All of the ninety-three volunteers from a men's physical education class in elementary gynmastics and tumbling improved significantly ($p < .05$) in RT, and most of them improved in MT regardless of the motivating stimuli they received. The five groups of stimuli were:

1. No motivating stimulus,
2. motivated by a dim light,
3. motivated by a bright light,
4. motivated by a bright light plus shock,
5. motivated by sound.

Effects of Gender and Age Upon Reaction Time and Movement Time

Hodgkins (18) in studying the difference of RT and MT between males and females found males were faster than females in both RT and MT. The speed of both RT and MT increased until early adulthood (19 years old) and then decreased, according to Hodgkins. The peak speed in males is maintained longer in life than in females.

Botwinick (5) found the responses of the elderly (sixty-five to eighty-one years of age) were much less variable than younger groups (eighteen to thirty-two years

of age). There were twenty-nine subjects tested in the older group, and thirty-four subjects tested in the young group. Furthermore, he found that the slowing of mean TT was not related to motivation. He did find that the slowing may be related to a state of preparedness on the part of the S to respond.

Evans (13) in a fifty year longitudinal study found that simple-sensory reaction to auditory stimulus in an undistracted condition did not increase or decrease significantly over a fifty year period. He did find that if irregular or intermittent types of distractions were made, simple sensory reaction would increase significantly. Evans stated that speed of response in directly related to the difficulty of the task.

Physiological Effects

Henry (15) found that the strength--mass ratio of a limb seemed to be unrelated to limb speed.

Meyers (25) determined that strenuous physical exercise had no discernable effect on simple finger and foot RT. He stated that there was no apparent relationship between RT and the sum of the recovery pulse counts following the exercise.

Tweit (37), in his study of the effects of a training program on individuals of low fitness, found that total body RT was significantly ($p < .01$) improved by participation in a strenuous physical training program. However, Rarick (2) found that speed of muscular performance cannot be increased appreciably in highly skilled individuals.

Phillips (31) found that arm exercises produced no statistically significant advantge in MT. He also found that warm-up exercises do not influence RT.

Schmidt (35), in studying the effects of positional tensioning and stretching on RT and MT, found that stretching had no effect on either RT or MT. Furthermore, he found that MT was not affected by positional tensioning, but RT was. According to Schmidt (35), RT decreased progressively with increased positional tensioning.

Smith (33) found that during a state with tensioned muscles, the S produced a four percent faster MT and a seven percent faster RT, as compared with having the arm in a more relaxed condition. However, the increases were statistically ($p < .05$) insignificant between conditions of relaxation, tension, and stretch.

Clark (10) concluded from his study of preliminary muscular tension on RT, that increased muscular tension in the form of preparatory set, resulted in a faster RT.

Smith (34) found the arm to be four percent faster than the leg in a forward motion, but that the direction of movement had no effect upon RT of the arm. In addition, he stated that speed was clearly specific to the limb.

Relationship of Reaction Time and Movement Time to Athletic Success

Studies done previously on the relationship of RT and MT to athletic success are conflicting. Keller (19), in his study of the relationship of quickness to success in athletics stated, "There is a positive relationship between the ability to move fast and success in athletic activities." He also states, "The relationship for quickness is not the same for all sports." (20, p. 154)

The variability in RT's of sportsmen, according to Knapp (22), is significantly less ($p < .01$) than the variability in the RT's of research students. Knapp (22) also stated that top class racquet-game players, between the ages of twenty and thirty, have significantly faster RT's than those of a sample population of twenty to thirty-year old students.

Patrick (30), in studying basketball players came to the conclusion that, "Boys with the best reaction time were not only the best basketball players as determined by subjective rating, but were better in sports where quick reaction was a factor." (31, p. 68) He goes on to say that potential basketball players have quicker reaction time to visual stimuli than boys with restricted basketball potential.

Waechter (38), in his study of MT of selected groups of athletes and non-athletes, found that there was no significant difference in MT between non-athletes and athletes. All groups had a mean TT of one hundred and forty-four milliseconds.

The above studies all deal with variables which may affect RT and MT. Generally, it can be stated that there are four categories of variables that affect RT and MT. They are:

1. those variables unrelated to RT and MT,
2. those variables positively affecting RT and MT,
3. those variables negatively affecting RT and MT,
4. those variables which are conflicting.

Those variables unrelated to RT and MT were practice, the strength-mass ratio of limbs, warm-ups, anxiety

(only RT), direction of movement, and tests being conducted on different days. Furthermore, it was found that RT and MT were unrelated.

Those variables positively related to RT and MT were motivation factors, muscular tension, and shortening the foreperiod. Variability seems to decrease with age and athletic ability.

Those variables negative affecting RT and MT seem to be thinking about the task, stress, complexity of the task, age, and lengthening the foreperiod time.

Conclusions regarding the effects of selected physiological states on RT were conflicting.

Chapter 3

METHODS AND PROCEDURES

The following study attempted to measure the relationship of three variables--RT, MT, TT--to success in the game of racquetball.

Racquetball Success

Success in racquetball was measured by the use of a double elimination racquetball tournament. Rules governing the elimination or progression of S's were only that the player win or lose two out of three games. International Racquetball Association rules were used.

Instrumentation

The following instruments and machines were used and designed for the accumulation of RT, MT and TT data on the S's.

A wide range oscillator (Model 200 cd, Hewlett-Packard) with a variable frequency output from 0 to 65 x 10k. An electronic counter (Hewlett-Packard 532/B) which counted the number of frequencies put out by the oscillator. The electronic counter counted up to six digits. A Nelson reaction timer, 30" long, designed by Fred B. Nelson. Gravity was a constant (32 ft./sec./sec.) as the timer was

released from a magnet and dropped to the floor. The reading obtained from the timing stick was calibrated in milliseconds and was defined as TT. (Nelson reaction timer, Model RT-2) A variable direct current power supply (California Computer Products, Model 30-500) was set for nine volts direct current. A H-O reaction and speed of movement instrument designed by Dr. Ralph Hight and the researcher made it possible to put all of the aforementioned equipment into one functioning unit. A photograph may be seen in Figure 1. A black box, 6" x 6" x 4", housed a switch which controlled the entire apparatus. An electrical diagram is shown in Figure 2.

Operation and Control or Reaction Instrument

The variable frequency oscillator was set at ten thousand frequencies per second. The oscillator and counter were checked for accuracy by placing the dial on the "one second" setting. The electronic counter counted the number of frequencies for one second. Any slight adjustment of the frequency oscillator was therefore possible.

The dial of the electronic counter was placed in the open gate position which allowed the counter to count

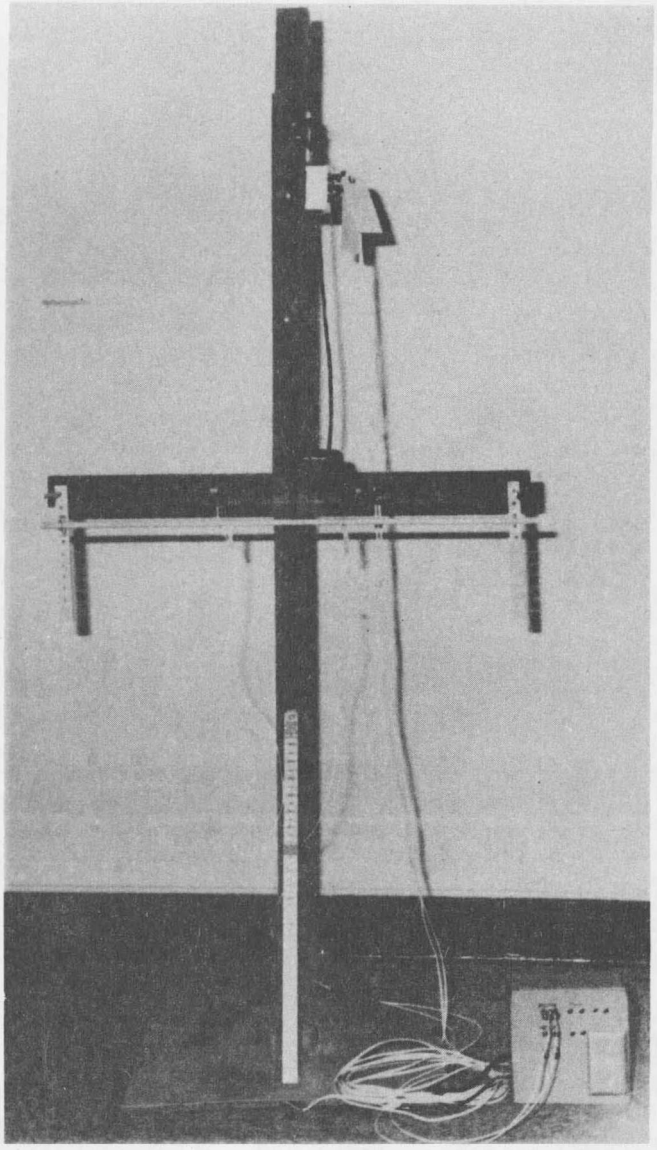

Figure 1. H-O Reaction and Speed of Movement Instrument