A STUDY OF THE RELATIONSHIP BETWEEN PHYSICAL TRAITS AND TENNIS SKILLS AS HELD BY SELECTED HIGH SCHOOL VARSITY TENNIS PLAYERS

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CHAPTER I

INTRODUCTION

For many years the topic of association between physical abilities of various types has been a subject of speculation, observation, and considerable controversy and for more than forty years, a matter of experimental study.[1]

Coaches and students of the sport generally agree that there are definite skill characteristics possessed in common by successful athletics. If a coach could identify these skill attributes in his individual players, through reliable methods, the task of selecting team personnel would be greatly reduced.

A coaches ability to identify the skill potential of his players is a function pertinent to the success of his team. This is true in all sports. Da Grosa states that a coach definitely must decide on formations and plays in football that will be within the capabilities of his squad as nothing looks worse than a football team trying to execute plays from formations not designed for them.[2]

It would appear, therefore, that research designed to

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[1]Lloyd Jones, A Factorial Analysis of Ability In Fundamental Motor Skills, Teachers College, Columbia University, New York City, 1935, p. 1.

[2]John Da Grosa, Functional Football, (fifth edition; New York: A.S. Barnes Company, 1956), p. 275.

gather information which would enable coaches to expedite the choice of players in relation to game play should be of immeasurable value.

I. STATEMENT OF THE PROBLEM

The purpose of this study was to ascertain what physical traits of high school varsity tennis players can be defined. More specifically this investigation was designed to gain insight into the following questions:

1. Determination of skill elements common to successful tennis players.
2. Factors generally found to be present in the more successful tennis players.
3. What physical traits correlate significantly to skilled tennis performance.

The study was not intended to serve as an instructional device or as a guide for the development of novice tennis players. It was designed to function as a device with which to determine the skill traits of high school varsity tennis players and present graphically the factual information concerning the skill elements.

II. BASIC ASSUMPTIONS AND HYPOTHESIS

It was assumed that coaching techniques could be improved if the coach had a positive method of identifying

the basic skill elements essential to the performance of good tennis players. It was further assumed that all successful skilled tennis players possessed certain skill elements identifiable to their success.

It was the hypothesis that the findings of such a study of the relationship of physical traits and tennis skills would be of value: (1) in showing the relationship between strength, speed, agility and flexibility to success or failure; and (2) that physical strength, speed, agility and flexibility were valid criteria in determining a players potential in tennis.

III. METHOD OF PROCEDURE

Method of Procedure. The subjects used in this study were ten voluntary athletes from the varsity tennis team, Rolling Hills High School, Palos Verdes, California. The tests were administered at the near completion of the varsity tennis teams season in May, 1967. The tests were conducted at the tennis courts located on the campus of Rolling Hills High School, Palos Verdes, California.

This study was administered under the supervision of Dr. George Milton, associate professor of physical education and this investigator, a graduate student in physical education.

Analysis of the data used in this study was computed from seven tests of physical skills given to each of the ten varsity tennis players. The Dyer Backboard test, push-ups, the standing broad jump, the shuttle run, the fifty-yard dash, the toe-touch test and the side step test constituted the seven physical skill tests.

The physical skill test data was correlated with the data obtained from an evaluation of the ten varsity tennis players by three tennis experts. The tennis experts evaluated each of the ten varsity tennis players as they performed in playing tennis. The tennis experts evaluated the ten performers as to their skill in performance of the serve, the forehand, the backhand, the volley and the over head.

The ten varsity tennis players were ranked to their success in the physical skill test battery, and to their success in each individual test comprising the physical skill battery. These rankings were then correlated with the ranking of the ten varsity players from the tennis expert evaluation and correlations were found.

Techniques of Analyzing Data. The ranking of the varsity tennis players success in the physical skill tests was correlated with the ranking of the expert evaluation and correlation between the two rankings was found by the

Spearman Rank Order. Each of the individual tests of the physical skill test battery was correlated with the expert evaluation ranking and the correlation between the two groups was again found by the use of the Spearman Rank Order correlation method.

The correlation coefficients derived from the correlation of the physical skill test battery, and each individual test of the battery, to the expert evaluation of the tennis skills, were then compared to the 0.01 and 0.05 levels of significance, with eight degrees of freedom, necessary for a significant finding. The findings were reported.

IV. DEFINITION OF TERMS

Included in the study were terms which have been variously interpreted. It was believed important to define some of these terms so as to provide a common basis of discussion.

Motor Ability. Motor ability refers to the level to which one has developed his capacity to learn motor skills as body strength, speed, flexibility and agility.[3]

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[3]John Bovard, Test and Measurements in Physical Education, (New York: Prentice Hall, Inc., 1959), p. 239.

Agility. Agility refers to the total body ability to change direction of the entire body or parts of the body rapidly in response to unexpected circumstances.[4]

Strength. Strength is the quality of capacity of muscle that determines the quantity weight that can be lifted, pushed or pulled.[5]

Flexibility. Flexibility is the ability to move the bodies limbs around a joint through their full range of motion.[6]

Speed. Speed is the rate of performance as indicated by the amount of work accomplished to time taken in.

Co-ordination. Co-ordination is the harmonious working together of the total muscles of the total body.

Skill. Skill is the ability to use an acquired or developed knowledge effectively in doing anything.[7]

Skilled Tennis Player. The skilled tennis player referred to this study were the varsity tennis athletes of Rolling Hills High School, Palos Verdes, California.

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[4]H. Harrison Clarke, Application of Measurement to Health and Physical Education, (New York: Prentice Hall, Inc., 1945), p. 287.

[5]Ibid., p. 7.

[6]Ibid., p. 151.

[7]Ibid., p. 153.

CHAPTER II

REVIEW OF THE RESEARCH

In order to determine what possible studies of a similar nature might be available and to avoid any duplication, various guides and materials were reviewed. Materials reviewed were divided into four areas; studies and tests relating to (1) strength and power; (2) speed; (3) agility, co-ordination and flexibility and; (4) tests of tennis ability.

Research Related to Physical Strength and Power. The strength quality has usually been determined by either of two methods: (1) measurement of static strength through the use of dynamometers; and (2) dynamic strength measurement through testing the individuals ability to handle his bodyweight, as exemplified by chinning, and push ups.[1]

The most complete test of strength available is one devised by Kellogg, medical supervisor of the Battle Creek Sanitarium. In 1896, Kellogg proposed a dynamometer which could be adjusted in many ways for the testing any muscular group. The fact that about half an hour is required to

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[1]John Horrocks, The Psychology of Adolescence, (New York: Houghton-Mifflin Co., 1951), p. 352.

administer the test to each individual and the $300.00 price on each instrument puts it beyond most researchers.[2]

In order to solve administrative problems in connection with grouping boys for purposes of team competition within the school and within class periods, Rogers computed a classification index on the basis of a total score obtained in a strength test.[3] The strength score was obtained by adding the following items:

1. Number of cubic inches in lung capacity.
2. Number of pounds pressure in right grip.
3. Number of pounds pressure in left grip. (The hand dynamometer used for items 2 and 3).
4. Number of pounds lifted using back.
5. Number of pounds lifted using legs. (The back and leg dynamometer used for items 4 and 5).
6. Strength of arms: number of pull ups and push ups.

According to Bovard, Rogers strength tests were significant in measuring the strength of the body, together with lung capacity and conformed to all the criteria of a useful measure of athletic ability.[4]

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[2]Charles McCloy, Tests and Measurements in Health and Physical Education, (New York: Appleton-Century-Crofts, Inc., 1942), p. 20.

[3]John Bovard, Tests and Measurements in Physical Education, (Philadelphia: W.B. Saunders Co., 1950), p. 128.

[4]Ibid., p. 128.

In an experimental study with five hundred high school girls, Anderson selected specific tests relating to leg strength, back strength, lung capacity and arm strength and concluded that neither total strength nor physical fitness is a valid predictor of the athletic ability of the girls tested. Anderson did deem the strength test reliable as predictors of such abilities for the purpose of classification of girls for gymnasium activities.[5]

Carpenter, in a selected study of women's physical fitness and strength tests found that two elements often used, namely chinning and dipping, were not satisfactory arm strength tests and suggested the substitution of a push and pull test of some sort. She further concluded that strength and power are two of the most important factors in predicting the athletic ability of women.[6]

Bovard pointed out that power appeared to be a basic component of achievement in athletic skills.[7] In relating to tests involving the projection of the body through space,

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[5]Theresa Anderson, "Strength Tests for the Prediction of Athletic Ability in High School Girls," Research Quarterly, Volume VIII, No. 1, (March 1936), 36-142.

[6]Aileen Carpenter, "A Critical Study of the Factors Determining Effective Strength Tests for Women," Research Quarterly, Volume IX, No. 4, (December 1938), 3-32.

[7]John F. Bovard, Tests and Measurements in Physical Education, (Philadelphia: W.B. Saunders Co., 1950), p. 128.

Bovard concluded that the simplest available test of power is the vertical jump although related research by McCloy points to the contention that the standing broad jump may be considered as adequate a test of power as the vertical jump.[8]

In an attempt to determine the relationship between the standing broad jump as a test of leg power and strength characteristics of twelve year old boys, Clarke tested eighty-one boys in the Medford, Oregon, public schools. Anthropometric measures were included in the study. As a consequence to this study, Clarke concluded that the leg power of twelve year old boys can be indicated by the distance the body weight can be projected horizontally in the standing broad jump but is dependent upon the subjects body size. Thus the actual work, distance jumped multipled by weight was deemed as an effective measure of leg power by Clarke.[9]

McCraw and Byron used three fitness tests in determining the reliability of physical fitness strength tests. The three tests used were push-ups, sit-ups, and pull-ups. The study was concerned with comparing the reliability using

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[8]Charles McCloy, Tests and Measurements in Health and Physical Education, (New York: Appleton-Century-Crofts, Inc., 1942), p. 65.

[9]H. Harrison Clarke, "Relationship Between the Standing Broad Jump and Various Maturational, Anthropometric, and Strength Tests of Twelve Year Old Boys," Research Quarterly, Volume 35, No. 3, (October 1964), 250-264.

one trial, the better of two trials, and the average of two trials in administering push-ups, sit-ups, and pull-ups. Data was obtained by administering each of the tests on four separate days to 152 boys at the elementary, junior high and senior high levels. The result of the investigation showed that all groups improved in performance during the four trials on each of the tests but that using the better of two trials on separate days was no more reliable than using a single trial on one day.[10]

Clarke and Peterson in a study of the contrast between athletic groups and non-athletic groups, in the specific areas of maturational, structural and strength characteristics found important factors relating to strength. The subjects used were 202 boys in the junior high schools of Medfore, Oregon, during the 1956-57 school year. Each boy was rated by maturity, stre[illegible]sts. Clarke found that strength was a co[illegible]differentiation of athletic ability and specifically, the standing broad jump showed that the outstanding athlete demonstrated superiority over regular players and produced the highest ratios of the entire study.[11]

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[10]Lynn McCraw and Byron McClenny, "The Reliability of Fitness Strength Tests," Research Quarterly, Volume 36, No. 3, (October 1965), 289-295.

[11]H. Harrison Clarke and Kay H. Peterson, "Contrast of Maturational, Structural and Strength Characteristics of Athletes and Non-Athletes Ten to Fifteen Years of Age," Research Quarterly, Volume 32, No. 2, (May 1961), 163-175.

Research Related to Speed of Running. McCloy suggests that tests of running appear to be especially useful for a quick classification of performers into homogeneous groups and for the prediction of certain aspects of athletic ability.[12]

Clarke correlates speed with strength, in that speed is dependent upon strength but yet they are not directly proportionate to each other. In explaining this statement Clarke said that strength and speed are not directly proportionate to each other because for an individual to double his speed requires more than doubling his strength. In this connection, Clarke found in tests involving runners, for every ten per cent increase in speed an additional three per cent of the muscles tension is devoted to merely overcoming internal resistance, thus reducing the amount available for work.[13] Other things being equal, however, the stronger the individual, the faster he can run.

Merritt in a study of tests of athletic ability among

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[12]Charles McCloy, Tests and Measurements in Health and Physical Education, (New York: Appleton-Century-Crofts, Inc., 1942), p. 75.

[13]H. Harrison Clarke, Application of Measurements to Health and Physical Education, (New Jersey: Prentice Hall, Inc., 1950), p. 59.

the male population of Pomona College included among the physical tests that of the fifty-yard dash.[14] In justifying the use of the fifty-yard dash rather than the hundred-yard dash or a running event of longer distances, Merritt stated that the distance of fifty-yards was more of a true test of speed and not one of endurance as the running events of longer distances are.[15]

Bacche determined the relationship that existed between selected anthropometric and physical performance measures and performance in the running hop, step, and jump. In doing so, Bacche used as one of his measuring tests the fifty-yard dash. Also included were the standing broad jump, the running broad jump and the standard hop, step, and jump. Bacche deemed the tests as significant in relation to the criterion of physical performance. The two highest measures of motor ability were the running broad jump (r= .859) and the fifty-yard dash (r= .815). Bacche concluded that there was a very significant relationship existing between

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[14]Earl J. Merritt, "An Investigation of the Educational Significance of Intercolligate Football at Pomona College 1935-42," (Unpublished Masters Thesis, The Claremont College, Claremont, 1944), p. 135.

[15]Ibid.

performance in the fifty-yard dash and the basic motor elements of the physical performance test.[16]

Hodgkins in a study of 930 men and women attempted to distinguish the difference between males and females of various ages in their reaction time and movement time and to ascertain whether or not a relationship existed between reaction time and speed. Volunteers were recruited from the Recreation Department of Santa Barbara, California, as well as the public school system. Results indicated that the speed of both males and females increases up to early adulthood and then decreases. The tests also showed that there were no relationship between speed of reaction and speed of movement.[17]

Keller studied the nature of the relationship between "speed and bodily movement" or speed and success in athletics. She based her studies on girls of high school age and tested in the area of reaction time and speed. Keller concluded that there is a positive relationship between the ability to move the body quickly and success in athletic activities and

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[16]Leverne W. Bacche, "Selected Anthropometric and Physical Performance Measures to Performance in the Running Hop Step and Jump," Research Quarterly, Volume 34, No. 2, (May 1964), 107-115.

[17]Jean Hodgkins, "Reaction Time and Speed of Movement in Males and Females," Research Quarterly, Volume 34, No. 3, (October 1963), 335-343.

those individuals not quite quick enough for fast team games might possibly be outstanding performers in an activity utilizing slower total body reaction time and movement time.[18]

Agility, Flexibility and Co-ordination. One of the more significant tests of agility, flexibility and co-ordination is the Burpee Test.[19] This test was first presented by Burpee, Y.M.C.A., of New York City. The test was selected because of its ability to test agility, flexibility, co-ordination as well as endurance. The test is performed as follows:

> Upon the command to begin, the subject flexes his hips to the squat rest position, leans forward, and places his hands on the floor somewhere in front of the feet. He then thrusts both legs backward to the front leaning-rest position, with the body straight from the shoulders to the feet. He returns to approximation of the squat-rest position, and then to a standing position. He then repeats this movement as rapidly as possible until the command stop is given.[20]

The test is not used by itself, but is a component of general motor capacity tests.

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[18] Louis F. Keller, "The Relation of Quickness of Bodily Movement to Success in Athletics," Research Quarterly, Volume 28, No. 2, (May 1951), 146-155.

[19] Charles McCloy, Tests and Measurements in Health and Physical Education, (New York: Appleton-Century-Crofts, Inc., 1942), p. 84.

[20] Ibid., 85.

Another test of agility and co-ordination is the side step test. This test was first proposed by Edgren as a means of predicting basketball ability but since been modified by McCloy.[21] Three parallel lines are drawn on the floor four feet apart. The subject stands astride the middle line and upon the signal go, side-steps to the right until his right foot has touched across the outside line to the right. He then side-steps to the left until his left foot has touched across the outside left hand line, repeating this left and right movement as rapidly as possible for ten seconds. Each trip to the outside line counts one point. This simple test has shown itself to be a good one for predicting games and skill potentiality as it correlates highly with basketball, tennis, soccer, speedball, and football success in McCloy's estimation.[22]

The shuttle-run in its various forms of administration, is another test of both agility, co-ordination, flexibility and speed. In his study of the aspect of general athletic ability of college men in 1928, Cozens included the shuttle-

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[21]Charles McCloy, Tests and Measurements in Health and Physical Education, (New York: Appleton-Century-Crofts, Inc., 1942), p. 85.

[22]Ibid.

run, as a test for agility. The author said:

> This event is to measure not only speed of legs but ability to change directions quickly, a quality extremely important in all types of athletic endeavor, basketball, hockey, speedball, tennis and the like.[23]

Reliability coefficients ranging from .91 to .97 and validity coefficients from .59 to .90 were reported on the test.[24]

In 1922, Muscio reported a study of fifty-six boys and girls and thirty-two college men and women using simple motor tests.[25] The tests were selected to measure agility and speed of movement with the hands, arms, wrists; deftness with the hands, and strength. The tests included tapping, aiming, traceing and reaction time and steadiness. Musico concluded from the tests that:

> Motor capacities appear to vary independently of one another and from individuals performance in

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[23] F.W. Cozens, "The Measurement of General Athletic Ability in College Men," (Doctorial Dissertation, University of Oregon, 1928), p. 13.

[24] H. Harrison Clarke, Application of Measurements to Health and Physical Education, (New Jersey: Prentice Hall, Inc., 1950), p. 211.

[25] C. Spearman, "The Theory of Two Factors," Psychological Review, 21:101-115, 1925, p. 114.

> one such activity is not, in general, the slightest indication of what his performance in another such activity will be.[26]

Tests of flexibility, or range of motion, have been proposed in two major fields, medicine and physical education. The development of flexibility tests date back to World War I, when they were used for the evaluation of disability claims.[27] Measurement has been in linear units and in degrees of a circle. The goniometer, a 180-degree protractor with extended arms, is particularly useful for the purpose of measuring flexibility.[28] The center of the goniometer is placed at the joint being measured with the body extremities flexed as fully as a disability permits and again with as full extension as possible; the difference between the two readings represents the range of motion.

Tests of Athletic Ability Relating to Tennis. One of the more significant studies of proficiency tests and athletic ability was constructed by Earl J. Merritt investigating test scores as a possible indice for football success,

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[26]C. Spearman, "The Theory of Two Factors," Psychological Review, 21:101-115, 1925, p. 115.

[27]H. Harrison Clarke, Application of Measurements to Health and Physical Education, (New Jersey: Prentice Hall, Inc., 1950), p. 151.

[28]Ibid.

in his study completed in 1944.[29] In his study, Merritt studied physical performance tests administered to Pomona College males and attempted to correlate the ability ratings to success in football. The findings illustrated that athletes could not be gleaned from the male population at Pomona College by the means of ability tests.[30]

A number of tests that provide for the measurement of individual skill elements in tennis have been proposed. Beall, presented one of the first of these, with tests of forehand and backhand strokes and serving.[31] Anderson has presented two tests for each stroke, one on the court and the other indoors.[32] Other tennis tests available are forehand and backhand strokes across the net made either by dropping the ball, allowing it to bounce, and hitting it, or hitting a ball thrown over the net from the other side.

It was Beall who first secured expert opinion on the qualities necessary to play excellent tennis by subjective

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[29]Earl J. Merritt, "An Investigation of the Educational Significance of Intercolligate Football at Pomona College 1935-42," (Unpublished Masters Thesis, The Claremont College, Claremont, 1944), p. 134.

[30]Ibid., p. 137.

[31]H. Harrison Clarke, Application of Measurement to Health and Physical Education, (New Jersey: Prentice Hall, Inc., 1950), p. 316.

[32]Helen I. Driver, Tennis For Teachers, (Philadelphia: W.B. Saunders Co., 1936), p. 19.

evaluation by expert tennis players and by physical qualities. Because of the large number of these qualities, they were divided into groups as follows:[33]

1. Organic condition.
2. Muscular co-ordination.
3. Accurate knowledge of strokes.
4. Interest.
5. Agility.
6. Qualities which made for success in any game such as aggressiveness, concentration, patience, good judgement, strategy, perserverence.

No attempt was made to measure group qualities. On account of the lack of measuring devices, specific tests were outlined for the first five groups of qualities and given to 174 women students in tennis classes meeting twice a week. Each student was tested at the beginning of the semester and again after a rather brief period of instruction and practice. A number of general conclusions in regard to Beall's study were pointed out:[34]

1. A test which would measure tennis co-ordination would have to be based on the specific elements used in various stroked and not on general co-ordination.

2. The success of the tests given in this study shows a possibility for devising, at once, simple tests for measuring many qualities necessary for good tennis players.

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[33]Elizabeth Beall, "Essential Qualities in Certain Aspects of Physical Education with Ways of Measuring and Developing the Same," American Physical Education Review, Volume XXXIII, (December 1928), p. 48.

[34]Ibid., p. 648.

The tennis test that has been sufficiently validated is the Dyer Backboard test.[35] This test is comprised of an individual attempting to hit the ball against the backboard, from a distance of five feet, as many times as possible during a thirty second span. This test, however, measures general tennis ability only, and does not attempt to analyze the various elements and strokes used in the game, or the physical necessities. Clarke states that it is therefore an excellent classification device for beginning tennis players and measures their progress being made in the game as a whole.[36]

Hewitt used the Dyer Backboard test in attempting to determine the classification of both skilled and novice tennis players. Hewitt disclaimed the Dyer test because it did not discriminate sufficiently at the beginners level. While Dyers test was conducted from a restraining line five feet from the wall with only ground strokes involved, Hewitt used a twenty foot restraining line and had the students serve and then follow up with ground strokes. The Hewitt revision of the Dyer test was administered to two advanced

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[35]Joanne T. Dyer, "The Backboard Test of Tennis Ability," Research Quarterly, Volume VI, No. 1, (March 1935), p. 63.

[36]H. Harrison Clarke, Application of Measurements to Health and Physical Education, (New Jersey: Prentice Hall, Inc., 1950), p. 317.

classes and the results were compared with the rank order of play ability. Both classes showed correlations of .89 and .84 and the results of both classes were significant at the .01 level of confidence.[37]

Through the review of previous studies and research there has been found no previous tests or standards for the classification of fundamental tennis skills. Due to the need of such a test of tennis skills so as to compare the physical performance test to and draw valid factors that contribute to skilled characteristics common to successful tennis players, a panel of experts on tennis was formed to evaluate performers tested.

Best has stated that in areas where no research in evaluation is found, other outside criteria other than statistical research may be used.[38] Best further explained that one such criteria is that what experts believe constitute the best conditions or practices. These experts may be selected from a group of practitioners in the field who are assumed to be most familiar with the characteristics under consideration.[39]

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[37]Jack E. Hewitt, "Revision of the Dyer Backboard Tennis Test," Research Quarterly, Volume 36, No. 2, (May 1965), 153-157.

[38]John W. Best, Research in Education, (Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1959), p. 191.

[39]Ibid.

Summary of the Research. After carefully examining the related literature, it was noted that tests of strength, power, speed, agility, flexibility and co-ordination appear to be basic components of achievement in athletic skills. More specifically, the push-up test, the standing broad jump, the side-step test and the fifty-yard dash are often reliable as predictors of athletic ability. The Dyer Backboard test was the only tennis test found that has been sufficiently validated.

RELATION OF THE STUDY TO PREVIOUS RESEARCH

Upon reviewing the literature certain factors were found to be distinguishing factors in relation to the problem under investigation. These factors can best be described by the following: (1) Change of direction (agility), and important element of motor ability, is a significant factor in determining skills in tennis games; (2) Tests of physical capacity have been standardized and show high correlations with various athletic abilities;(3) Attempting to use scores from tests as a predictive device for specific athletic ability are seldom valid; (4) Motor capacities vary independently

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[39] John W. Best, Research in Education, (Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1959), p. 191.

of one another and an individuals performance in one is not a valid indication of his performance in another activity; and (5) The tools of physical measurement utilize the age old activities of running, jumping and throwing and these abilities are fundamental to successful achievement in athletic skills.

This portion of the investigation was conducted in an attempt to appraise the testing methods used in other studies and also to become familiar with the evaluation methods used by other investigators. It was the sincere hope that the findings might prove to be an aid in the development of the investigation undertaken in similar studies.

Analysis of the Problem. Achievement scores in physical education and athletics are valuable to students and coaches because they represent not a teachers subjective opinion as to the performance of an individual, but an objective measure which can be used by the coach and individuals concerned in the determination of his present level of ability. Except in rare cases, pupils are interested in learning of his present level of ability, its status, meaning and what they can do to improve themselves. This is true not only of individuals but of groups. Bovard expressed a similar opinion by the following: "The spirit of competition engendered by objective

scores made under identical conditions offers a valuable incentive to improve.[40]

Although there have been a large number of tests in the field of athletics, those in which validation has been attempted are comparatively few.[41] Tests in the athletic program attempt either to predict potential playing ability or evaluate present status but are most often used as a partial means of determining the course marks or semester grades in a particular sport.

It may be said that physical education and the athletic endeavor are both an art and a science. As an art it is effective in proportion to the spirit and genius of the teacher and player. As a science it progresses by experimentation and by measurement, for quantitative methods are the key to accurate knowledge of results. The tools of physical measurement utilize the age old activities of running, jumping and throwing; activities that have been practiced with interest by men of the race since prehistoric times.

Limitations. The major limitations in this study is one common to all studies which involve the use of subjects that perhaps do not constitute a normal sampling. The results of the study represent only the subjects tested and

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[40] John F. Bovard, Tests and Measurements in Physical Education, (Philadelphia: W.B. Saunders Co., 1950), p. 29.

[41] Ibid., p. 52.

cannot be generalized to the remainder of the population. Environmental factors and the learning aspect may also have somewhat distorted the results.

Another limitation lies in the small sample size and use of a somewhat intact group. Still another limitation may lie in variations in subject attitude influenced by extraneous factors. Other aspects of limitations include such things as finances, time, availability, reliability of pertinent records and the nature and source of human assistance.

CHAPTER III

DESIGN AND PROCEDURE OF THE STUDY

Introduction. It was the purpose of this study to determine what physical traits of highly skilled tennis players can be defined. Within this aspect, it was hoped that a determination of skills and factors related to the more successful tennis player could be brought to light so as to gain a better insight into what physical traits correlate to the skilled tennis player.

Any study of the present time, or forecast of the future, must be based on past experiences, and if there is to be any possibility of accuracy in this study of the physical traits of the skilled tennis player, there must be frank and honest evaluation of these experiences.

Selection of Subjects and Location of Study. Subjects were selected from the Rolling Hills High School, Palos Verdes, California. The criteria for the selection of this school and the subjects was; (1) availability to the investigator, and; (2) the past history of tennis excellence on the part of the varsity tennis teams performance. The varsity tennis team performers agreed to co-operate with the administration and completion of the tests. A minimum of ten varsity tennis performers was selected for the testing

players were within the age group of fourteen to eighteen years and were freshmen, sophomores, juniors, and seniors in academic class standing.

Time of Year. The tests were administered at the near completion of the varsity tennis teams season and the end of the school year, in May, 1967. It was assumed that if the tests were administered to each subject at the close of the tennis season and at the end of the school year, each of the participants would have the same opportunity for training and physical conditioning.

Facilities. The facilities involved in testing procedures were four concrete tennis courts located on the campus of Rolling Hills High School, Palos Verdes, California.

Equipment. Equipment used in the administration of the study were; (1) tennis rackets; (2) six new tennis balls; (3) back up boards; (4) adhesive tape; (5) one hundred foot steel tape measure; (6) stop watch; (7) pencils and score sheets; (8) eight foot tumbling mat; (9) ten foot tape measure; (10) four towels; and (11) two blocks of wood, 3"-5"-1½".

TESTING PROCEDURES

The following tests were selected to be administered to the subjects; (1) push-ups; (2) standing broad jump;

(3) fifty yard dash; (4) side-step test; (5) toe-touch; (6) the shuttle run; and (7) the Dyer Backboard test. The necessary materials were arranged at stations in the order which they were to be used in the test. The investigator, with the ten varsity tennis players, moved as a group to and from each test station with each varsity player tested individually. Each person being tested was given a score sheet and a pencil and was responsible for recording his score on each test.

At the first station, the Dyer Backboard test was administered. Each player furnished his own tennis racket. The investigator supplied the tennis balls. All players participated in the tests wearing a tennis uniform consisting of tennis shoes, socks, shorts, and a polo shirt. A backboard, with ten feet of height and fifteen feet of width was employed for each individual taking the test one at a time. On the backboard a plainly visible line three inches in width and three feet from the ground surface was marked to represent the net. A restraining line, five feet from the base of the wall was marked on the court. A stop watch with a second hand was used to determine thirty seconds. Two tennis balls were given to each player. The players were instructed to hit the ball against the backboard, above the

line as many times as possible after the signal "Go", and to stop upon the command "Stop!" There was no limit to the number of times the ball could bounce before the subjects hit it. The subjects could volley the ball but had to play all balls from behind the restraining line. Subjects were allowed to cross the line to retrieve balls. The number of successful attempts (above the line) were recorded for each of the twenty individuals. The investigator counted the number of attempts by each participant.

At the second station, the strength test involving pushing strength (push-ups) and the power test (standing broad jump) were administered.

For the push-up test, each student was tested one at a time. Each student got into position to perform the test by:

(1) Lying prone, face down on the court.

(2) Placing hands with fingers forward, just outside shoulder width.

(3) Keeping body straight (head to feet) and raising it off the court.

Each subject performed the push-up test by:

(1) Pushing up with arms until they were straight and locked at the elbows.

(2) Bending the arms and lowering the body until the chin only touches the mat.

(3) Repeating the push-up as many times as possible.

Only one fair attempt was allowed for the test and no resting was permitted between push-ups. There was no time limit imposed and each correctly performed push-up counted as one push-up and the total number performed correctly by each individual was counted and voiced by the investigator and the participant recorded his score on the score sheet.

The second portion of the strength and power test, the standing broadjump, was administered next. A tumbling mat marked with a take off line two feet from the starting end was used for the test. Also included among equipment was a ten foot ruled tape measure to measure the length of the jump. A towel was placed at the end of the mat to wipe off the soles of the individuals shoes. Each subject was instructed to move into position to perform the standing broadjump by standing with the feet several inches apart with the toes of both feet touching the take-off line. Each subject performed the test by bending at the knees, swinging the arms, raising the heels and jumping forward with both feet as far as possible. Three attempts of the test were allowed. Approximately five minutes was allowed between attempts, with each attempt measured, and the best one of the three recorded on the score card. The feet could not leave the take-off line until the jump was being made and no slide, step or hop was permitted. The distance jumped was measured from the starting line to the back heel or nearest point of

the mat touched by any part of the body. The distance was recorded as total inches to the nearest inch. Participants who previously jumped, aided in measuring other subjects attempts.

The speed test (fifty-yard dash) was administered at the third test station. The speed test was conducted by the investigator with the assistance of the varsity tennis coach, Rolling Hills High School. All ten subjects were tested in the same manner. A three point football stance with feet at shoulder width and body weight forward on one hand, was used for the starting position. The subjects were started on a designated verbal signal which was given by the person at the starting line. A straight running surface, (the concrete tennis courts) a starting line, a finish line marked on the running surface, and a stop watch with a second hand were used to administer the test.

The starter gave the command, "Take your mark," "Set," "Go!". The word "Go" was accompanied by a downward sweep of the starters arm as a signal for the timer standing at the finish line to start the watch. The time was recorded in seconds and tenths of a second.

At the fourth station, three tests were conducted, namely the agility test (shuttle run), body control and co-ordination (side-step test) and the flexibility test (toe touch).

For the first of these tests, the shuttle run[1], a flat level concrete surface, with two parallel lines drawn thirty feet apart was used, along with a stop-watch with a second hand to record the better of two attempts to the nearest tenth of a second. Two blocks of wood 3"-5"-1½" were placed on the lines, one at the starting line and one at the turning line.

Each performer took a position, of their choice, behind the starting line and upon a command by the starter, "Take your mark," "Set," "Go!", the subject started running to the other line, picked up one block, turned back toward the starting line and placed (not threw) the eraser on the line; he then turned back and picked up the second block and ran back across the starting line placing the block on the line. The stop-watch was stopped when the subjects second block was placed on the starting line. Two fair attempts at the test were allowed with five minutes rest between. The better of the two attempts was recorded on score sheets handed out to each performer.

For the second of the three tests, the side-step test, three parallel lines, four feet apart were marked off on the

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[1] AAHPER Youth Fitness Test, American Association for Health, Physical Education and Recreation, 1201 Sixteenth Street, Northwest Washington, D.C.

concrete surface of the tennis court. A stop-watch was used to measure the time to the nearest tenth of a second and score sheets were handed out to the performers to record their scores. Each performer, one at a time, stood astride the mid line and upon the signal, "Ready," "Go," sidestepped to his right until he crossed the outside line with his left foot. He then returned to the mid-line where he sidestepped to his left until he crossed the outside line to the left. He repeated the movements as rapidly as possible for ten seconds, with each trip over the outside line and back to the center line counting one point.

For the third of the tests conducted at the fourth station the flexibility (locked-knee-toe-touch) test was conducted. A stop-watch with a second hand was used as a measuring device. Each subject was instructed to stand erect with hands resting on hips, and upon the command, "Ready," "Go," to bend from the waist, keeping knees locked, and touch finger-tips to the toes of the tennis shoes. Next, the subjects returned to the original up-right position with hands on hips. Only the number of correctly executed toe-touches were recorded with each correctly performed down-and-up movement counting as one toe-touch. The total number of movements correctly done in thirty seconds were recorded on each performers scorecard.

Judgement by Expert Opinion. In the final form of judgement, each of the ten performers were evaluated by three tennis experts. The three experts were picked because of their knowledge of tennis and strong backround in physical education. The three judges all graduated from college with major fields of study in physical education. The three judges were; Jan Krc, varsity tennis coach at Rolling Hills High School, Palos Verdes, California; Bob Kostka physical education instructor, Ridgecrest Intermediate School, Rolling Hills, California; and the investigator served as the third member of the team of experts. Only the varsity tennis coach was familiar with the players being tested. Each expert judged the ten skilled tennis players as they performed a variety of basic tennis strokes; serve, forehand, backhand, overhead and volley. Scoring charts were given each expert with designated areas to place the individuals performance rating as to poor, fair, good or excellent. Each of the ten players hit ten serves, ten overheads and ten volley shots. The investigator served as the second player setting each performer up for the shots. In acting as a judge and also serving as the second player, the investigator attempted to establish some degree of conformity to the tests as all of the performers would be hitting against the same type of strokes and not a varying degree depending upon the

player they were being tested with. It was also the investigators belief that a person can often judge to a better degree a tennis players caliber by stroking with him. A score of zero was given for each "poor" marking; two points for each "fair" marking; three points for each "good" marking; and five points for each "excellent" marking.

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

The purpose of this study was the identification of physical traits possessed by high school varsity tennis players. The Dyer Backboard test, push-ups, the standing broad-jump, the fifty-yard dash, the shuttle run, the side step test, the locked-knee-toe-touch and a tennis skill test by expert evaluation, were used to study these traits. Coefficient of correlations were determined for the physical test battery as a whole, and for each individual test, through the use of the Spearman Rank Order correlation method. The 0.05 and 0.01 levels of significance were established as the criterion for these correlations.

Tennis Skill Test Evaluation by Experts. The tennis skill test was given to each of the ten skilled tennis players and the players were evaluated by each of the three tennis experts. Each player was then ranked according to his degree of proficiency and the sum ranking was correlated to their season tennis ranking as a member of the varsity tennis team.

Correlation between the skill ranking by experts and the participators final varsity tennis team ranking from game competition was found to be .887. The correlation surpassed the 0.05 and 0.01 levels of significance of .632 and .765,

with eight degrees of freedom. Due to this high correlation, a high degree of significance was obtained for the given subjects of this study in relation to the tennis skill evaluation by experts.

Physical Performance Test. The physical performance test battery was correlated with the tennis skill evaluation by experts, in order to determine valid factors contributing to the physical traits of the highly skilled tennis player.

The physical performance test battery when compared and correlated to the tennis skill evaluation by experts yielded a .249 correlation coefficient. This correlation was well below the 0.01 and 0.05 levels of significance, with eight degrees of freedom, necessary for significance. Because of this low and invalid correlation, the physical performance test battery was deemed insignificant in the accuracy of predicting and determining physical skills relating to successful tennis ability.

In singling out each specific test used in the physical performance test battery and correlating them individually with the tennis skill evaluation by experts, the following information was found:

1. The Dyer Backboard Test. The scores on the Dyer Backboard test delivered a .410 correlation coefficient with the tennis skill evaluation by experts. This correlation

was well below the 0.01 level of significance as well as the 0.05 level of significance.

2. The Push-Up Test. The scores derived from the push-up test yielded a negative correlation of -.291. This correlation coefficient was very much below the 0.01 level of significance as well as the 0.05 level of significance.

3. The Fifty-Yard Dash. In correlating the scores obtained from the fifty-yard dash with the tennis skill evaluation by experts, a correlation of .453 was found. This correlation coefficient was below the 0.01 and 0.05 levels of significance.

4. The Side-Step Test. The scores on the side-step test delivered a .194 correlation coefficient with the tennis skill evaluation by experts. The correlation was well below the 0.01 level of significance and the 0.05 level of significance.

5. The Standing Broad Jump. The scores derived from the standing broad jump yielded a correlation coefficient of .243 when correlated with the tennis skill evaluation by experts. This correlation was insignificant at the 0.01 and 0.05 levels of significance.

6. The Knee-Locked-Toe-Touch Test. When correlated with the tennis skill ranking by expert evaluation the knee-locked-toe-touch delivered a correlation coefficient of .355. The correlation coefficient was well below the 0.01 level

TABLE I

INDIVIDUAL PHYSICAL SKILL TEST CORRELATION COEFFICIENTS AND LEVELS OF SIGNIFICANCE AT THE 0.01 AND 0.05 LEVELS OF SIGNIFICANCE WITH 8 DEGREES OF FREEDOM

Physical Test	Correlation Coefficient	0.01 Significance Level (N-2)	0.05 Significance Level (N-2)
Dyer Backboard Test	.410	.765	.632
Push-Up Test	-.291	.765	.632
Shuttle Run	.330	.765	.632
Fifty-Yard Dash	.453	.765	.632
Side-Step Test	.194	.765	.632
Standing Broad Jump	.243	.765	.632
Knee-Locked-Toe-Touch	.355	.765	.632

N= 10

of significance as well as the 0.05 level of significance.

7. The Shuttle Run. The scores on the shuttle run test delivered a .330 correlation coefficient with the tennis skill evaluation by experts. The correlation was well below the 0.01 level of significance and the 0.05 level of significance.

Summary. An analysis of the results of this study states the insignificance and unreliability of the physical performance test and each component part of the physical performance in relation and correlation with the tennis skill ranking by expert evaluation. The insignificance of the physical performance test under the situation of the study was seen in the .253 correlation which was very much below the 0.01 and 0.05 levels of significance. Each specific physical performance test was likewise insignificant in regards to the 0.01 and 0.05 levels of significance, with the highest correlation coefficient ranking being that of .456 in the fifty-yard dash.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

The purpose of this study was to ascertain the relationship of the basic qualities of physical strength, speed, co-ordination, agility, change of direction and flexibility to success in tennis by skilled varsity tennis players. This was to be determined by comparing the results of the strength, speed, co-ordination, agility, flexibility and skill test to success in tennis as measured by evaluation of each individual tennis stroke by tennis experts. The test battery was administered by the investigator with the aid of Rolling Hills High School, Palos Verdes, California, tennis coach Mr. Jan Krc. The data was subjected to correlation with the tennis skill evaluation by experts and analyzed by the Spearman Rank Order of Correlation.

FINDINGS

The results of the study indicated the following findings:

1. There was no significant correlation between strength, speed, agility, co-ordination, flexibility and tennis skill as exhibited by high school varsity tennis team members

as the coefficient of correlation was .249 between expert judgement and the physical test battery.

2. The Dyer Backboard test which is the most significant tennis test yet constructed as judged by tennis experts yielded a coefficient of correlation of .410 in correlation with the tennis skill evaluation by experts which was insignificant at the 0.01 and 0.05 levels of significance necessary for significance.

3. The push-up test data when correlated with the tennis skill evaluation by experts yielded a negative -.291 correlation coefficient which was very much below the 0.01 and 0.05 levels of significance necessary.

4. The fifty-yard dash data delivered a .453 correlation coefficient in correlation with expert evaluation of tennis skill which was not significant at 0.01 and 0.05 levels of significance.

5. The side-step test was found to be insignificant in correlation with the tennis skill evaluation by experts as the coefficient of correlation was .194 and thus well below the 0.01 and 0.05 levels of significance necessary.

6. The standing broad jump delivered a .243 correlation coefficient in correlation with expert evaluation of tennis skills which was not significant at the 0.01 and 0.05 levels of significance.

7. The knee-locked-toe-touch test data when correlated with the tennis skill evaluation by experts yielded a .355 correlation coefficient which was well below the 0.01 and 0.05 levels of significance necessary.

8. The shuttle run test data delivered a .330 correlation coefficient in correlation with the tennis skill evaluation by experts which was not significant at the 0.01 and 0.05 levels of significance.

CONCLUSIONS

Within the limits of this study the following conclusions are justified, by the results of the study:

1. The physical test battery cannot be justified as a measurement for determining success in tennis by high school varsity tennis team members.

2. Each individual test component of the test battery cannot be justified as successful tests to determine the success in tennis by high school varsity tennis team members.

3. Tennis is such a complex activity that the success to which a test battery could evaluate or predict tennis ability and specific physical skills would depend on how closely such a battery would parallel the complex movements of tennis and other variables such as desire, attitude and tennis knowledge.

RECOMMENDATIONS

As a result of this study the following recommendations are presented as a basis for further research:

1. An extended battery of tests related to speed, power, co-ordination, flexibility and strength more closely associated with tennis and administered to a greater number of high school varsity players.

2. An expert evaluation of tennis skill of high school varsity tennis players based on a free form evaluation sheet for experts to judge, thus yielding an answer as to what experts look for or at in a skilled tennis player.

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APPENDIX

INDIVIDUAL RANKING OF
GENERAL TENNIS SKILLS

PLAYER EVALUATED_____

EVALUATOR_____

Check your choice of the following alternatives as to the skill possessed by the individual as he performs the following basic tennis strokes.

	POOR	FAIR	GOOD	EXCELLENT
SERVE				
FOREHAND				
BACKHAND				
OVERHEAD				
VOLLEY				
COURT POSITION				

OBSERVATIONS AND COMMENTS: