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To the Graduate Council:

I am submitting herewith a thesis written by Sherri Lochridge Allinder entitled "The Effects of Rope Skipping and Movement Drills on Footwork and Tennis Playing Ability." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Physical Education.

Donna Clland
Major Professor

We have read this thesis and
recommend its acceptance:

Carolyn Adams

Nancy Lay

Accepted for the Council:

Sutton A. Smith
Vice Chancellor for
Graduate Studies and Research

THE EFFECTS OF ROPE SKIPPING AND MOVEMENT DRILLS ON FOOTWORK AND TENNIS PLAYING ABILITY

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements of the Degree

Master of Science

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by

Sherri Lochridge Allinder

August 1973

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S. L. A.

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ABSTRACT

The purpose of this study was to compare two experimental groups with each other and with a control group in order to determine:

1. The comparative effectiveness of two movement exercises on footwork ability in tennis, as measured by judges' ratings.
2. The comparative effectiveness of two movement exercises on general tennis playing ability, as measured by the Revised Dyer Backboard Test.

The subjects involved in this experimental research were 38 women enrolled in a beginning tennis class at The University of Tennessee at Knoxville, during the spring quarter, 1973. The class met three times a week for 40-minute sessions for eight weeks. The class was randomly divided into two experimental groups and one control group. At the end of the quarter, there were 13 women in Experimental Group I, 14 women in Experimental Group II, and 11 women in Group III, the control group. Treatments were randomly assigned to the three groups.

Both experimental groups participated in the regular tennis class in addition to the movement exercises to which they were assigned. Experimental Group I skipped rope for five minutes prior to each tennis class period. Experimental Group II participated in three movement drills prior to each tennis class period. Group III participated in the same beginning tennis class as did the two experimental groups but did not participate in either movement exercise during the eight-week period.

The data obtained from this study were initial and final Dyer Backboard scores and initial and final judges' ratings. After the data

were analyzed by a one-way analysis of covariance, it was found that:

1. After final scores were adjusted for initial differences, none of the three groups differed significantly from the other groups on footwork ability, as measured by judges' ratings.
2. The improvement in general playing ability made by Group I was statistically significant over the improvement made by Group II, as measured by the Dyer Backboard Test.
3. The difference in general playing ability between Group I and Group III was not statistically significant, as measured by the Dyer Backboard Test.
4. The improvement in general playing ability made by Group III was statistically significant over the improvement made by Group II, as measured by the Dyer Backboard Test.

The investigator concluded that it is just as beneficial for a beginning tennis class to practice tennis skills as it is to combine tennis skill practice with rope skipping or movement drills.

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CHAPTER I

INTRODUCTION

The strategy of tennis is to hit the ball away from the opposing player and out of his reach. One way the opposing player can overcome this is to move quickly and be ready before the ball reaches its destination. This promptness and readiness require proper footwork (56, p. 27).

When first learning the skill of tennis, most people can easily learn the procedure of hitting a ball which they drop or which is dropped for them. Progressing beyond this stage, the importance of footwork in hitting a moving ball becomes apparent (30, p. 2).

Because the tennis ball rarely bounces at the same height or in the same place twice, the ability to move around the court quickly, forward, backward, and to the side, as well as shifting the body's weight is the prerequisite to successful tennis play (68, p. 262). The perfect tennis swing means little when the player is too close to or too far from the ball, or when he fails to shift his weight into the stroke (16, p. 22). Proper footwork adds power to the stroke by allowing the body's weight to be transferred into the swing.

Good tennis players are not always innately fast runners, but they do have good footwork. They react quickly to a ball coming to them and start moving into the proper position for stroking the ball at the first cue (30, p. 3).

I. STATEMENT OF THE PROBLEM

This study was concerned with determining the effectiveness of

two exercises commonly used to develop footwork skill in beginning women tennis players. The purpose of this study was to compare two experimental groups with each other and with a control group in order to determine:

1. The comparative effectiveness of two movement exercises on footwork ability in tennis, as measured by judges' ratings.
2. The comparative effectiveness of two movement exercises on general tennis playing ability, as measured by the Revised Dyer Backboard Test.

II. LIMITATIONS OF THE STUDY

Like most studies that involve experimental research, this study was limited by several factors that could not be controlled by the investigator:

1. It was impossible to control the outside activities of the subjects.
2. There was no assurance of maximum enthusiasm from the experimental groups during their movement exercises.
3. The reliability of the judges was not statistically determined because of the practical factor of time involved.

III. DEFINITIONS OF TERMS USED

Footwork. "Footwork is the adjustment of the feet to place the body in position for activity" (15, p. 75). Good footwork in tennis is the action of the feet in placing the body in position to stroke the ball more efficiently.

Subjective rating. A subjective rating is a rating given by a panel of judges who evaluate on the basis of a rating scale which defines the distinguishing points between different level performances (5, p. 39).

Rope-skipping pattern. The rope-skipping pattern used in this study was a heel-and-toe shuffle suggested by Plotnicki (50) and taken from Prentup (53, p. 18).

Movement drills. Three movement drills were used in this study. One was an agility run used to improve footwork in badminton and the other two were movement drills used by Polte (52) to teach tennis players to move around the court.

Movement exercises. When referring to the rope-skipping pattern and movement drills collectively, the investigator called them "movement exercises".

Revised Dyer Backboard Test. The Revised Dyer Backboard Test is used to measure tennis playing ability. The test requires a student, standing behind a 20-foot restraining line, to hit a tennis ball for 30 seconds above a three-foot line drawn on a backboard. The student's score is the number of correct hits made in a total of three 30-second trials.

Group I. Group I is the term used to refer to those 13 students whose experimental treatment was participating in a rope-skipping pattern.

Group II. Group II is the term used to refer to those 14 students whose experimental treatment was participating in three movement drills.

Group III. Group III is the term used to refer to those 11 students who served as the control group in this study.

CHAPTER II

REVIEW OF THE LITERATURE

Because the purpose of this study was to determine the comparative effectiveness of rope skipping and movement drills on tennis footwork and playing ability, the investigator divided the literature into the following areas: (1) rope skipping, (2) movement, (3) footwork, and (4) measurement of playing ability.

I. LITERATURE RELATED TO ROPE SKIPPING

Rope skipping has been used by athletic coaches for many years. It was found to be one of the most popular activities used to develop agility, balance, coordination, movement, rhythm, endurance, and hand-eye coordination (53, p. 3). Beasley (7) and Lee and Wagner (39) stated that rope skipping is one of the finest exercises for learning a light step and eliminating jerky movements.

Ainsworth (1), Vannier and Poindexter (68), and Stafford and Duncan (61) stated that rope drills are ideal for teaching students to push off the balls of their feet as well as to remain on their toes throughout an activity. Kraft (38) and Barta and Donnallely (6) recommended rope skipping specifically for the development of footwork and body rhythm.

Beasley (7) directly related good tennis footwork to rope skipping. He expressed his opinion in the following statement:

> The steps of the great tennis players are light ones and can best be described by a patter-patter sound of the feet as the player glides over the court, exactly the same patter sound as in skipping a rope (7, p. 58).

In addition to using rope skipping as a footwork developer, McPherson (33) supported her reason for doing so with the following statements:

1. Rope skipping uses a shuffling motion similar to that used on the tennis court.
2. Rope skipping is an excellent warm-up device.
3. Endurance and strength are built by rope skipping.
4. All techniques of footwork are involved in rope skipping (33, p. 24).

Szepessy (64) conducted a study to determine the effect of rope skipping on the development of motor ability in deaf children. Rope skipping, as a regular part of the volleyball class was found to improve the children's agility. There was no agility improvement in the control group. Pecka (49), studying junior high school boys, also concluded that rope skipping improved agility.

Donaghe (14) studied the effect of rope skipping on physical fitness and badminton achievement of college women. It was found that both the control and experimental groups improved significantly in physical fitness and badminton skill. Donaghe concluded that rope skipping did not improve physical fitness or skill to any greater extent than badminton instruction alone.

Underwood (67) reported the results obtained from his study with elementary school children. These children were tested for agility

improvement after skipping rope for an eight-week period. There was no significant difference in the agility performance of the subjects after the study. Underwood concluded that daily rope skipping did not make a difference in the agility of elementary children.

Stopka (62) used rope skipping as one method of improving vertical jump ability. He found that rope skipping did not increase vertical jump ability as much as active regular exercise did. Delores Curtis (12) studied endurance, leg power, agility, and coordination of children. She found that daily rope skipping did not significantly improve the above-mentioned qualities.

II. LITERATURE RELATED TO MOVEMENT

The ability to get around the tennis court quickly, to move forward, backward, and to either side, and to shift the body's weight is the prerequisite to successful tennis play (68, p. 261). Good tennis play depends largely upon the player's ability to position himself properly in relation to the ball. Establishing this relationship with the ball depends on quick movement into the hitting position (10, p. 43).

Beasley (7) suggested daily practice in running backward and forward on the court. He noted that this drill would enable the player to move backward with ease, and would build speed and a sense of balance. Backward movement is essential for defensive play.

Gould (21) felt that skill in tennis depended on movement. He also divided the common movement faults into the following three divisions:

1. The player arrives at the ball too late, making it impossible to step toward the net into the shot.
2. The player overruns the ball and must fall back on his heels to hit it.
3. The player's legs are too stiff and his knees will not bend (21, p. 38).

McPherson (33) and Wickstrom (69) both noted that movement was the secret to the body's placement into a balanced hitting position, to the execution of the shot, and to recovery to a readiness position. Achieving even an average game of tennis involves rapid movement. In order to rise to an advanced level of tennis, a player must be able to move swiftly to an extreme boundary of his court, make an effective play, and then recover to a central readiness position (69, p. 84).

Beasley (7) and Robinson (54) encouraged the tennis player to keep on the balls of his feet and remain in constant motion throughout the game. Playing flat-footed leads to fatigue, and spine jars result from coming down on the heels (7, p. 62). Playing from an anchored position makes it difficult for the player to pivot his body's weight into the stroke (7, p. 64). Stopping completely causes the player to lose precious seconds because more time and energy are needed to put the body into motion again. The continual foot movement causes tension in the muscles which makes it possible for the player to move the feet quickly in the direction of the ball (54, p. 12).

According to Leighton (40), the three keys to better tennis were: (1) increased concentration, (2) quicker reaction, and (3) movement ability. Keller (35), Patrick (48), and Beise and Peasely (8), in

separate studies on body quickness and reaction time, concluded that there was a positive relationship between ability to see, react, and move the body quickly, and success in athletic activities. On the other hand, Honda (30) observed that movement on a tennis court was not primarily concerned with an individual's pure reaction time, but with his quick response to a situation in play.

Gates (20), in his study on direction change, found that skill in change of direction was an important factor in determining agility and games ability. He stated that change of direction was an important factor in determining success in tennis.

Jones (32) studied the effect of a movement pattern, to facilitate agility and footwork, on badminton playing ability. The Wilcoxon Rank Sum Test showed no significant differences in the experimental and control groups in badminton playing ability. Jones concluded that it was equally beneficial for a beginning badminton class to practice game skills and to combine game skills practice with a movement pattern.

III. LITERATURE RELATED TO FOOTWORK

According to most authors, the prime requisite for success in tennis, as in other sports, is the use of proper footwork (16, p. 22). Poor footwork has prevented many average players from becoming skilled tennis players (54, p. 11).

Ainsworth (1), unlike many tennis instructors, introduced footwork prior to the tennis strokes. She said that the placement of the body and feet in the correct position is most important. Everett and

Dumas (16) felt that the perfect swing means little when the player is too close to or too far from the tennis ball. Driver (15) described the importance of footwork in tennis as follows:

1. Good footwork adds power to a stroke because body action can be thrown into the stroke.
2. Good footwork allows the ball to be hit off the forward foot at the racket's reach from the body.
3. Good footwork insures perfect timing which makes possible a stroke that is not hurried (15, p. 75).

McPherson (33), Johnson and Xanthos (34), and Miller and Ley (44) all observed that proper footwork determined tennis success. Footwork is related to the following: (1) change in direction, (2) transfer of weight, (3) change in time, and (4) accelerated reaction time (33, p. 22). Good footwork gets the player into the best possible position from which to execute his shot while poor footwork causes him to hit from an awkward, off-balance position, making easy shots more difficult and hard shots almost impossible (34, p. 18).

Beasley (7) felt that exercises and practice drills in footwork enable most people to develop good footwork. He expressed his ideas about the importance of footwork in the following paragraph:

> Footwork is the real exercise and the only actual work you do in tennis. How far you go in your game depends upon your footwork and how far you develop it. Without good footwork, you can never play good tennis. . . . It is by your footwork that you are enabled to hit on balance, that you control your weight and adjust yourself to a comfortable position in the execution of a stroke (7, p. 54).

> Sluggish footwork results in being late, so that you have to expend added effort just to reach the ball. This hurried

> footwork hampers your pivoting and timing and the result is that you are playing the ball under unfavorable instead of favorable conditions (7, p. 55).

Tilden stated that "all footwork should be used to bring the player to the ball with his weight under such control that he can use it as he wishes when he hits the ball" (65, p. 28). He felt that simplified foot movement is needed for preparation to execute a correct stroke. Tilden used "simplified movement" to mean starting on the correct foot. "The champion starts with the correct foot and spaces his run so that he arrives on the correct foot in position to hit" (65, p. 30).

Scharff (56) and Barnaby (4) emphasized the use of short steps when running for the ball. Short steps allow a quick change of direction while long strides can cause loss of balance and poise (4, p. 41).

Tarbert (45) noted that in order to play good tennis, one must be a fast court coverer. He stated:

> A good tournament player is faster at covering five yards of court than a sprinter. A player is not a track star and would never set records in a 50-yard dash, but he starts quickly and his speed at short distances is impressive both because of his excellent footwork as well as his anticipation (45, p. 141).

Noel (47) said that no strokes can be executed properly without good footwork, nor can the player be in the correct place at the correct time without it. She also stated, "Without good footwork, the player won't get very far because correct movement of the racket depends on the correct position of the body and therefore, of the feet" (47, p. 52).

McPherson (33) said that the symphony of coordination, timing, and precision is responsible for making tennis players champions. She further stated that the basic element upon which this symphony of movement

is built is footwork. McPherson observed that footwork should be given primary attention in the early stages of instruction to provide a base upon which to build a good tennis game. She believed that footwork must be practiced in order to be perfected (33, p. 22).

McPherson (33), Beasley (7), Brown (10), Vannier and Poindexter (68), and Robinson (54) highly recommended rope skipping to develop lightness in the feet, rhythm, coordination, and to teach students how to push off from the balls of their feet. Additional drills such as agility runs and hopscotch variations have been used to develop footwork.

Honda (30) conducted a study to determine the influence of a footwork exercise aimed to shorten reaction-movement time on tennis playing ability. The experimental group participated in the footwork exercise every week in addition to the tennis class. After the data were statistically analyzed, Honda concluded that the footwork exercise used in this study significantly improved reaction-movement time but did not significantly improve the tennis playing ability as measured by the Dyer Wallboard Test.

IV. LITERATURE RELATED TO MEASUREMENT OF PLAYING ABILITY

There have been many studies conducted to perfect valid and reliable tennis skills tests, both subjective and objective. Some tennis skills, such as form, are best evaluated subjectively, while other skills are evaluated by an objective skills test (57, p. 423). The type of evaluation used, then, is determined by the particular tennis skill being tested.

Hewitt (28), in 1965, revised the Dyer Backboard Test by extending the 5-foot restraining line to a 20-foot restraining line and adding a serve to put the ball in play. The validity coefficient of the Revised Dyer Test was found to be .73 for beginning players and .84 for advanced players (28, p. 155). Hewitt concluded that the 20-foot restraining line forced players to use different ground strokes in addition to the volley. By using various tennis strokes, the validity of the test was raised considerably.

Broer and Miller (9) conducted a study in order to evaluate a tennis skills test. The student began the test by standing behind the baseline where he used a courtesy stroke to hit the ball across the net. The object was to hit the ball over the net and under a rope stretched 4 feet above the net. The opposite side of the court was marked off into seven sections which were worth different numerical values. The student's score was the sum of 14 trials with the forehand and 14 with the backhand and was determined according to the court section in which the ball hit. The test was found to be reliable and valid, with a reliability coefficient of .80 $\pm$ .047 for beginners and .80 $\pm$ 0.43 for intermediates. The validity coefficient was .61 for beginners and .85 for intermediates. The authors concluded that this skills test was an improvement over the subjective judgment of quality tennis instructors as a means of grading the forehand and backhand tennis strokes.

Fox (19) continued the study of validity of the Dyer Backboard Test and Broer-Miller Test. The subjects taking part in this study

were tested subjectively by four judges after which they were given the Dyer and Miller Tests. A validity coefficient of .81 was found between the average judges' ratings and a combination of the Dyer and Miller Tests. Fox concluded that the Dyer and Miller Tests combined constitute a valid measure of tennis ability.

Kemp and Vincent (36) investigated the validity of a tennis skills test that evaluated players during a game situation. Two players of equal ability were tested simultaneously as they rallied for three minutes. A player's score equaled the combined number of hits for both players minus his errors during the rally. The validity coefficient for beginning players was found to be .84 while the validity coefficient for intermediate players was .93. The validity of this test was found by correlating it with a round robin tournament.

Another significant study was conducted by Hewitt (27) who investigated a method of testing the forehand, backhand, and the serve in tennis. The court in this test was marked into areas that were assigned point values. Ten balls for the forehand and 10 balls for the backhand were hit to the subject by the instructor, and 10 balls were served by the subject. The subject's score was determined by the blocks into which his return shots hit. Validity coefficients ranging from .52 to .93 were found by ranking all the players after a round robin tournament and comparing the tournament score with the score on the skills test. By the use of the "test-retest" method, reliability coefficients were found to range from .75 to .94. Hewitt concluded that the Revised Dyer Backboard Test should be used to test tennis skill because

of its simplicity. Hewitt further stated that his test to evaluate three tennis skills should be used only if a backboard is not available for administering the Revised Dyer Backboard Test.

In their article on measurement, Barrow and McGee (5) stated that the most reliable and valid method to rate skill subjectively is to use a rating scale which defines carefully the distinguishing points between a performance worth five points and one worth two points (5, p. 39). They said that the opinion of experts is a more accurate measure than a poor skills test and that no apologies should be made for subjective ratings. To insure validity, they stated that if more than one rater is used, the raters must have the same anchor points from which to form their judgments. These anchor points can be established by a discussion of their ratings at the beginning of the test.

Hillas and LeFevre (29) and Haskins (23) have written articles on subjective evaluation by rating scales. Haskins emphasized the fact that the judges must be completely familiar with the rating scale and must have a vivid mental picture of the items they are observing. Hillas and LeFevre listed the following advantages of using rating scales to evaluate skill:

1. The qualities to be evaluated are determined and recorded in advance.
2. The order of the evaluation is indicated and degrees of the quality being examined are provided.
3. The instructor or judge can observe and evaluate the student as he rallies against a backboard (29, p. 13).

CHAPTER III

PROCEDURE

This study was concerned with determining the effectiveness of two exercises commonly used to develop footwork skill in beginning women tennis players. The purpose of this study was to compare two experimental groups with each other and with a control group in order to determine:

1. The comparative effectiveness of two movement exercises on footwork ability in tennis, as measured by judges' ratings.
2. The comparative effectiveness of two movement exercises on general tennis playing ability, as measured by the Revised Dyer Backboard Test.

This chapter is concerned with the procedures incorporated in conducting this study. The following headings denote the procedures: (1) selection of subjects and assignment to groups, (2) selection of the jury of experts, (3) description of the subjective rating scale, (4) selection of the tennis skills test, (5) selection and description of the movement drills, (6) selection and description of the rope-skipping pattern, (7) administration of the movement exercises, (8) equipment used, and (9) statistical analysis of data.

I. SELECTION OF SUBJECTS AND ASSIGNMENT TO GROUPS

The subjects involved in this experimental research were 38 women enrolled in a beginning tennis class at The University of Tennessee at

Knoxville, during the spring quarter, 1973. The class met three times a week for 40-minute sessions for eight weeks.

The class was randomly divided into two experimental groups and one control group. At the end of the quarter, there were 13 women in Experimental Group I, 14 women in Experimental Group II, and 11 women in Group III, the control group. Treatments were randomly assigned to the three groups.

Both experimental groups participated in the regular tennis class in addition to the movement exercises to which they were assigned. Experimental Group I skipped rope for five minutes prior to each tennis class period. Experimental Group II participated in three movement drills prior to each tennis class period. Group III participated in the same beginning tennis class as did the two experimental groups but did not participate in either movement exercise during the eight-week period.

II. SELECTION OF THE JURY OF EXPERTS

In order to determine the comparative effectiveness of two movement exercises on footwork ability in tennis, as measured by judges' ratings, a jury of experts was selected. Three judges were chosen to rate subjectively the footwork of the subjects. The judges were selected according to the following qualifications: (1) previous experience as a tennis instructor, (2) previous experience as a tennis player, and (3) previous study of mechanical analyses of tennis movements.

III. DESCRIPTION OF THE SUBJECTIVE RATING SCALE

The jury of experts rated the subjects subjectively on four

specific tennis skills according to a five-point scale shown in Figure 1. The ratings for the four skills were added to represent a total subjective rating for each subject. In order to determine whether improvement occurred, this subjective rating was made once prior to and once after the eight-week tennis period. The three judges' total subjective scores for each subject were averaged for the initial and final ratings.

IV. SELECTION OF THE TENNIS SKILLS TEST

The method used to determine the comparative effectiveness of two movement exercises on general tennis playing ability was the Revised Dyer Backboard Test. This test was administered before and after the eight-week period (28). The Dyer Test was chosen by the investigator because it required minimum equipment and because its validity coefficient with beginner playing ability is .73 (27, p. 240). The Dyer Test and the subjective ratings were conducted simultaneously in order to conserve time.

V. SELECTION AND DESCRIPTION OF THE MOVEMENT DRILLS

Selection

One agility run (10, p. 126) and Polte's (52) two movement drills were selected as the movement drills to be used in this study. The agility run was chosen because recovering to a central readiness position after hitting the ball should be emphasized in tennis (69, p. 85), and exercises that involve running short distances backwards are important

Subject_____ Date_____

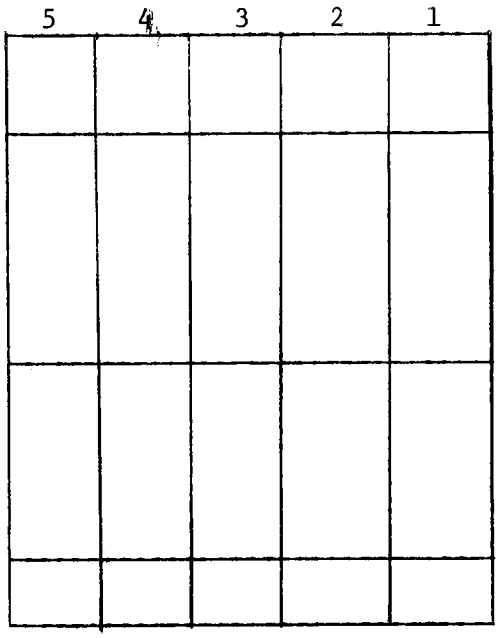
SKILLS

1. Reaction Time

2. Movement and Footwork
   a. Moved efficiently and quickly
   b. Shifted weight onto forward foot as hit the ball

3. Hitting Stance
   a. Formed good relationship with the ball.
   b. Pivoted side of the body to the backboard.

4. Point of Contact



Judge_____ Total Score_____

Figure 1. Subjective rating scale.

in developing better footwork in tennis (54, p. 12). Polte's two movement drills were chosen to develop reaction time, footwork, and movement (52).

Other factors that determined the selection of the three movement drills were the investigator's available class time, the possibility of administering the drills on either a tennis court or in a gymnasium, the minimum equipment required to administer the drills, and the similarity between the movement drills and the movement used in playing tennis (32, p. 19).

Description

The course of the agility run is diagrammed in Figure 2. Three squares were drawn along the tennis court with chalk, two feet from the net with 10 feet between each square. The three squares were numbered: 1, 2, and 3. The center base was placed 33 feet from the number 2 square. The subject moved from the center base to the squares in number order, returning to the center base each time and facing the net at all times (10, p. 126).

For the second movement drill, students facing the net were placed in staggered lines that were parallel to the baseline. With her back to the net, the investigator stood between the net and the students. The students moved to both sides and to the front and back as indicated by the investigator's hand movements. The students remained on their toes during the entire drill. Small steps were taken up and back, and side-leaps were taken to the sides (52).

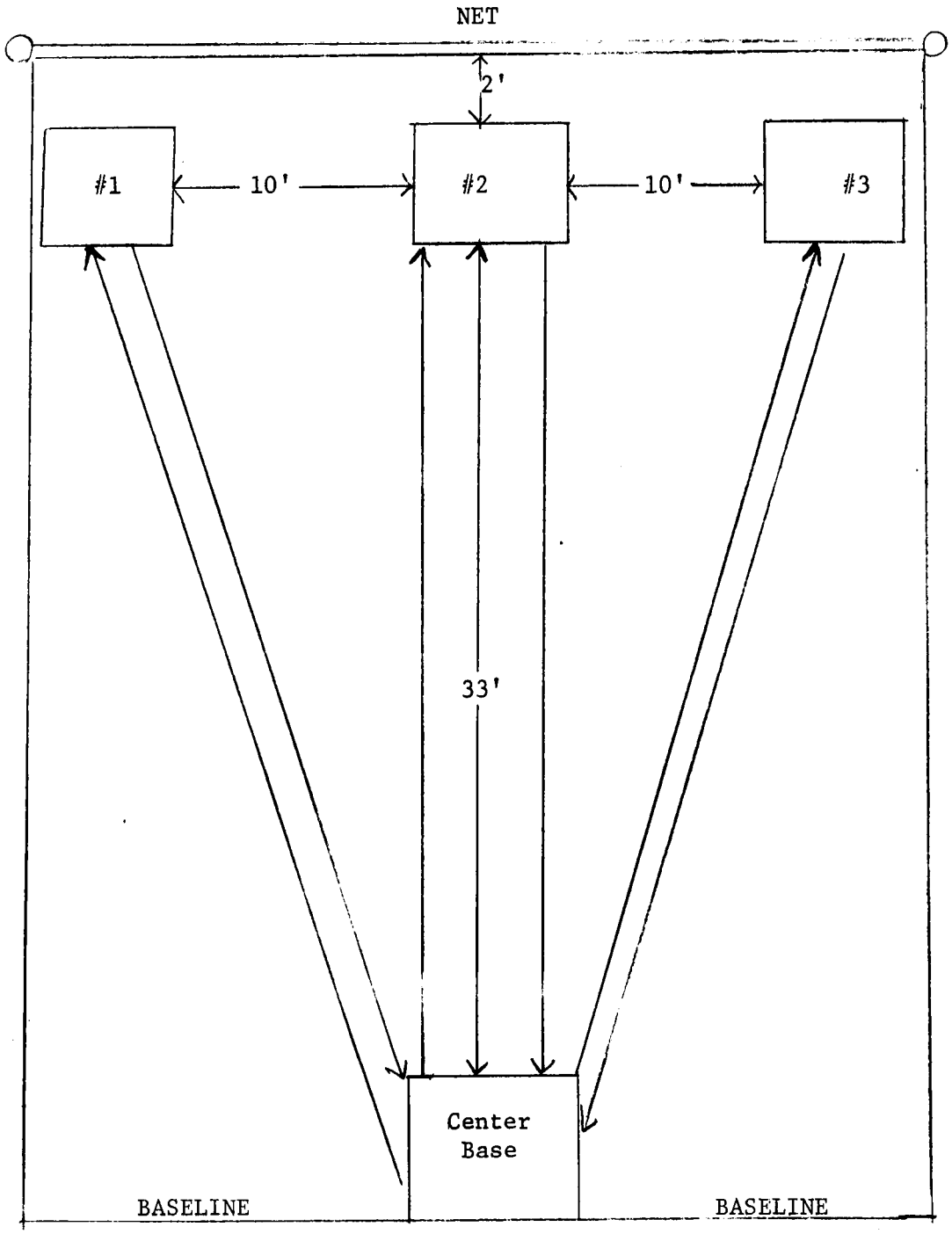


Figure 2. Agility run.

The third movement drill, shown in Figure 3, necessitated that the subject keep her eyes on the tennis ball in addition to moving around the court. The subjects were divided into groups of three. The three subjects formed a perpendicular line to the net. One subject was one foot from the net, the second subject stood on the baseline, and the third subject was two feet behind the baseline. The first subject tossed the ball to the second subject at the baseline, who ran up and caught the ball with her hand as if she were using a tennis racket. Having tossed the ball, the first subject then continued to the position behind the baseline, while the receiver moved to the net position in order to toss the ball to the third subject who had moved up to the baseline. The three subjects, while moving on the balls of their feet, continued to toss, catch and rotate positions during the entire drill (52).

VII. SELECTION AND DESCRIPTION OF THE ROPE-SKIPPING PATTERN

Rope skipping was chosen by the investigator as the second method of improving tennis footwork and playing ability because rope skipping is one of the finest exercises for learning a light step. The patter sound of the feet when gliding over the tennis court can best be described by the patter sound of the feet while skipping a rope (7, p. 58). A heel-toe shuffle was used as the rope-skipping pattern (53, p. 18). This shuffle kept each subject light on her feet and in constant movement throughout the exercise. The shuffle was practiced without a rope until both feet could alternately touch heel and toe lightly to the floor. Once this was accomplished, the subject practiced the shuffle while jumping a rope.

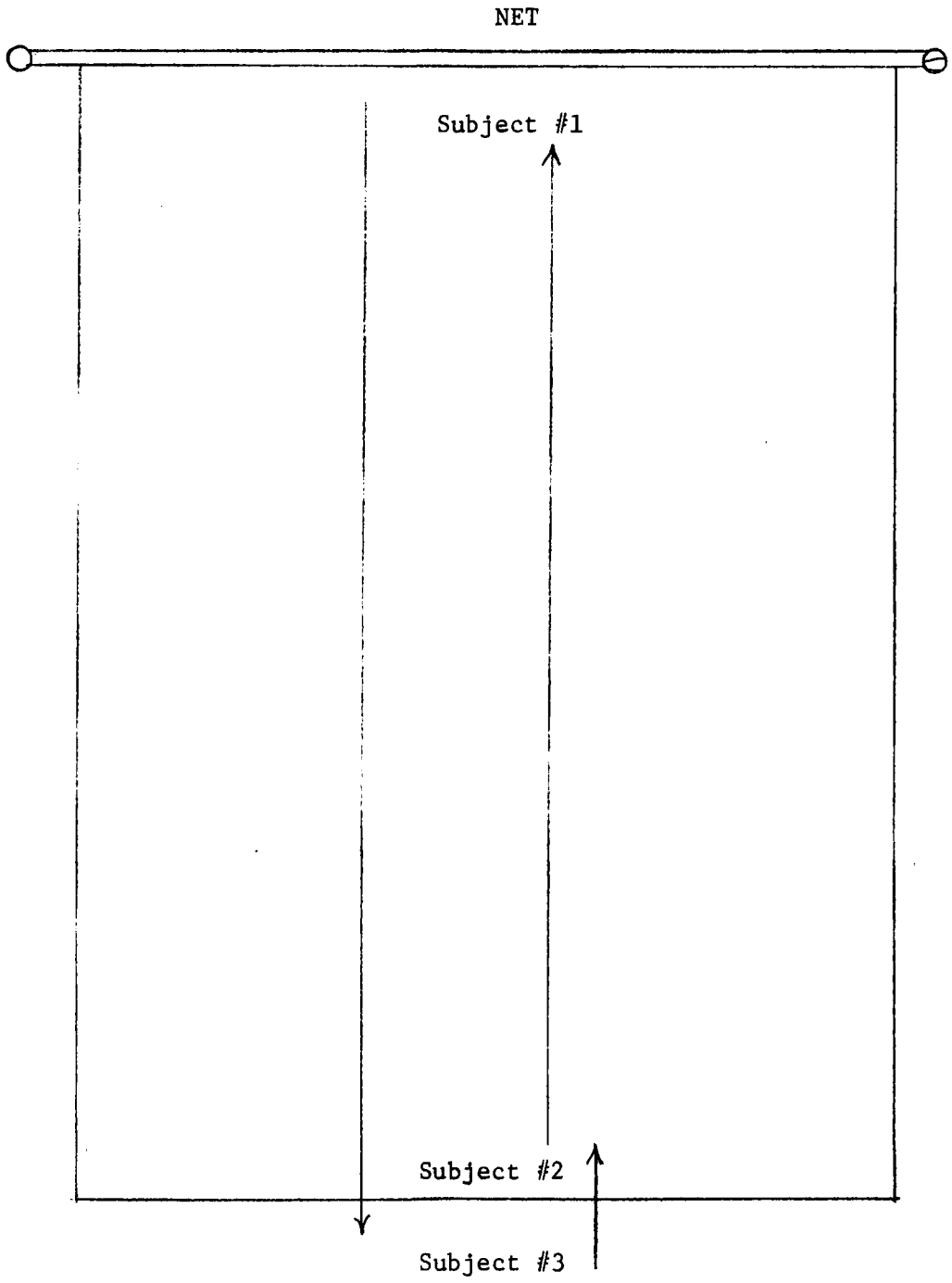


Figure 3. Movement drill.

VIII. ADMINISTRATION OF THE MOVEMENT EXERCISES

The rope-skipping pattern and movement drills were simultaneously administered five minutes prior to every scheduled class period, which met three times a week for eight weeks. Written and verbal instructions were given to both experimental groups before they initially began their exercises. The investigator was the only administrator during the entire study. The two experimental groups participated in their movement exercises on the tennis courts, except when rainy days necessitated indoor participation.

IX. EQUIPMENT USED

The equipment used to carry out this study was supplied by the investigator, the subjects, and the Physical Education Department at The University of Tennessee at Knoxville. The equipment consisted of the following: (1) one stop watch, (2) one tape measure, (3) chalk, (4) 15 jump ropes, (5) tennis balls, and (6) paper and stencils for the judges' rating sheets and for the movement instructions used by the experimental groups.

X. STATISTICAL ANALYSIS OF DATA

The investigator recorded the initial and final Dyer Scores and the initial and final subjective ratings for each subject. A one-way analysis of covariance was used to analyze the results of the Dyer Test, and a one-way analysis of covariance was used to analyze the results of the subjective ratings made by the judges.

CHAPTER IV

ANALYSIS OF DATA

At the end of the experimental period, the final objective scores and subjective ratings were obtained. The data were then analyzed to find out if there were any statistically significant differences in the experimental and control groups in tennis footwork ability and general tennis playing ability.

I. ANALYSIS OF THE DYER BACKBOARD SCORES

The ANOVA Table for the unadjusted post-test Dyer Scores is shown in Table I. The calculated F value of 16.600 was significant at the .0001 level of confidence, indicating a significant difference between the final (post-test) scores of the three groups.

An analysis of covariance was then used to determine whether the final test scores differed significantly after they had been adjusted for initial differences. The results of this analysis appear in Table II. The calculated F value of 6.942 was significant at the .0033 level of confidence, indicating a significant difference between the adjusted final (post-test) scores of the three groups. Duncan's New Multiple Range Test indicated that Group I and Group II were significantly different at the .05 level, as were Group II and Group III. Groups I and III were not significantly different.

II. ANALYSIS OF THE SUBJECTIVE RATINGS

The ANOVA Table for the unadjusted post-subjective ratings is

TABLE I

ANOVA TABLE FOR UNADJUSTED POST-TEST DYER SCORES

Source	DF	Sum of Squares	Mean Square	F Value	Prob > F
Regression	3	807.47834636	269.15944879	16.60017	0.0001
Error	34	551.28481154	16.21425916		
Correct Total	37	1358.76315789			

TABLE II

ANACOVA TABLE FOR ADJUSTED POST-TEST DYER SCORES

Source	DF	Sequential SS	F Value	Prob>F
Pre Dyer	1	582.34489380	35.91560	0.0001
Group	2	225.13345256	6.94245	0.0033

shown in Table III. The calculated F value of 14.213 was significant at the .0001 level of confidence, indicating a significant difference between the final (post-subjective) ratings of the three groups.

An analysis of covariance was then used to determine whether post-subjective ratings differed significantly after they had been adjusted for initial differences. The results of this analysis appear in Table IV. This calculated F value of 2.016 was not significant at the .05 level of confidence.

TABLE III

ANOVA TABLE FOR UNADJUSTED POST-SUBJECTIVE RATINGS

Source	DF	Sum of Squares	Mean Squares	F Value	Prob > F
Regression	3	1732790.06260	577596.68753	14.21306	0.0001
Error	34	1381707.51634	40638.45636		
Corrected Total	37	3114497.57895			

TABLE IV

ANACOVA TABLE FOR ADJUSTED POST-SUBJECTIVE RATINGS

Source	DF	Sequential SS	F Value	Prob > F
Pre Subj	1	1568955.275843	38.60765	0.0001
Group	2	163834.786761	2.01575	0.1471[a]

[a]No significant differences in means of subjective ratings.

CHAPTER V

SUMMARY AND CONCLUSIONS

I. SUMMARY

The purpose of this study was to compare two experimental groups with each other and with a control group in order to determine:

1. The comparative effectiveness of two movement exercises on footwork ability in tennis, as measured by judges' ratings.
2. The comparative effectiveness of two movement exercises on general tennis playing ability, as measured by the Revised Dyer Backboard Test.

The subjects involved in this experimental research were 38 women enrolled in a beginning tennis class at The University of Tennessee at Knoxville, during the spring quarter, 1973. The class met three times a week for 40-minute sessions for eight weeks. The class was randomly divided into two experimental groups and one control group. At the end of the quarter, there were 13 women in Experimental Group I, 14 women in Experimental Group II, and 11 women in Group III, the control group. Treatments were randomly assigned to the three groups.

Both experimental groups participated in the regular tennis class in addition to the movement exercises to which they were assigned. Experimental Group I skipped rope for five minutes prior to each tennis class period. Experimental Group II participated in three movement drills prior to each tennis class period. Group III participated in the

same beginning tennis class as did the two experimental groups but did not participate in either movement exercise during the eight-week period.

The data obtained from this study were initial and final Dyer Backboard Scores and initial and final judges' ratings. After the data were analyzed by a one-way analysis of covariance, it was found that:

1. After final scores were adjusted for initial differences, none of the three groups differed significantly from the other groups on footwork ability, as measured by judges' ratings.
2. The improvement in general playing ability made by Group I was statistically significant over the improvement made by Group II, as measured by the Dyer Backboard Test.
3. The difference in general playing ability between Group I and Group III was not statistically significant, as measured by the Dyer Backboard Test.
4. The improvement in general playing ability made by Group III was statistically significant over the improvement made by Group II, as measured by the Dyer Backboard Test.

II. CONCLUSIONS

According to the results of this study, the following conclusions can be drawn:

1. Rope jumping is superior to movement drills in developing general tennis playing ability as measured by the Revised Dyer Backboard Test.

2. Regular participation in tennis class can be expected to induce greater improvement in general tennis ability than would regular practice of movement drills.
3. Rope skipping cannot be expected to induce greater improvement in general tennis ability than would regular participation in a tennis class.

III. DISCUSSION

During the course of this study, the investigator observed several uncontrollable conditions which possibly played a detrimental part in the study. The following is a list of these conditions:

1. During the experimental period, the subjects were unable to play tennis outside for three weeks due to rain. Their practice was limited to backboard work in a gymnasium.
2. The large number of students enrolled in the class made it necessary for each student to share a court with three people.
3. Several subjects in the experimental groups were frequently absent and did not participate in their assigned movement techniques.
4. During the quarter, 20 subjects were eliminated from the study because they passed a proficiency examination on the tennis course, dropped the class, or failed to show up for the initial or final evaluation.

IV. RECOMMENDATIONS FOR FURTHER STUDIES

After conducting this experimental study, the investigator would

like to make the following recommendations:

1. This study should be repeated and should involve the following changes: (a) the study should involve a larger number of subjects, and (b) the study should be made over a longer period of time.
2. The investigators of similar experimental studies that involve student subjects should be the class instructors.
3. In order to increase the enthusiasm of the experimental subjects, the instructor should provide them with some type of recognition for their participation in the experimental activity.

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APPENDIX

TABLE V

RAW DATA OBTAINED FROM DYER TEST

Group I			Group II			Group III		
Subject No.	Pre-Scores	Post-Scores	Subject No.	Pre-Scores	Post-Scores	Subject No.	Pre-Scores	Post-Scores
1	33	38	1	25	29	1	22	36
2	28	34	2	34	26	2	30	34
3	27	36	3	32	31	3	37	41
4	26	32	4	36	36	4	28	32
5	14	24	5	25	32	5	21	24
6	28	29	6	30	30	6	30	38
7	15	28	7	23	29	7	29	34
8	21	26	8	28	34	8	26	34
9	19	19	9	30	31	9	42	45
10	21	33	10	21	27	10	27	30
11	22	37	11	30	29	11	21	32
12	27	31	12	35	35			
13	11	30	13	11	11			
			14	28	24			

TABLE VI

RAW DATA OBTAINED FROM SUBJECTIVE RATINGS

Group I			Group II			Group III		
Subject No.	Pre-Ratings	Post-Ratings	Subject No.	Pre-Ratings	Post-Ratings	Subject No.	Pre-Ratings	Post-Ratings
1	9.67	13.33	1	6.67	10.00	1	6.00	11.33
2	11.33	13.67	2	8.67	9.67	2	4.67	9.33
3	8.00	11.67	3	6.33	8.00	3	12.33	13.67
4	12.33	13.00	4	8.33	14.00	4	9.33	15.00
5	4.00	7.00	5	6.00	8.67	5	5.67	6.67
6	7.67	8.33	6	9.33	9.67	6	10.00	14.00
7	7.00	8.33	7	6.33	13.67	7	14.67	15.67
8	6.00	7.00	8	13.67	15.00	8	10.67	13.33
9	8.33	7.00	9	10.33	11.33	9	11.67	13.67
10	7.33	7.67	10	5.33	7.33	10	8.67	13.67
11	8.33	8.00	11	12.33	11.00	11	8.67	10.67
12	9.33	15.33	12	6.67	7.33			
13	5.67	10.67	13	6.00	6.67			
			14	8.33	9.33			

TABLE VII

MEANS AND STANDARD DEVIATIONS FOR DYER SCORES

	N	Mean Pre-Test Scores	Mean Post-Test Scores	Mean Adjusted[a] Post-Test Scores	Standard Deviations Pre	Post
Group I	13	22.46	30.54	32.88	6.46	5.43
Group II	14	27.71	28.86	27.85	6.54	6.14
Group III	11	28.45	34.55	33.06	6.50	5.57

[a]Adjusted means based on pre-test means.

TABLE VIII

MEANS AND STANDARD DEVIATIONS FOR SUBJECTIVE RATINGS

	N	Mean Pre-Subjective Ratings	Mean Post-Subjective Ratings	Mean Adjusted[a] Post-Subjective Ratings	Standard Deviations Pre	Post
Group I	13	8.08	10.08	10.36	2.26	2.99
Group II	14	8.17	10.12	10.34	2.52	2.61
Group III	11	9.30	12.46	11.83	3.04	2.68

[a]Adjusted means based on pre-test means.

VITA

Sherri Ann Lochridge Allinder was born in Madisonville, Kentucky, on January 14, 1949. She is the only child of Mr. and Mrs. Wallace Lochridge.

The writer received her early education in Madisonville, Kentucky, at the Madisonville City Schools, and was graduated from Madisonville High School in 1967. The following September she entered Murray State University, and in December, 1971, she received a Bachelor of Science degree in Vocational Home Economics and Physical Education. She was selected The Outstanding Senior Woman at Murray State University and is listed in "Who's Who in American Colleges and Universities."

The writer was employed at Elizabethtown High School, Elizabethtown, Kentucky, for four months before entering the Graduate School at The University of Tennessee in September, 1972. She received a Master of Science degree in Physical Education in August, 1973.

The writer is married to Joseph Craig Allinder of Madisonville, Kentucky.