

A COMPARATIVE ANALYSIS BETWEEN
THE PREMOTOR REACTION TIME
OF WOMEN ATHLETES AND
WOMEN NON-ATHLETES

by

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My parents and persons who have helped me along the way.

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Chapter 1

INTRODUCTION

Coaches and physical educators are concerned with the factors which affect the speed of response. Reaction time is one of the factors which affect an athlete's speed of response in activities requiring fast reaction (42). The trackman or swimmer who can start faster, the baseball runner who can react faster to the pitcher's motion, and the tennis player who can react faster to the opponent's shots, all have a clear advantage over other performers (42).

Reaction time as referred to in other studies is the delay between the presentation of a stimulus and the initiation of a response to it (42, 48). However, different uses and interpretations of reaction time by different researchers has revealed conflicting and confusing definitions of reaction time. Reaction time is typically interpreted to include a period of movement time.

The apparatus needed for measuring reaction time are:

(1) a timer, usually a chronoscope, which recorded time in hundredths of a second and is activated by a stimulus (typically a buzzer or light) (42); (2) a switch that, when released or depressed, stopped the timer (42).

This however, is response time as interpreted by this investigator and not reaction time. Response time is the total

period of time in which reaction time and movement have occurred.

For the purpose of this study reaction time begins with the presentation of the stimulus and ends with initiation of a muscular response. Reaction time does not include the muscle response itself.

Reaction time however is important to the success of an athlete. However, the factors determining the speed of reaction are very complex and include many variables (42, 48). One factor which may affect an athlete's reaction time is the speed of nerve transmission (11, 51). Herman von Helmholtz in the early 1850's reported that nerve impulses travel at the rate of 50 to 100 meters per second (11). Subsequent research has confirmed his figure of 100 m/sec. This figure makes it clear that most reaction time involves delays in the central nervous system and not along the peripheral system (11).

Lawther on the other hand opposes the view that the speed of nerve transmission is important in improving reaction time. Lawther feels nerve transmission is so brief, that it should be ignored as an important factor in reaction time (32). Youngen has stated that reaction time may be divided into many parts (52). The reaction time physiological process may possibly follow this sequence: (1) sensory perception; (2) latency period in the sense organ; (3) conduction of the afferent nerve impulses from the proper sensory centers; (4) elaboration in the cerebral hemispheres and spinal cord; (5) conduction of the afferent nerve impulses to the proper striated muscles or organs; and (6) muscular response (52). However, which factors

had the most influence on the speed of reaction time are questionable.

Weiss, in 1965, fractioned reaction time into two motor components (49). The two motor components of reaction time were the premotor reaction time and the motor reaction time (49). The premotor reaction time was considered in this investigation.

The premotor reaction time as a component of reaction time was investigated by this investigator to help understand its relationship to fast reactions. The premotor reaction times of women athletes and women non-athletes were compared to determine if there was a difference.

Statement of the Problem

The purpose of this study was to compare the premotor reaction time of women athletes and women non-athletes. More specifically, the purpose of this study was to determine if women athletes had a faster premotor reaction time than the women non-athletes. It was assumed that the women athlete's premotor reaction time would be faster than the women non-athlete's because of the process of selecting superior athletes for varsity teams. Because of this difference in selecting superior athletes for varsity teams, a significant difference in premotor reaction is hypothesized.

Delimitations of the Study

The subjects in this investigation consisted of sixty-two female students attending Kansas State University during the Spring semester of 1973. The sixty-two women were divided into

two groups. One group consisted of thirty-two women athletes and the second group consisted of thirty non-athletic participant women enrolled in physical education activity classes. All subjects were volunteers recruited during the beginning of the Spring semester of 1973.

Limitations of the Study

Each subject in the athletic group was considered an athlete by her membership on a varsity team rather than her athletic ability.

The investigator was not able to control the factors affecting the motivation of each subject. Therefore, the results obtained in this investigation are not thought to apply to any other population than the population which was tested.

Definition of Terms

Women Athlete - These subjects were females who were starting members of an inter-collegiate athletic team at Kansas State University during the Spring semester of 1973. The women athletes were from the: (1) basketball team; (2) volleyball team; (3) softball team; (4) field hockey team; (5) track team; and (6) the gymnastic team.

Women Non-Athlete - These subjects were females who were enrolled in a physical education activity class during the Spring semester of 1973 but not a member of any athletic team.

Premotor Reaction Time - It was that period from the presentation of the stimulus to the first appearance of increased electrical potential as measured on the physiograph print out.

Need for Study

In the recent past women's athletics have enjoyed little popularity in our society. Consequently, the influence of reaction time on success for women in athletics has not interested researchers, coaches, or women athletes. A review of the literature indicates a change in society's attitude toward women's athletics is occurring. The following are some examples indicating the societal change and supporting the assumption that research such as this is needed.

Today literally millions of girls and women are participants at all levels of competition (28). These new women athletes are breaking with traditional values and are participating in sports which normally were not considered as a woman's sport. In 1968, Penny Ann was the first woman to ride as a jockey on a major track (40). Penny received her jockey license from the Kentucky Racing Commission. Mrs. Patricia Palinkas was another first in women's athletics. In 1970, Mrs. Palinkas became the first professional football player to play with a major semi-professional football team (13). She held the football for her husband, who was a place kicker for the Orlando Panthers of Florida. Women athletes are moving into areas which have traditionally been a man's domain. However, this has not always been the situation.

It was not until 1912 that women were first permitted to compete in swimming and tennis in the modern olympics (28). However, early history does show that women did participate at times in major athletic competition; but for most women athletic

participation on a large scale was non-existent. Religious epigraphic pieces in ancient Greece showed that Caearea Tralles, a citizen of Hermesianax, had three daughters who distinguished themselves at the Pythian and the Isthmian Games (14). Tralles' daughters defeated the male athletes in the stade (200 yard foot race) and the war chariot race (14). Except for these and similar instances women have had to play a secondary role in athletics throughout history.

Today however, women are more self-reliant, stronger and capable of performing activities that call for the highest degree of skill and physical performance. Vastly improved standards of living, nutrition, and general health have produced a generation of girls and women who are physically more mature and stronger than those of the past decades (28). The decades of the sixties and early seventies have seen new developments in the athletic performance of women (28). The public's attitude toward femininity and athletics has also changed and has been directly affected by some of the newer women athletes. Olga Korbut, a Russian olympic gymnast, has literally captured the heart of each person who has seen her perform (10). Olga is an excellent athlete and she presents an acceptable feminine image to the public. America has Miss Kathy Rigby, who is also an olympic gymnast. These two women athletes and others have helped to dismiss the "old wives tale" that women athletes cannot be feminine and that they will acquire large ugly muscles (20). The picture of athletes for women is changing and more and more women will want to participate in competitive competition as it becomes more

socially and culturally acceptable.

This current trend toward an increased athletic participation by women is having an effect on the established structures which govern athletes in this country. Women athletes are going to court to receive the right to compete at the high school, college and professional level of athletics. In 1970 Miss Julia Burach of Monroe, New York filed a suit against the Department of Education in Monroe, New York to allow her to play on the all boys varsity tennis team (12). In March of 1973 at a Big Eight athletic conference meeting, a major change was made in the eligibility rule of the conference to include women (4). The ruling read, "every student of a member institution participating in any intercollegiate athletic event is recognized by the conference . . ." (4). This ruling by the Big Eight Conference to allow women to participate in intercollegiate competition was a major step in giving women the right to participate on a college team. The Big Eight Conference has set a precedence for other athletic conferences to follow, opening the way for increased numbers of women athletes. But do the coaches and physical educators thoroughly understand the factors which will improve the performance of women athletes? In an interview with Miss Judy Akers, the Women's Athletic Director at Kansas State University on April 17, 1973, the following statement was made:

It is good that women will be allowed to compete against men in the Big Eight Conference, but women still should compete against other women for some time yet. . . . even the best women athlete will find it difficult to compete against a good male athlete.⁴⁷

This statement may have some truth. On March 11, 1973 Bobby Riggs, a fifty-five year old former male tennis professional, soundly defeated Mrs. Margaret Court, one of the current best women tennis professionals today (27).

This increasing number of women athletes and the constant improving of athletic performance will continue for women if coaches and women are able to understand the factors which limit or improve performance.

The premotor reaction time is one of the many factors which may answer some of the questions about improving women's speed of response in athletic performance. A woman athlete must be able to react instantaneously to the sound of the pistol or the movement of her opponent. Quick reactions are essential for women in basketball, field hockey and other sports (28, 42). However, a review of literature revealed a limited number of studies which investigated the reaction time of women athletes and no studies investigating the premotor reaction time of women athletes.

Chapter 2

REVIEW OF LITERATURE

The review of literature is divided into three principal areas. The investigator discussed the findings of other researchers which relate to this study. The first area of discussion revealed findings of researchers who investigated the reaction time of trained and untrained subjects. This section was further divided into three sub-groups: (1) male athletes vs. male non-athletes; (2) males vs. females; and (3) female athletes vs. female non-athletes. The second section of the review of literature discusses the findings of other researchers who have reported that reaction time is independent of movement time. The third section of the review of literature discusses how premotor reaction time is a fraction from reaction time and how premotor reaction has been investigated by other researchers.

Trained vs. Untrained

Reaction time studies have investigated reaction time of three groups which are: male athletes vs. male non-athletes; male vs. female; and female athletes vs. female non-athletes. Trained and untrained subjects in groups were normally given a reaction test to see if differences exist between their reaction time.

Male Athletes vs. Male Non-athletes. Keller investigated "total body quickness." He used 295 male athletes and 277 male non-athletes in his experiment (24). Each subject moved his

entire body as fast as he could when directed to do so. Thirty-six trials were given and a subject either moved right, left, or forward. Results from this study showed that the athletic group was significantly faster than the non-athletic group in "body quickness." Keller, concluded that successful performance in athletics is positively related to the ability to move the body quickly (26).

Burley investigated the reaction time of male athletes and male non-athletes to simple and complex visual stimuli (6). The athletic group was comprised of football backs, linemen, basketball players, baseball players, and swimmers. Non-athletes were considered as non-letter winners. The results of the study showed that the athletic group had faster reaction times than the non-athletic groups in both simple and complex visual stimulation. Further investigation showed that the basketball and baseball players had the fastest reaction time within the athletic group.

In another study 57 athletes and 26 non-athletes were tested to determine their peripheral visual reaction time (23). The athletic group was comprised of football players, baseball players, basketball players, track runners, and gymnasts. The stimulus was presented at angles from 60 to 105 degrees with forty-five trials being averaged to obtain the mean peripheral visual reaction time. Results from the investigation showed that the athletic group was superior to the non-athletic group in peripheral reaction time. All of the athletic groups differed from the non-athletes at the one percent level of confidence.

A second part of this same investigation determined if practice would improve peripheral reaction time. The peripheral vision reaction time of eighteen non-athletes and nineteen athletes were compared after practice. This group was randomly selected from the larger group. Results from the second part of the study showed that both groups improved their peripheral vision reaction time, but the athletic group was still significantly faster than the non-athletic group (23).

Male vs. Female. Cureton investigated the verticle jump times of champion athletes. Total body reaction time was measured with the Illinois Reaction Timer. This apparatus included an electric time clock recording device, a stimulus unit, and a response unit which measured reaction time. During the test, each subject stood on a platform on the floor. Upon seeing the stimulus a subject jumped vertically and high enough to move both feet off the platform, thereby stopping the timing device. Five groups' reaction times were compared with the United States Olympic swimmers and divers. These six groups ranked as follows in mean reaction time to the visual stimulus: (1) thirty women physical education majors, .268 seconds; (2) thirteen male track and field stars, .274 seconds; (3) thirty-seven male physical education majors, .290 seconds; (4) one hundred women non-physical education majors, .316 seconds; (5) twenty olympic swimmers and divers, .321 seconds; and (6) eighty male non-physical education majors, .390 seconds.

Significant differences were found in Cureton's study but the women physical education majors demonstrated the fastest

reaction time of the six groups. Of the group of non-physical education majors, the women again had faster reaction times than the men. In this same study Cureton also compared the reaction time of 150 subjects from the general population of college students at the University of Illinois to three groups of champion athletes. The mean reaction time for the non-athletic group was .350 seconds and the mean for the three champion athletic groups was .305 seconds. Results of this study showed the athletes generally have a faster reaction time than the non-athletes (8).

Lanier investigated the degree of relationship among various simple motor performances and reaction time measures. He tested thirteen students, six men and seven women. Results of the study showed a lack of correlation between simple types of motor activities and reaction time measures (30).

Henry also tested forty men and forty women to determine differences in the attention-directed responses to a visual stimulus. Two sets were employed: motor and sensory set. Forty-five responses were made by each subject and fifteen of these responses were made without attention direction. Henry found no significant differences in the patterns of the subject's "motor" and "sensory" responses, thereby disputing the validity of the generality that "motor" responses are the faster of the two. No sex differences were observed (16).

Female Athletes vs. Female Non-athletes. Beise and Peasley conducted an experiment to determine if women skilled in sports demonstrated similarity in speed of responses, and if

"fundamentals" of reaction time differ from one sport activity to another (3). Three groups of women served as subjects. The skilled group was comprised of twenty-four tennis players, twelve golfers, and eleven archers. Another group was comprised of fourteen subjects who had taken the Brace Motor Ability Test and the third group consisted of fourteen subjects who were classified as unskilled because they failed to achieve an average grade in a sport activity class. Reaction time of the arm and leg were measured for each group. Reaction for the leg was determined by removing the foot from a plate on the floor. The arm reaction time was determined by removing the dominant hand from the plate upon seeing the stimulus. The sequence of trials required the subject to alternate arm and leg responses.

Results of the study showed that there was a significant difference between the mean leg and arm reaction time of the skilled and unskilled group when compared. The mean differences between the skilled group and the Brace Motor Ability group in both leg and arm reaction time were not significant. Differences in mean reaction times between the unskilled group and the Brace Motor Ability group were also significant. In every instance the unskilled group was significantly slower. Beise and Peaseley also concluded that "a girl with fast reaction of the arms does not necessarily have fast reaction time of legs" (3).

In 1959, Louis A. Youngen also compared the reaction of women athletes to women non-athletes (52). One hundred and twenty-two women served as subjects in this study. Seventy-five subjects were women non-athletes who volunteered from

physical education activity classes and forty-seven subjects comprised the athletic group. The women's athletic group consisted of eight tennis players, seven fencers, twelve swimmers and twenty field hockey players. The subject had to release a telegraph key to measure reaction time after she heard a buzzer. Thirty-five consecutive reaction time trials were recorded. However, only the last twenty trials of each subject were used to compute the individual mean. The mean reaction time of the women athletic group was .248 seconds and the mean reaction time for the non-athletic group was .273 seconds. The analysis of the data showed that women athletes have a significantly faster reaction time than the non-athletes. Within the athletic group reaction time scores did not vary significantly (52).

Independence of Reaction Time from Movement Time

Henry investigated reaction time and speed of movement function as independent factors (15). He measured one hundred college men on two different types of apparatus. In the treadle press apparatus the subject had to move his hand forward from the reaction key five and one-half inches to press the treadle. In the ball snatch apparatus, the subject had to move his hand from the reaction key to the tennis ball, pulling it down. Two chronoscopes were used to measure reaction time and response time. Movement time was computed by subtracting reaction time from response time. The ball snatch mean measures were .193 seconds for reaction time and .121 seconds for movement time. Mean time for the treadle press was .216 seconds and mean movement time was .089 seconds. From these two independent

experiments, Henry demonstrated that there was no correlation between reaction time and speed of movement. He concluded the two measures functioned independently of each other.

Slater-Hammel studied twenty-five male physical education students to investigate the relationship of reaction time to speed of movement (45). Measurement of reaction time of a visual stimulus and speed of arm movement over the 120 degree arc were obtained. The data from the experiment showed that the mean reaction time of the group was .244 seconds and movement time was .238 seconds. Correlations between the two measures were not statistically significant ranging from $-.07$ to $.17$. It was concluded that reaction time is independent of movement and movement time cannot be predicted from reaction time.

A study by Miles investigated the reaction time football charge of eighty football players (35). The results of this study showed that reaction time does not determine if an individual will be above average in his football charge (35).

Probably one of the best studies showed that reaction time is independent of movement time was done by Henry and Trafton. Reaction time was defined for twenty-five male physical education majors as the time between the start of the signal and the beginning of the pressure on the starting blocks. Researchers determined if reaction time can determine differences in the time of a measured sprint. The mean reaction time for the first fifty yard run was .133 seconds, and for the second run .133 seconds. A correlation of .14 seconds was found between reaction time and the fifty yard run times. Henry and Trafton

conclude that "fast reactors" were not fast runners. However individual differences in reaction time can be neglected except for very short distances, ten to fifteen yards at the most (18).

Fractioning of Reaction Time

Premotor reaction time was fractioned from reaction time in a study by Weiss (49). In this study the premotor reaction time was measured as the time from the stimulus onset to the appearance of the muscle action potential. The purpose of Weiss' study was to determine if major changes in reaction time with preparatory interval, motivation and age occur in the central nervous system rather than the periphery.

In this study Weiss tested twenty-four subjects. Fourteen were between the ages of 18 and 30 and ten were between 65 and 80 years of age. Surface electrodes were strapped over the approximate location of the muscles, which control the index finger of the hand. These electrodes were fed into a preamplifier, which was fed into a dual beam cathode ray oscilloscope. On a second channel earphones which registered a sound of 85 decibels was attached. As soon as the subject heard the stimulus, he had to lift his finger (opening the circuit). After lifting his finger the tone ceased and the camera stopped recording. The reaction time preparatory intervals ranged from 1 to 4 seconds. Each subject had eight trials to familiarize themselves with the apparatus and the procedures. Each subject was presented with 24 practice trials during which his mean reaction time was commuted. The subject then had 12 trials, 3 at each preparatory interval, with the preparatory interval being randomized. These

procedures were repeated; however, this time the subject was told he would receive an electrical shock whenever his reaction time measure exceeded his mean value.

Results of the study showed that the older subjects had a slower premotor reaction time than the younger subjects. With motivation (electrical shock) both groups improved their premotor reaction time but the younger group was significantly superior at the .001 level of confidence. Weiss concluded that changes in reaction time because of set and motivation occurred predominantly in the premotor component and were therefore seen primarily as central nervous system rather than a peripheral nervous system phenomena. Weiss also suggested that the difference in reaction time between the two groups lay in the premotor component and it could have been greatly affected by one's ability to hear (49).

Botwinick and Thompson investigated the motor components of reaction time which Weiss had identified and named. Thirty-four men and sixteen women at Duke University and North Carolina University participated in this study. The mean age of the subject was 21.3 years. The subjects either volunteered in order to fulfill the requirements of a first course in psychology or in order to receive a nominal hourly fee.

Subjects, during the test, sat in a lounge chair and were instructed to press down on a telegraph key to initiate a reaction time sequence. Two seconds after the key press a warning signal of 0.5 second duration came on. The preparatory intervals were: 0.5, 3.0, 6.0 and 15.0 seconds, and each subject was assigned an

irregular and regular preparatory interval series. The regular series was constant and in order and the irregular varied within a block of trials. Subjects performed both the irregular and regular series four different times for a total of eighty-four reaction responses. The stimulus which followed the preparatory interval was a sound which registered approximately 85 decibels from the position of the subject. Hearing the sound the subject raised his finger. Surface electrodes were strapped to the subject's forearm above the extensor digiforum communis. Electromyography tracings were recorded for only the middle twenty-one reaction responses of each of the four preparatory intervals. Only the middle ten scores of each trial were used in the analysis of the data, making a total of forty scores being analyzed.

The electromyography tracings were analyzed manually using a millimeter scale. The premotor reaction time was the distance between the point on the electromyography tracing where the stimulus began and the point at first increased muscle firing (5, 49). The reaction time was the measured distance between the stimulus onset and the finger lift response. The premotor reaction time was subtracted from the reaction measurement to give the motor time.

Results of the study showed that correlation between reaction time and premotor reaction time were so high that prediction of one from the other, either between or within subjects, may be made with very little error. It was also concluded that premotor reaction time and motor time were unrelated and motor

time had no appreciable relation to the preparatory interval (5).

Langass and Hayes also confirmed the finding of Weiss that premotor reaction time corresponds to the central nervous system (31). In this study eighteen male subjects volunteered to help the investigators determine if premotor and motor reaction time are a function of movement time. These investigators also confirmed the finding of Slater-Hammel that reaction time was not dependent on movement time.

Laine Santa Maria investigated premotor and motor reaction time differences associated with the stretching of the hamstring muscle (29). Results showed that motor reaction time decreased with increased muscle stretch. However, premotor reaction time increased rather than decreased in increased muscle stretch. Laine Santa Maria concluded that there was no relationship between premotor and motor reaction time and lags in the central nervous system are independent of lags associated with the rate of muscular tension development.

Schmidt used electromyographic tracings to determine the relationship of premotor and motor reaction time with preliminary muscular tension (43). With the right hand the subject grasped a hand device which was modified from a hand dynamometric and its distal end was fed into Baldwin-Lima Hamilton SR-4 load cell so that electrical energy could be transmitted to the Beckman Type R Dymograph. Recordings were on a curvilinear writing unit. Surface electrodes were placed on the right forearm about 1.5 inches below the elbow. Before electrodes were placed on the forearm the area of the arm was wiped with alcohol and electrode

paste was placed in the center of the electrodes. Three channels recorded results from the test. Channel one recorded the stimulus, a light flash; Channel two recorded the electrical activity in the muscles of the forearm; and Channel three recorded the change in tensions.

Subjects were seated so that they could see the pen level of the polygraph and the paper movement. Subjects then squeezed the device until either 8, 37 or 59 lbs. was obtained. After a subject had reached the level of tension desired, the paper speed was turned on (25 cm/sec.). A light flashed 2-4 seconds (in randomized order) after the paper was turned on. Subjects then had to squeeze the handle as quickly and as forcefully as possible, when the light came on. Subjects received 5 trials at each pretension level. This experiment was repeated and sound was used as the stimulus. Results of the study showed that total reaction time appeared to be somewhat faster on experiment II than in experiment I. This difference could have been attributed to either a sampling error or the well known superiority of auditory over visual stimuli for reaction time (43).

Premotor reaction time also appeared to shorten between pretension levels of 2.2 to 19.9 lbs. and remained nearly constant between 19.9 and 37.4 lbs. However, motor reaction time appeared to increase regularly with increasing pretension. It was concluded that premotor reaction time is a function of the central nervous system (43).

These conclusions also supported the findings of Henry and Rogers that increasing pretension will cause greater activa-

tion and that partial contraction was equivalent to partially initiating a motor program to contract, thereby shortening the central reaction time (43).

Summary

Studies of reaction time for the most part clearly indicate that trained persons have possessed a faster reaction time than an untrained person (6, 8, 15, 23, 26, 30). Studies also revealed that trained men had a faster reaction time than trained women (16, 28). However, there was only one study found which showed women having faster reaction time (8). Reaction time seemed to vary depending on the complexity of the skill to be performed, the type of stimulus used, and the level of arousal of the subject when taking the test.

Other investigators have determined that reaction time is independent of movement time (16, 18, 35, 45). It is generally agreed that a person with fast reactions does not have to possess fast movements (15).

Reaction time was shown to be independent of movement time, and reaction time was fractioned into premotor reaction and motor time (5, 49). Premotor reaction time was shown to be a function of the central nervous system (5, 39, 49). It was also shown that the premotor tension will improve the premotor reaction time but will not necessarily improve the motor time (29, 43).

Chapter 3

PROCEDURE

Testing Apparatus

The testing apparatus used in this study was a four channel physiograph with rectilinear recording, Model 4A, manufactured by Narco Bio Systems. The stimulus producing unit and recording device were self-contained components of the physiograph.

The external components used in this study by the investigator were essential for the completion of this study. The following items of equipment were used in connection with the physiograph: (1) pre-amplifier/cable; (2) three surface electrode/wire; (3) physiograph paper (5mm x 5m); (4) electrode paste; (5) physiograph ink; (6) clock-timer; (7) millimeter vernier ruler calipers'; (8) alcohol; and (9) white towels.

Subjects

Data was collected at Kansas State University during the Spring Semester 1973 from sixty-two women volunteers. The subjects comprised two groups: thirty women non-athletes and thirty-two women athletes. The athletes included: (1) eight track athletes; (2) four softball athletes; (3) six volleyball athletes; (4) seven field hockey athletes; (5) five basketball athletes; and (6) two gymnasts in the athletic group. The subjects ranged in age from 18 to 22 years of age. The average

age of the women non-athletes was nineteen years and two months and the average age of the women athletes was nineteen years and eight months. All subjects maintained a freshman, sophomore, junior or senior class status.

The premotor reaction test described below was administered during regularly scheduled classes from March 1, 1973 to May 7, 1973 of the spring term. All data were obtained between the hours of 8:30 a.m. and 4:30 p.m. The premotor reaction test was conducted in the Physical Education Laboratory at Kansas State University.

Testing Methodology

All subjects were requested to fill out a personal data card (Appendix B). Afterwards each subject was taken into the testing room to be prepared for the test. All subjects were tested individually. After entering the room the subject was given the experiment instructions to read (Appendix C). Questions of subjects were answered, then subjects assumed a comfortable sitting position in a straight back chair. Subjects then placed their dominant hand on the desk top in front of them. Caution was taken to insure that subjects had enough of their dominant hand and forearm on the desk top so that they could keep their forearm parallel to the floor and desk top with little or no effort. The dominant hand was placed in a position on the desk top which allowed the fingers to be extended and the palm and heel of the hand in contact with the desk top. Fingers could be slightly open. At this point the physiograph was turned on and given an opportunity to warm up.

The subject then had her forearm wiped with alcohol to eliminate unnecessary oils which would interfere with the conduction of the electrical activity. Electrode paste was placed in the center of each surface electrode. Two surface electrodes were placed over the muscle area of the forearm which controlled the hypertension of the hand at the wrist. The third surface electrode was used as a ground.

The sites for the electrodes were located by placing the investigator's thumb and index finger over the location of the proper muscles. Location of the muscles was aided by having the subject hyperextend the hand. Two surface electrodes were placed over the lateral surface of the forearm over the extensor carpi radialis brevis and the extension carpi ulnaris approximately two to three inches below the elbow (50). The third electrode acted as the ground and it was placed on the lateral surface of the forearm. These electrodes were held in place by a rubber strap with holes in it. Investigator made sure electrodes did not touch and electrodes were placed so that its rectangular shape was running parallel with the forearm toward the hand.

The terminals of the electrodes were connected to the pre-amplifier. The pre-amplifier was then turned on and the pre-amplification was set at the numeral six. The downward controls were set at the numeral one. The downward control varied the distance of the recording from the stimulus. Paper speed for the investigation was set at 1.0 cm/sec. This faster speed allowed for better reading and more accurate conversations.

For this investigation the sound made by the time and event marker was used as the stimulus for the subjects. The time and event marker registered a stimulus of approximately 75 decibels at the location of the subject. The subjects were then given three trials to familiarize themselves with the procedures. Adjustments of amplification and the recording distance of each subject was made during these three practice trials. If more practice trials were needed to make amplification adjustments, the investigator would do so. This enabled the investigator to record the electromyography tracing during the test.

The subjects were now instructed that the test would begin. The sweep second hand clock was turned on and the subjects were told to listen for the stimulus and respond to it each time they heard it. The investigator would press the time and event marker at the predetermined time (Appendix A). This was running time and no period was allowed for rest between trials. The running time gave the subjects time to prepare for the next stimulus.

Each subject received thirty trials and the preparatory interval varied from one to seven seconds running time. The investigator did not use the first eight or last seven premotor reaction time readings. Eliminating the first eight and last seven premotor reaction readings gave a statistical measure which minimized the effects of learning and fatigue on the part of the subject (5). Each subject during the test was presented with the same randomized sequence of time intervals (Appendix A). A subject was only tested once and the entire test took no longer

than fifteen minutes. All data was recorded on the physiograph paper and the data was transferred to the subject's personal data card. For the purposes of identification a four digit number was placed on each personal data card and the same number was placed on the physiograph paper which contained each subject's premotor measures. After the test was completed the subject's arm was wiped clean with alcohol and dried with a towel.

Premotor Reaction Time. The premotor reaction time was measured as the period from the stimulus onset to the first appearance of increased electrical potential change as measured on the physiograph print out. To calculate the time of the premotor reaction time the investigator divided the relative velocity (1 cm/sec) into the measured distance ($\tau = \frac{d}{v}$) (34). To calculate the measured distance the investigator measured the distance between the first perpendicular line made by the time and event marker (stimulus) and the first appearance of increased electrical potential change as measured on the physiograph print out. A line was drawn from the first perpendicular line (stimulus) until it was parallel to the first appearance of the muscle firing on the recording channel. The distance between the two lines was measured manually with vanier calipers. All data was then transferred to the subject's personal data card and computer sheets. The computer center at Kansas State University was utilized to calculate the investigator's data.

Statistical Procedures. The arithmetic means were computed for the premotor reaction time of each subject using

the middle fifteen reaction measures. A two-way nested analysis of variance was computed to determine differences between the women athletes and the women non-athletes. The premotor reaction reading between subjects within groups and between readings of subjects, within groups was compared to determine if more subjects with fewer trials per subject would give better statistical results. Data was tested at the .05 level of confidence.

A Review of Literature in Support of Procedures. The investigator felt it was necessary to relate to the reader some of the results which have been determined from previous studies in reaction time.

Reaction Time. Experiments in reaction time were greatly influenced by Wundt in Germany and Cattell in the United States in the early 1900's (42), but the investigator will only discuss studies which relate to this study and which influenced the investigator's procedures. The investigator will discuss how the nature of the stimulus, the level of arousal, various limbs, and the age and sex of an individual influences reaction time.

Nature of Stimulus. Reaction time for different sensory stimuli have exhibited considerable commonality. The reaction times for sound, touch, and electric shock stimuli are almost identical. However, reaction time to light generally seems to be higher than that for sound. Higher reaction times from light stimulus may reflect delays in the photochemical processes which convert light into electrical energy (48). Colgate found

that subjects reacted faster to auditory stimulus than to either visual or tactile. When both light and sound were used as a stimulus, it was discovered that the subject will probably react to the noise rather than to the light (9).

Level of Arousal. The attention, motivation and anxiety of a subject will influence reaction time. It has been shown that the same subject will exhibit a faster reaction time when either is altered. Motivation can increase or decrease reaction time. However, it has been shown that various incentives such as money, food, verbal coaching, and electrical shock could improve performance (42, 48).

Limbs. Researchers have used fingers, hands, feet, legs and the total body to investigate reaction time (26, 44, 48). However, reaction time is approximately 20-30 milliseconds faster for hand movements than for foot movements (11). The distance of the limbs from the brain may account for this difference. The stimulus must also be one which can be identified by the subject. The distance of the subject from the stimulus will also affect the reaction time (48).

Age and Sex. Teichner reported that males have faster reaction times than females at most age levels and training did not seem to change reaction time (48). Hodgkins reported that reaction time is at its peak between the ages of 19 and 25 years and gradually decreases as the person grows older (21).

Chapter 4

RESULTS AND DISCUSSION

Results

The results of this study will be presented in chart form. The two groups were referred to as the women athletic group and the women non-athletic group.

The mean premotor reaction time was computed from each subject's fifteen middle premotor reaction readings. The middle fifteen premotor reaction readings were used to eliminate learning and fatigue effect on the part of the subject. The premotor reaction mean of each woman athlete is shown in Appendix D. Appendix E shows the premotor reaction mean of each woman non-athlete.

The computed mean premotor reaction time of the woman non-athletic group was .2451 seconds (group 1) and the woman athletic group's (group 2) mean premotor reaction time was .2213 seconds. The mean score and standard deviation of the mean are shown in Table 1.

Table 1

Mean Scores, Standard Deviation of
Mean for Two Groups

Group	Number of Subjects	Mean	Standard Deviation of Mean
1	30	.2451	.0050
2	32	.2213	.0048

The statistical analysis of variance between groups, and between readings within subjects within groups, is shown in Table 2.

Table 2
Two-Way Nested Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squared	F
Between Groups	1	.1321	.1321	*11.67
Between Subjects/ Groups	60	.6789	.0113	* 7.49
Between Readings/ Subjects/Groups	868	1.3306	.0015	

F.05 (1,60 = 4.00; significant for 1 and 60 df at the .05 level)
*Significant F at .05 level.

The analysis of data indicates that a significant difference does exist between the two groups in premotor reaction time. Therefore the null hypothesis is rejected.

The variation between subjects within groups was almost eight times as great when compared between the reading within subjects, within groups.

Discussion

The statistical analysis of data revealed that women athletes premotor reaction time was significantly faster than the women non-athletic group at the .05 level.

In a study by Beise and Peaseley, reaction time between skilled and unskilled women in reaction time showed that trained women were statistically faster than unskilled women (3).

In Youngen's study the mean reaction time between women athletes and women non-athletes was also significant. The women athletes were statistically faster than women non-athletes in finger reaction time.

The variance between subjects within groups was almost eight times greater than the variance between readings of subjects within groups when compared (Table 2).

Data from Table 2 showed more subjects with fewer trials was the best approach to measure the premotor reaction time of women athletes compared to women non-athletes in this study. This is because the variance between readings of subjects was so small it could be explained by instrument error.

The woman athlete of today will continue her efforts to gain acceptance in the sports world. Women of all age groups will be competing in the years ahead at the high school, college and professional level of sports competition. These new women athletes will have the knowledge obtained from research to help them improve in their goals to succeed in sports.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

It was concluded within the limits of this study:

1. Women athletes can be expected to have a faster pre-motor reaction time than women non-athletes.
2. Fewer trials per subject and more subjects would improve procedures for future studies.

Recommendations

1. It is recommended that the premotor reaction of males and females be compared to determine differences in pre-motor reaction times which might exist.
2. It is recommended that studies be conducted to determine if reaction time can be predicted from premotor reaction time.
3. It is recommended that reaction time and premotor reaction be compared to determine differences and to define these terms.

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LITERATURE CITED

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APPENDICES

APPENDIX A

Random Sequence of Stimulus Interval

<u>2</u>	<u>7</u>	<u>4</u>	<u>7</u>	<u>2</u>	<u>3</u>	<u>2</u>	<u>5</u>	4	2
6	7	1	6	5	1	3	5	4	3
6	6	7	<u>6</u>	<u>5</u>	<u>1</u>	<u>2</u>	<u>2</u>	<u>6</u>	<u>4</u>

The score read from the left to right. The first eight measures and the last seven measures were not used in the (-) statistical computation (41).

APPENDIX B

Personal Data Card

1. _____ digit number.
Four
2. _____ , _____ , _____
Last Name First Name Middle
Initials
3. _____
Social Security Number
4. Athlete _____
5. Women Non-Athletes _____
Activity Class
6. Date of Birth _____
Year Month
7. Classification _____
Fr. Soph. Junior Sr.
8. Have you been ill during the last 48 hours? _____
Yes No

PMT	PMT
1. _____	8. _____
2. _____	9. _____
3. _____	10. _____
4. _____	11. _____
5. _____	12. _____
6. _____	13. _____
7. _____	14. _____
15. _____	

APPENDIX C

Instructions

TO: Volunteers for Research Study

FROM: Kenneth D. Mosely

TOPIC: Research Thesis

The investigator will compare premotor reaction times of women non-athletes to see if there is any significant difference in the premotor reaction times of the two groups. The premotor reaction time will be measured on a physiograph.

1. Take a comfortable sitting position in the chair provided for you and relax.
2. Place your dominant hand on the desk top in front of you with the forearm exposed. Fingers of hand should be extended with the palm of the dominant hand and heel of the dominant hand in contact with the desk top.
3. Three surface electrodes with electrode paste will be placed on the arm after the forearm is wiped with alcohol.
4. Subject will have to raise her hand from the wrist as fast as possible from the top of the desk top. Insure that the heel of the hand remains in contact with the desk top at all times. Subject will then lower hand as quickly as possible to prepare for the next stimulus.
5. Each subject will get three practice trials before the test starts. Let the investigator know if you cannot hear the stimulus.
6. You will raise your hand thirty times during the test and only when you hear the stimulus.
7. During the test look at the wall in front of you. Investigator will give you only one preparatory warning of approximately 3 seconds and then the test will begin. Investigator will stop you when test is completed.
8. Do you have any questions?

REMEMBER - TRY AND DO YOUR VERY BEST DURING THE TEST!

THANK YOU FOR VOLUNTEERING FOR THIS STUDY

APPENDIX D

Women Athletes Mean Premotor Reaction Times (Units in Seconds)

(1) .2678	(11) .2105	(21) .2323	(31) .2226
(2) .1751	(12) .2000	(22) .2191	(32) .2220
(3) .2298	(13) .2327	(23) .1817	
(4) .2273)	(14) .2254)	(24) .2263)	
(5) .2113	(15) .1883	(25) .2284	
(6) .2142	(16) .2151	(26) .2368	
(7) .2131	(17) .2683	(27) .2539	
(8) .2759	(18) .2174	(28) .2216	
(9) .2646	(19) .2383	(29) .1809	
(10) .1831	(20) .2191	(30) .1748	

APPENDIX E

Women Non-Athletes Mean Premotor Reaction Times (Units in Seconds)

(33) .2449	(42) .2458	(51) .2360	(60) .2334
(34) .2589	(43) .2221	(52) .2453	(61) .3025
(35) .2313	(44) .2247	(53) .2199	(62) .2320
(36) .2725	(45) .2481	(54) .2780	
(37) .2648	(46) .2114	(55) .2579	
(38) .2880	(47) .2147	(56) .3155	
(39) .2275	(48) .2250	(57) .2123	
(40) .2488	(49) .2291	(58) .2891	
(41) .2207	(50) .2127	(59) .2255	

A COMPARATIVE ANALYSIS BETWEEN
THE PREMOTOR REACTION TIME
OF WOMEN ATHLETES AND
WOMEN NON-ATHLETES

by

KENNETH DON MOSELY

B. S., Morgan State College, 1971

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Health, Physical Education,
and Recreation

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1973

The purpose of this study was to determine if women athletes had a faster premotor reaction time than women non-athletes.

Data was collected at Kansas State University during the Spring semester of 1973 from sixty-two women volunteers. The subjects comprised two groups: thirty women athletes and thirty-two women non-athletes.

For the test, electromyography tracings were recorded on a physiograph. Surface electrodes were located over the lateral surface of the extensor carpi radialis brevis muscles and the extension carpi ulnaris muscles, approximately two to three inches below the elbow. Each subject hyperextended her dominant hand from the wrist up as fast as possible upon hearing the stimulus.

Each subject had thirty trials; however, only the middle fifteen premotor reaction measures were utilized in statistical computations.

The premotor reaction time was measured from the stimulus onset to the first appearance of increased electrical potential change as measured on the physiograph print out.

A two way nested analysis of variance revealed a significant difference at the .05 level in favor of the athletic group. A significant difference at the .05 level was also found when the variations between subjects within groups were compared with the variations between the readings within subjects within groups.

It was concluded on the basis of data collected that:

(1) women athletes can be expected to have a faster premotor reaction time than women non-athletes; and (2) fewer trials per subject and more subjects would improve future studies.