THE EFFECTIVENESS OF THE KLI~-KLAG INSTRUCTIONAL AID
IN LEARNING THE TENNIS BACKHAND DRIVE

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ABSTRACT

THE EFFECTIVENESS OF THE Klic-Klac INSTRUCTIONAL AID IN LEARNING THE TENNIS BACKHAND DRIVE

by

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The purpose of this study was to determine the effectiveness of the Klic-Klac as an instructional aid in learning the tennis backhand drive.

Subjects selected for this investigation were beginning tennis players, ranging from 8 to 16 years of age, with no previous organized instruction. Subjects were selected from the summer tennis clinic offered at California State University at Northridge. The subjects were allowed to select the days of the week to participate in the clinic (either Monday-Wednesday or Tuesday-Thursday), and this random selection resulted in two groups of 19 subjects each.

Group I was the experimental group, and subjects used their own tennis rackets with the Klic-Klac teaching aid attached. Subjects of Group II, the control group, used their own tennis rackets without the Klic-Klac throughout the study. The study lasted four weeks, with the subjects training twice weekly for one hour at the same time.
of day.

The findings of this study indicate that there was a significant difference, in favor of the Klic-Klac instructional aid, in tennis backhand performance between the groups utilizing the Klic-Klac instructional aid and those utilizing the traditional teaching method.
CHAPTER I

INTRODUCTION

Tennis has been one of the fastest growing sports in our society, and many people, both young and old, are participating in the sport. It is not uncommon to see children as young as eight and nine years of age enrolling in tennis classes, clinics, or taking private lessons from professional teachers. The tennis boom has resulted in participation by more than an estimated 40 million Americans.

With such a popular sport, it is not surprising that the approaches of instructions vary. What appears to be unique is the role that instructional aids play in the teaching of and development of tennis skills.

Instructional aids in teaching tennis would seem to be very valuable in learning the various strokes, but they are seldom being used in today's teachings. This might be because of the impracticality of these instructional teaching aids.

This study was concerned with a topic of significant interest to all those involved with tennis - teachers, coaches, and students. Learning to play tennis effectively requires, among other things, hitting the ball consistently on the "sweetspot" of the tennis racket. An instructional teaching device which would aid in hitting the ball
on the correct spot of the strings of the racket would seem to be beneficial to the student in learning groundstrokes.

There is now a new teaching aid being manufactured and soon to be placed on the market called the Klic-Klac. This device appears to be based on feedback principles, which indicate that additional sources of sensory input will enhance learning and/or performance. This study was designed to determine if the Klic-Klac would significantly improve performance of the backhand tennis drive.

The American sports enthusiasts have been known to purchase all types of "gimmicks" alleged to cure or improve ailments and weaknesses in their sport. If it can be shown that the Klic-Klac does improve tennis performance of beginners, it will be of tremendous value to both instructors and students.

The Problem

Statement of the Problem

The problem of this study was the lack of information about the effectiveness of an instructional aid (the Klic-Klac) in learning tennis groundstrokes.

Statement of the Purpose

The purpose of this study was to scientifically evaluate the effectiveness of the Klic-Klac as an instructional aid in learning the tennis backhand drive.
**Hypothesis**

The investigation was designed to test the following null hypothesis: there will be no significant difference in tennis backhand performance between the groups utilizing the Klac-Klac instructional aid and those being taught by the traditional teaching method.

**Assumptions**

The study was based on the following assumptions: (1) that the learning task (backhand drive) was a novel gross motor skill which could be used to indicate that motor learning had taken place; (2) that the two groups came from the same population; (3) that each subject tried to the best of his/her ability; (4) that factors such as environment and administration procedures were equitable among the two groups.

**Limitations**

Noticeable throughout the study were the following delimiting factors: (1) the small number of students involved in the study; (2) the students meeting and practicing only twice a week; (3) the use of the backhand groundstroke only, as being the determinant of successful tennis performance; (4) Group I contained 8 males and 11 females, while Group II contained all female subjects.

**Definition of Terms**

The following terms are used in the study and are defined specifically as they are used in this investigation:
Ground Stroke. A stroke taken after the ball bounces. It consists of the ball being carried forward on the racket strings with a sweeping movement which keeps the ball and racket in contact during part of the forward swing.

Backhand Drive. The stroke used to return balls which bounce to the backhand side of the player. It consists of a horizontal swing which imparts slight top spin to the ball which is directed near the baseline.

Self-drop. The player dropping the ball into the proper position to enable the player to hit the ball effectively.

Sweetspot. This is the area found just below the center of the racket strings which has the greatest resiliency.

Klic-Klac. An instructional aid consisting of two thin pieces of formica, which are attached to the strings on both sides of the tennis racket.

Organization of the Remaining Chapters

The study is organized into five chapters. Chapter II contains a review of the literature which is relevant to the present investigation. Chapter III describes the research methodology by which the study was conducted. Chapter IV includes the presentation and interpretation of the data, and a discussion relating to the study. Chapter V includes a summary, conclusion, and recommendations for future studies.
CHAPTER II

REVIEW OF RELATED LITERATURE

The primary focus of this study was upon subjects acquiring a particular tennis skill with the use of an instructional aid. Many factors influence motor learning, and in order to analyze the value of a tennis aid it is important to understand some specific factors which affect learning. The first part of the review of literature will focus on motor learning principles which apply to this study. The second part of the review will include instructional aids in tennis, and the third part pertains to tennis skills tests.

**Basic Motor Learning Principles**

There are numerous factors which affect the efficiency of motor learning and performance. It is beyond the scope of this review to include all motor learning principles. Factors which specifically relate to this study, feedback and kinesthesis, will be discussed.

**Feedback**

According to Marteniuk (21:13), feedback is a general, all-inclusive term referring to the information a performer receives
about the performance of a skill, either while he is performing it, or after the skill is completed. Information about feedback is received through any one, or combination of, the sensory systems.

Feedback may be either intrinsic or augmented and may serve three functions. It can provide knowledge, motivation, and reinforcement. According to Fitts (14:28), feedback is processed like information resulting from any other stimulus. It may also serve as a reward, providing extremely strong motivation to continue a task, since it relates to the distance between a present state and a goal. Since feedback sometimes operates as a source of reinforcement, it may be an important or even a necessary condition for learning. When it serves as a reinforcer, the occurrence of the stimulus serves to strengthen responses which are in close temporal proximity to it. In this sense, feedback, both intrinsic and augmented, serves as a powerful reinforcer in the learning of skills.

Intrinsic feedback is response-produced feedback that is supplied to the performer as a natural consequence of the movement itself. When one balances on one foot, for example, information arising from the muscles and joints of the weight-bearing limb provides kinesthetic cues about the rate of movement and location. At the same time, information from the eyes and middle ear arises as a consequence of the motion. This kind of feedback arises naturally from any response of the organism and is not dependent on external cues from the environment (11:28).
Augmented feedback is the provision of special information which is ordinarily not present in a task; it is extrinsic to the individual and takes the form of either verbal information by an instructor or an external stimulus (26:413). Drowatsky (11:89) states that the primary purpose of augmented feedback should be to call attention to the critical, intrinsic cues and to aid the student in properly using them as a guide to performance.

The basketball jump shot, for example, may be practiced with only intrinsic feedback, or the performer may receive augmented feedback to supplement intrinsic feedback. When students execute a jump shot, they receive continuous feedback regarding their body movements during the shot. They also see the results of their movements — the ball goes into the basket or misses the basket in a particular direction. In this example only intrinsic feedback is utilized, that is, all the feedback is inherent in the task. Sage (30:414) further states that augmented feedback may be provided by an instructor who may give specific information about why errors in shot direction occurred or who may simply say, "Excellent shot," if the ball goes into the basket.

Augmented feedback may also be provided in other ways. In order for learning to continue, an instructor or instructional aid may serve to provide learners with feedback regarding the consequences of their behavior. Various aids such as videotape, films, and "gimmicks" have been used as instructional aids to augment information to learners (30:415).
**Intrinsic Feedback**

Fortunately, many tasks supply intrinsic feedback during and/or immediately after the response is made. Such tasks as kicking a soccer ball or serving a tennis ball provide feedback as a consequence of the actions. When a soccer ball is kicked, the ball either goes into the goal or misses in one direction or another. Proprioceptive feedback supplies data regarding the body movements which are associated with varying degrees of deviation. The tennis serve either hits the net, goes out of bounds, or lands in bounds. Thus, the learner can immediately feel and see what the consequences of the movements are (30:415).

Although the precise roles that the various sensory systems play in providing intrinsic feedback for learning have not been determined, there is good evidence that they play a prominent role. Learners commonly receive visual and auditory information about the success of their responses, but they also receive feedback concerning the amount of force applied, locations of limbs, body postures, and pressure exerted via the proprioceptors. Although neurophysiological evidence is unclear about how and to what extent these receptors provide feedback, there is good evidence that they are a rich source of information to the student (30:415).

Adams (1) suggests that intrinsic feedback via the sensory systems is important for developing accurate pursuit rotor tracing which in turn is responsible for making corrections and structuring appropriate motor responses. It also appears that early motor learning is
primarily under visual control, with control gradually shifting to
kinesthesia as learning progresses. Fitts (14:29) states:

Visual control probably is very important while an
individual is learning a new perceptual motor task.
As performance becomes habitual, however, it is
likely that proprioceptive feedback or "feel"
becomes the more important.

Augmented Feedback

Augmented feedback has been found to enhance learning and
performance. Even if the task itself supplies feedback about the
subject's performance, supplemental information frequently enhances
learning. Reynolds and Adams (27) found that on a target-pursuit
task in which subjects could see whether or not they were on the
target, additional information in the form of a clicker, which
sounded when the subjects were on the target, clearly enhanced learn-
ing and performance on the task. The clicker was especially helpful
later in practice, when the subjects were able to remain on the
target for long periods of time.

Smode (34), using a tracking task in which subjects learned to
keep a randomly varying needle centered by rotating a dial, found
that performance was greatly enhanced with augmented feedback. In
discussing augmented feedback, Sage (30:417) cites the works of Fitts
and Leonard. Fitts and Leonard found that augmented feedback in the
form of a continuous series of clicks at the rate of two per
second enhanced performance in a timed perceptual task. Robb (28)
investigated the course of learning an arm movement pattern under
varied conditions of feedback. She found that the group which
received the greatest variety of feedback produced the most effective learning pattern.

The studies mentioned above would lead one to believe that augmented feedback always enhances motor learning and performance, but this is not the case. There is evidence reported by Bilodeau (5) indicating that when sufficient feedback is inherent in the task, the use of additional feedback does not further affect the acquisition or performance of the motor task.

**Auditory Augmented Feedback**

The literature in the area of auditory feedback in teaching tennis or any other skill appears to be lacking. This investigator was unable to find much research dealing with the influence of sound on learning a motor skill.

In discussing auditory feedback, Ferrell (13:20) makes reference to the work by Kincade who tested the effectiveness of augmented feedback (auditory clicks) in a gunnery track test. His hypotheses were that if the fundamental feedback and discernible signals were clear, subjects would use the augmented feedback as confirmation of their behavior, whether adequate or inadequate; and secondly, when augmented feedback was used where the fundamental information was obscure, subjects would supplement this feedback with the augmented feedback. From these hypotheses he predicted that in the former instance the removal of the augmented feedback following training would not result in performance deterioration. When subjects used the auditory feedback in place of the obscured fundamental feedback, however, there
would be deterioration in performance. His data gave significant support to the hypotheses. He noted that caution must be used in presenting auditory feedback; although when judiciously used, it could be a most useful training variable. He suggested that for the most permanent effects the fundamental cues must be clearly discernible to the subjects.

Reynolds and Adams (27) also studied the effects of augmented feedback in pilot training. They found that the effects of click reinforcement on the acquisition of skill led to a stable superiority in performance. They concluded that the effects of auditory feedback were similar to the effects of Thorndike's reinforcement theory. Although the clicks provided additional motivation, the continued superior performance level upon removal of the clicks showed that learning had taken place.

Smode (34) tested the hypothesis that a high amount of achievement information feedback (defined as feedback which tells a subject how his performance conforms to some objective reference) would result in superior performance, as compared to a low amount, by increasing the motivation of the subjects. Stating that most studies have shown the effect of information feedback to be significant to performance but not learning, he also found that augmented information feedback significantly facilitated performance. One other finding of his study indicated that the high amount of feedback provided the best training. Smode felt that this could be identified as a learning effect, but that the "carry-over-of-motivation" hypothesis was also involved.
A study by Small (35) involved learning to deliver a bowling ball at a specified velocity equal to 70 percent of the student's maximum velocity. He found that precise quantitative information feedback resulted in significantly higher performance levels than when less precise qualitative information feedback was available. This study is supported by other studies which found that feedback which is more precise is of more value in learning than feedback which provides only a general measure of performance. One such study was conducted by Bennett (4) who found that learning appears to be facilitated by specific reinforcement.

The study by Noble and Noble (24) was the only one which relates specifically to the purpose of this investigation. They were concerned with the learning of a pursuit tracking under three experimental conditions: visual feedback, auditory feedback, and visual plus auditory feedback. The pertinent results were: (1) visual feedback was significantly superior to auditory feedback, and (2) visual plus auditory feedback was not significantly different than visual feedback.

Timing of Augmented Feedback

In discussing the frequency of augmented feedback, Sage (30) questions whether the augmented feedback should be administered after every performance or intermittently. Specifically, is the total number of feedbacks in a set of performances more important than the proportion of performances on which feedback is given? In
attempting to answer these questions, he cites Bilodeau and Bilodeau (6) who compared the learning rates of four groups that received feedback after every trial, and after every third, fourth, or tenth trial while performing a linear positioning task while blindfolded. Results indicated that performance improved only on the trials immediately following the presentation of knowledge of results.

Also, when they plotted the error scores for only the responses that followed knowledge of results (KR), the responses were almost identical for the four groups, indicating that no learning took place during trials without knowledge of results. The implication from this study is that it is the actual number of KR provided that determines rate of learning, and that the proportion of performances on which feedback is given is unimportant for learning. That is, whatever the distribution of KR, non-KR trials neither hinder nor facilitate the learning produced by KR trials. In support of this finding, Sage (30) also cites the work of Taylor and Noble (37) who taught subjects to respond to the Selective Mathometer, using 100, 75, 50, and 25 percent knowledge of results. They reported that 100 percent knowledge of results groups displayed the most efficient skill acquisition. It was also reported that with early withdrawal of knowledge of results, the subjects were slightly more susceptible to cessation of performance.

**Kinesthesia**

The sensory receptors which reside in the muscles, tendons, joints and vestibular apparatus signal information about the type of movement, amplitude of movement of body parts, and the over-all
orientation of the body to gravity. These sensory receptors, collectively known as the proprioceptors, are constantly active and normally serve as an important source of information during motor behavior (30:295).

The perceptual experience that is presumed to arise from the proprioceptors is called kinesthesis. It is assumed by physical education teachers and coaches that kinesthesis is important in motor learning and performance. Instructors and coaches frequently attempt to get students to use kinesthesis as a cue while learning and performing motor tasks. Students may be asked to concentrate on "getting the feel" of the correct movements as they are performed, or they may be placed in correct beginning and ending positions for a given task and asked to "sense" the limb angulations and muscular contractions (30:295).

The following are some definitions offered by authorities explaining kinesthesis. Scott (31) defined kinesthesis as the sense which enables us to determine the position of segments of the body, their rate, extent, and direction of movement, the position of the entire body, and the characteristics of total body motion. According to Magruder (23), kinesthesis is (1) the ability to recognize muscular contractions of a known amount, (2) the ability to balance, (3) the ability to assume and identify body position, and (4) the ability to orient the body in space. Phillips and Summers (26:456) referred to kinesthetic perception as "the conscious awareness of the voluntary movement."
Relationship of Kinesthesia to Motor Performance

Phillips and Summers (26) reported a relationship between the acquisition of bowling skill and kinesthesia and felt that kinesthetic sense was more important during the early stages of skill learning than later. This finding is in conflict with other research and probably comes from their use of a skill involving a familiar arm movement and the resulting transfer. This interpretation is supported by their finding that the preferred arm has more kinesthetic sensitivity than the nonpreferred arm.

Contrary to the findings of Phillips and Summers are those of Fleishman and Rich (15). Using a two-hand coordination task, they observed that sensitivity to proprioceptive cues was of greater importance later in perceptual-motor learning. This finding appears to be more consistent with the over-all trend in the literature.

Drowatsky (11:184) cites several studies which have reported little or no relationship between kinesthesia and motor learning. Rollo compared the effectiveness of teaching beginning golf skills by the traditional method with instruction through kinesthetic perception. She observed no difference between the two approaches of instruction. After evaluating simple and complex motor learning tasks, Hill reported that kinesthetic tests had zero correlation with both types of learning. Likewise, Sisley (33) reported a negligible relationship between kinesthesia and one's skill level in basketball, bowling and tennis. Finally, a study of elementary school boys and girls by Witte (40) showed no relationship between ball-rolling skills
and kinesthesis. Drowatsky (11:184) points out that there is no documented basis for the use of kinesthesis as the primary, initial teaching technique. It appears to be of greater value once the initial acquisition of the task has been accomplished. Jordon (18) reported that withholding visual feedback in the early learning stages of a motor skill requiring responses to proprioceptive feedback, produced significantly faster reaction times at the .01 level. Total response times were also significantly faster at the .05 level. He further concluded that visual feedback tended to be dominant in the brain in the early stage of learning, but once the skill was learned, the proprioceptors produced faster responses.

**Using Kinesthetic Cues in Teaching**

According to Sage (30:315), when kinesthetic cues are used as the primary teaching technique, it poses some rather serious difficulties. First, it is not completely clear to what extent kinesthesis is used, or is capable of being used by the learner. Second, there is such a bewildering number of proprioceptive signals impinging upon the learner prior to execution, during execution, and immediately after execution of a movement pattern, that it may be difficult to select the appropriate kinesthetic cues for attention in any of these periods. Third, there is lack of evidence to support the notion that an emphasis on the utilization of kinesthetic cues will result in improved performance.

However, there are some techniques which have been utilized in an effort to enhance motor learning through kinesthesis. In most
cases they have not been proven to be detrimental to skill acquisition and therefore teachers may wish to experiment with one or more of them.

One approach to enhancing skill acquisition through kinesthesia has been a manual manipulation technique in which learners relax as they are guided through the movement pattern. The assumption is that as learners are guided through the movement, the proprioceptors associated with the movement will be activated and will provide the learners with correct cues. Sage (30:316) cites Smith who has suggested that manual assistance helps learners to "get the feeling of the proper movement." This view is not supported by Drowatsky (11:184) who says there is little support for this claim and there is some reason to be suspicious of it, since the passive movement of body segments does not produce the same pattern of impulses as active movement and thus feedback is distorted. He believes more research is needed to find out the effectiveness of this procedure.

Another technique which has been tried employs an emphasis on "feel." The learner is repeatedly told to "feel the position" or "feel the movement." Experimental support for this method is non-existent. In one closely related study, an experimental group was taught bowling by the "kinesthetic-centered" method while a control group was taught without kinesthetic emphasis. Results showed no significant differences in bowling performance between groups (30:316).

Sage (30:316) further states there are a few limited situations
in teaching sport skills which lend themselves to an emphasis on feel, such as the preliminary and terminal positions in the baseball, golf, and tennis swings, gymnastics stunts, and others. Since correct preliminary and terminal positions in these tasks are important to proper movement execution, this approach helps learners to perfect these positions. In the above situations, students may be aided by learning the "feel" of these positions as they attempt to achieve the correct preliminary and terminal "feel" and thus perhaps execute the movement correctly.

Instructional Aids

Teaching aids have been an important part of sound tennis instruction. The purpose of these aids has been to motivate the students, to insure maximum effectiveness of the instructor, to simplify group teaching methods, and to accelerate the individual's mastery of the skills (2:36).

Ball Machine

An instructional aid which is very valuable in learning the forehand drive is reported in a study by Solley and Borders (36). They concluded the following information in regard to the Ball-Boy teaching machine: (1) Teaching machines which aid in standardizing and controlling speed and direction of balls are highly valuable in teaching specific skills in beginning tennis classes, and in normal-sized classes such machines aid significantly in achievement in these skills. (2) If traditional techniques are to be rotated
with such techniques reinforced by use of a machine such as the Ball-Boy, it is more effective to emphasize traditional techniques first and then add practice with the Ball-Boy. (3) It is possible, when speed and direction of balls is controlled with the machine, that students will develop habits which hamper performance in actual game conditions requiring a much larger variety of footwork patterns.

**Stroke Developer**

The stroke developer is an instructional aid and practice device consisting of a tennis ball suspended on an elastic cord which hangs from an overhead attachment, usually from a fence, and attaches to a base at the bottom. The stroke developer can help the student practice ground strokes from a number of starting positions. For the teacher with large classes and limited space, it becomes a means of involving more students in active practice and eliminates much of the standing around and waiting for a turn.

Other advantages of the stroke developer are that it (1) allows the student to practice a given stroke again and again until mastered without worrying about timing, (2) provides the novice with a quick method of feeling how to hit the ball correctly, (3) provides faster learning for the student because he practices a precise stroke, (4) gives advanced players an opportunity to correct errors as well as to practice footwork and strokes, and (5) makes demonstrations, explanation, and correction easy to give on the spot (41:38).
Tethered-Rebound Ball

This is a device that allows rallying with either the forehand or backhand strokes. It consists of a tennis ball attached to a length of elastic cord which is attached to a base that is located by the hitter. After the ball is hit, it returns on a bounce to the hitter to be struck again. The tethered-rebound ball replaces the backboard to a certain extent, but it provides more realistic practice when used across the net. It may be used on almost any level surface at school or at home. When used correctly it can develop hand-eye coordination, timing, and early backswing, footwork, and stroking ability. It also provides the teacher with another station and lends variety to the program (41:39).

Rohland (29) found no significant differences at the .05 level on the post-tests between the control group and the group utilizing the stroke developer and tethered-rebound ball. It is interesting, however, that he indicates "relative success for the experimental groups and the use of the aids with respect to the student's performance."

Shorty-Racket

The purposes of a study by Tatje (38:37) were to determine whether using a short-handled tennis racket facilitated the acquisition of basic tennis skills at the beginner's level and to determine the effect upon transferring to the standard racket. For the specific group of beginning freshmen high school girl tennis players, the following conclusions were evident: (1) The short-
handled racket facilitated the acquisition of tennis skill. The short-handled racket proved to be significantly better than the long racket for rallying. (2) Transferring rackets impaired performance. Subjects transferring to the short racket became better than those who continued with the long racket. Subjects transferring to the long racket performed the poorest relatively, so prior practice with the short-handled racket did not apparently facilitate performance with the standard racket. (3) Practice with the short racket appeared temporarily facilitating but was apparently detrimental to later use of the standard racket. The work of Koch (19) substantiates these findings.

Rebound Nets

Koch (19) reports that rebound nets have been another instrumental device for sound tennis instruction. The portable nets have had many advantages over the traditional backboards. The rebound nets have eliminated the noise, allowed better timing by lengthening the rebound interval without reducing the velocity, have allowed all shots to be practiced by making it possible to adjust the angle of the net, and have increased the number of participants by allowing students to hit on both sides of the net.

Rac-A-Bat

Barta (2:36) recommended another instrumental piece of equipment, the Rac-A-Bat. This instructional aid, similar to a paddle, has been proven to be an effective shortcut piece of equipment for learning
all the basic tennis strokes. There were four sound reasons given for the use of the Rac-A-Bat in beginning tennis classes. First, the beginner immediately learns the proper grip since the flat shape of the handle makes it very difficult to be held incorrectly. It was designed to insure a firm grip for the player. Second, the beginner learns control immediately. The Rac-A-Bat has very little resiliency, so the students are able to control the shots. Third, the beginner is able to achieve the feel of the stroke. The Rac-A-Bat is 12 inches shorter than the standard racket, but it is approximately the same weight. With a shorter handle, a player can control the shots and develop the ability to successfully rally the ball. And fourth, the player is forced to move to the ball. Due to the shorter handle, a player is no longer able to reach out for the ball, but he is forced to go to the ball, position himself, and swing away.

Audio-Visual

Hupprich suggests that still pictures and film be utilized in presenting motor activities. In discussing the merits of such techniques, she states:

Visual instruction has always had an important place in the teaching of physical education activities. Methods, devices, and techniques are usually viewed from the standpoint of their economy and effectiveness. The relationship of auditory perception (oral instruction) to visual perception (visual instruction) has a definite application to the teaching of such motor skills as tennis strokes. Their use is fundamentally tied up with efficiency in learning (17:94).
**Skills Tests**

The two most commonly used tennis skills tests for determining efficiency in the ground strokes are the Dyer and Broer-Miller tests. There are other tests used in the field, such as the tests designed by Hewitt (16) and DiGennaro (10), but most of them are variations of either the Dyer or Broer-Miller test.

**Dyer Test**

The Dyer test consists of striking a ball against a backboard at a distance of at least five feet, and scoring as many hits as possible above a three-foot line within the time limit of thirty seconds. The procedures state it is not necessary to allow the ball to bounce on the ground after it has been put into play.

The initial study used 736 subjects from representative women's tennis groups in 19 colleges. Validity of the test was determined by two methods: correlating the test scores with judgments of three experts, and correlating the test scores with standings of the subjects in a number of round-robin tournaments. A coefficient of .85 was obtained in the first study and coefficients ranging from .85 to .92 were obtained in the second validity study. Reliability of the test was determined by the test-retest method, which resulted in a range of coefficients from .86 to .92 (12).

This study showed high reliability and validity coefficients with intermediate college women. It did not report any statistics for young beginners. This study was also designed to have the
subject either rally or volley the ball against the backboard using the backhand and forehand. Since Dyer failed to specify what shot(s) should be used, it is not clear exactly what skills she was attempting to measure. A subject could simply use a short punching motion to hit the ball. This technique is not recommended for good groundstrokes. A person rallying the ball against the wall at a distance of 20 to 30 feet will obviously not score as many points as the subject who is volleying the ball five feet from the backboard wall.

Hewitt (16:153) states:

The Dyer test does not discriminate sufficiently at the beginner's level. When comparing beginners and advanced level students in tennis, the Dyer test discriminates best at the advanced level, probably because this test measures better the advanced skill of volleying.

Broer-Miller Test

Because of apparent dissatisfaction with existing tests, Broer and Miller (7) designed their own test. They believed the test could be used as a grading device as well as to identify strengths and weaknesses in the forehand and backhand drives.

The test consists of the subject dropping the ball while standing in back of the baseline, and driving the ball close to the baseline on the opposite court, under a rope four feet above the net. The subject drives 14 balls using the forehand and 14 balls using the backhand stroke, receiving the point value of the area into which the balls land. The total score is the total points of the forehand and backhand drives. The reliability of this test for
the beginning group was shown to be .80. The validity of the test was computed by correlating the subjective ratings of the students by the instructor and two judges, with their performance on the test. Validity for the beginning group from the ratings of the two judges was estimated at .61, while the correlation between the instructor's subjective rating and the test was .66. Validity for the intermediate group was estimated at .85. The higher correlation of the instructor's ratings of the subjects and the test as compared to the two judges was found because the instructor was better acquainted with the students' abilities. Lower correlations are to be expected for the beginning groups due to the fact that beginners are less consistent (7).

Implications For Present Study

It is known that feedback generally enhances learning. An awareness of one's performance is important in learning, not only because of its inherent reinforcement values, but because it tends to motivate one to continue work on the task. Performance in any task is more meaningful when the learner is aware of his progress. Most of the time the awareness of one's performance comes from either verbalization, seeing the performance on audio-visual equipment, or from the proprioceptors. Perhaps auditory input can also significantly contribute to awareness of performance.
In view of the sparse work done on auditory feedback in motor performance, this study will serve to contribute to the body of knowledge in this area. Specifically, this study attempted to ascertain if the Klic-Klac instructional aid, which is based on auditory feedback, can effectively enhance the learning of the backhand tennis drive.
CHAPTER III

RESEARCH PROCEDURES

The purpose of this study was to determine the effectiveness of the Klic-Klac as an instructional aid in learning the tennis backhand drive. Included in this chapter will be a discussion of the selection of subjects, the experimental design of the study, the equipment used, the testing procedures, the Broer-Miller tennis test, the training program, and the statistical design.

Selection of Subjects

Subjects selected for this investigation were beginning tennis players, ranging from 8 to 16 years of age, with no previous organized instruction. Subjects were selected from the summer tennis clinic offered at California State University at Northridge. The subjects were allowed to select the days of the week to participate in the clinic (either Monday–Wednesday or Tuesday–Thursday), and this random selection resulted in two groups of 19 subjects each. The results of the Broer-Miller tennis pre-test indicated that there were no significant differences between the two groups. The role of the experimental phase of the tennis clinic was not emphasized. Subjects were merely told that the purpose of the Klic-Klac and the tests
were to motivate them to become better tennis students. With the control group meeting on days opposite those of the experimental group, questions regarding the disadvantages of not having a Klic-Klac did not arise in the control group.

**Experimental Design**

Following an introduction to the study, subjects were familiarized with the basics of the backhand stroke, and the objective of the Broer-Miller test. Once the pre-test was conducted, subjects were equated into two groups as described under selection of subjects. Group I was the experimental group and subjects used their own tennis rackets with the Klic-Klac teaching aid attached.

The subjects in Group I attempted to contact the ball on the center of the Klic-Klac. Every time they were successful in accomplishing this task, the device emitted a sharp, abrupt "klac." If the ball strikes somewhat near the Klic-Klac area, but not directly on it, the Klic-Klac will give off an unclear, muffled sound similar to a "klic." The difference between the two sounds is equally distinguishable.

The basic concept behind the Klic-Klac is that by using it in practice, the subject will learn to associate a well-hit ball with the proper sound emitted by the Klic-Klac. Learning to hit consistently in the area of the sweetspot will greatly improve one's ground strokes.
Subjects in Group II, the control group, used their own tennis rackets throughout the study. Subjects in each group received identical instruction, with the only difference being the experimental group had the Klic-Klac attached to their rackets.

The study lasted four weeks, with the subjects training twice weekly for one hour at the same time of day. This was followed with the post-test. Instruction was provided by four experienced tennis coaches, each working with five subjects in a group and testing was conducted by the investigator and the assistant coach.

**Equipment**

**Klic-Klac**

The experimental variable used in this study was the Klic-Klac teaching aid. This aid weighs less than an ounce, consists of two white circular-shaped pieces of formica measuring two inches in diameter, has a black center spot, and is attached to the strings of the racket at the sweetspot with four bolts and nuts. This teaching aid has been designed with the goal of enhancing learning and is manufactured by Amerray Company of Lake Tahoe, Nevada.

**Tennis Rackets**

Subjects in both groups used their own tennis rackets throughout the study. The proper grip size and weight of the racket was checked to insure that each student was playing with a proper-sized racket.
Figure 1
KLIC-KLAC INSTRUCTIONAL AID
Tennis Courts

The California State University at Northridge tennis courts were used in conducting this investigation. They are painted green and red with the proper dimensions and include a regulation net.

Tennis Balls

An ample supply of new yellow Penn tennis balls were used in the study. New balls were used for both the pre-test and post-test.

Testing Procedures

The Broer-Miller tennis test, with slight modifications, was thoroughly explained and demonstrated to all subjects prior to the pre- and post-tests. There were two variations of the Broer-Miller test. Instead of using the forehand and backhand, the backhand ground stroke only was used as the determining criterion of tennis ability. This was done because the backhand stroke is considered more of a novel skill than the forehand. It was surmised that subjects used in this study would have experienced more movements in life closely resembling a forehand drive in tennis than the backhand drive, and for this reason only the backhand was tested. The second variation consisted of increasing the number of balls hit from 14 forehand and 14 backhand to 20 backhand only. It was believed with young beginners performing a novel skill that 20 trials would be more appropriate.
Subjects were tested two at a time on separate courts, with the remaining subjects involved in non-related tennis activity. The tester placed himself across the net from the subject and to one side of the court. The testing procedures were conducted in the following manner:

(1) The subjects stood behind the baseline, in the middle of the court, and dropped each ball to themselves.

(2) The subjects attempted to hit 20 tennis balls, one at a time, over the net and under the seven-foot restraining rope as deep into the backcourt as possible. The balls were hit in succession with only a 3 to 5 second rest period between attempts. Let balls were taken over.

(3) In order to receive the appropriate values as illustrated in Figure 2, balls had to be hit between the top of the net and the rope and land in the designated area or on the lines bounding the area. Each ball hit was scored 2-4-6-8-6-4-2, depending upon the area in which it landed. Balls that went over the rope scored one-half the value of the area in which they landed. If the subject missed the ball in attempting to strike it, this was considered a trial and received no points. The subject's total score equalled the sum of the 20 balls on the backhand drive.

(4) The tester recorded the points earned for each trial on the score card (see Appendix A) and the subject was verbally informed of his performance after each backhand drive. The
pre-tests and post-tests were administered on the first and last days respectively of the clinic.

![Diagram of Court Scoring Areas](image)

**Figure 2**

**DIAGRAM OF COURT SCORING AREAS**

**Broer-Miller Test**

Although several skills tests are available, the criterion measure selected was the Broer-Miller test. The rationale for the selection of this test has been discussed in Chapter II under the skills tests section.

There were two reasons why a variation of the Broer-Miller test was used in this investigation. The variations used may be reviewed in Chapter III under the section of Testing Procedures. First, it is reasonable to expect beginners to perform the task of
hitting a self-drop ball across the net. Beginners would not be able to rally a ball against a wall, which is a more difficult task to perform. Secondly, hitting a self-drop backhand shot over the net and into a designated area resembles a stroke used in playing tennis and requires a greater amount of accuracy as compared to "punching" the ball against a wall with a three-foot restraining line, which is possible with Dyer's test. Therefore, it is the author's opinion that the Broer-Miller test is more discriminating, more specific to the game of tennis, more popularly used in the literature, and more adequately fits the need of this study.

The test called for some modifications to the tennis courts. Two poles were attached to each net post, with a rope strung between them seven feet above the ground. Since the Broer-Miller test calls for the ball to land in specific court areas, the tennis court was marked into seven scoring areas with string taped to the surface. Large numbers were written on paper and taped down in their respective scoring areas to facilitate scoring. (See Figure 2)

Broer and Miller reported a reliability coefficient of .80 for their beginning group. The validity of this test was also computed by correlating the student's performance on the test. Validity for the beginning group was estimated at .61 while the correlation between the instructor's subjective rating and the test was .66. In discussing these low figures, they stated:

Lower correlations are to be expected for the beginning groups due to the fact the beginners are less consistent. This partially accounts
for the higher correlation of the instructor's ratings of the subjects on the test, as he was better acquainted with the student's abilities. (7:312)

Training Program

The training program consisted of four weeks with each group meeting twice a week for one hour. The experimental group met on Tuesday and Thursday and the control group on Monday and Wednesday. Because of the clinic format, the forehand, backhand, and serve were taught in this order.

The following is an outline of what was taught and practiced during the eight meetings:

Day

1. (a) pre-test, (b) introduction of forehand including grip, stroke, footwork and contact point, (c) self-drop single shot drill.

2. (a) forehand self-drop, (b) feeder drill consisting of tossing the ball underhand to the subject, (c) ½-court feeder drill consisting of the instructor standing at ½-court and hitting the ball to the subject.

3. (a) backhand introduction including grip, stroke, footwork and correct contact point, (b) backhand self-drop single shot drill, (c) underhand toss feeder drill, (d) forehand footwork and ½-court rally.

4. (a) backhand and forehand self-drop drill, (b) ½-court backhand feeder drill off the instructor's racket, (c) backhand footwork needed to hit a moving ball, (d) forehand 3/4-court rally emphasizing footwork.

5. (a) backhand and forehand self-drop drill, (b) backhand 3/4-court rally, (c) introduction of serve including grip, stance, stroke, transfer of body weight, contact point and follow through.
6. (a) backhand and forehand self-drop, (b) backhand and forehand 3/4-court rally, (c) serving practice.

7. (a) backhand and forehand self-drop drill, (b) backhand and forehand full court rally emphasizing footwork, (c) serving practice, (d) teach how to keep score.

8. (a) post-test, (b) when finished with test, attempt to play a game.

**Statistical Design**

The t-test was used to determine if significant gains were made within each group. Analysis of covariance was used to determine if differences existed between the adjusted post-test means of Group I and Group II. The covariant used to adjust the post-test means was the pre-test scores.
CHAPTER IV

ANALYSIS AND DISCUSSION

The purpose of this study was to determine the effectiveness of the Klic-Klac as an instructional aid in learning the tennis backhand drive. The subjects were allowed to select the days of the week to participate in the clinic and this random selection resulted in two groups of 19 subjects each. Subjects of Group I had the Klic-Klac instructional aid attached to their rackets while Group II subjects used their own rackets without the Klic-Klac. Both groups were given a pre-test and post-test on the modified Broer-Miller tennis test.

The reliability of the Broer-Miller test was determined by the use of split-halves method. Odd and even scores were utilized in determining the split-halves correlation coefficient. Pearson's product moment correlation coefficients were calculated between odd and even scores for all subjects on both the pre-test and post-test. The Pearson product moment correlation coefficient was corrected with the Spearman Brown Formula (8:42). The reliability of 20 backhand drives used in the tests for all subjects in Group I, the experimental group, was .76 on the pre-test and .80 on the post-test. For Group II, the control group, the reliability was .82 on the pre-test and .80 on the post-test. All of the above-mentioned
correlation coefficients were significant beyond the .01 level of confidence.

Essential to the use of analysis of covariance is homogeneity of variance. To confirm this homogeneity the Hartley F-Maximum Test was conducted for the pre-test and the post-test. The F-Max ratios were as follows: pre-test 1.10 and post-test 1.01. With 18 and 18 degrees of freedom, a value of 2.24 was needed to be significant at the .05 level. Since both F-Max ratios reported above fell far below this value, it was judged that homogeneity of variance existed.

Analysis of Data

Table 1 includes the means, standard deviations, gains, and the results of the t-tests which were used to determine whether significant gains were made within each group.

The resulting t values indicate that significant gains occurred within both groups. With a t score of 5.53 and 18 degrees of freedom, Group I made gains which were significant beyond the .001 level. For Group II, the t score of 3.17 and 18 degrees of freedom indicated gains which were significant beyond the .01 level. It is interesting to note that the experimental group had gains which exactly doubled those of the control group.
### TABLE 1

**SUMMARY OF MEANS, STANDARD DEVIATIONS AND GAINS**

<table>
<thead>
<tr>
<th>Group I (Experimental)</th>
<th>Mean</th>
<th>S.D.</th>
<th>Gain</th>
<th>t Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>30.11</td>
<td>15.66</td>
<td>18.32</td>
<td>5.53 b</td>
</tr>
<tr>
<td>Post-Test</td>
<td>48.42</td>
<td>17.76</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group II (Control)</th>
<th>Mean</th>
<th>S.D.</th>
<th>Gain</th>
<th>t Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>39.32</td>
<td>14.95</td>
<td>9.16</td>
<td>3.17 a</td>
</tr>
<tr>
<td>Post-Test</td>
<td>48.47</td>
<td>17.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a* Significant at .01 level  
*b* Significant at .001 level

Analysis of covariance was conducted using procedures recommended by Clark (9). Table 2 indicates the F ratio of 8.47 with 1 and 35 degrees of freedom was significant beyond the .01 level. Although the final unadjusted post-test means were almost identical, 48.42 and 48.47, when the initial differences were accounted for, the experimental group was significantly better than the control group. The final adjusted mean for the experimental group was 51.9 and 45.0 for the control group. The difference between 51.9 and 45.0 was judged to be significant without a post-hoc test because there were only two groups in the analysis and the F-ratio was found to be significant.
It was conceivable that differences existed in the effectiveness of the two groups between male and female students, and between young and old female students. The analysis of the difference between mean gains in males and females in Group I, the experimental group, is summarized in Table 3. A t-test score of .89 with 18 degrees of freedom was far from the necessary value needed for significance at the .05 level. Because there were no males enrolled in the clinic on the days the control group met, it was impossible to make such a comparison within Group II.

### Table 3

**Comparison of Mean Gains Between Males and Females in Experimental Group**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Mean Gains</th>
<th>S.D.</th>
<th>m</th>
<th>diff.</th>
<th>t Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males 8</td>
<td>14.38</td>
<td>14.55</td>
<td>5.29</td>
<td>6.97</td>
<td>.89</td>
</tr>
<tr>
<td>Females 11</td>
<td>20.64</td>
<td>13.89</td>
<td>4.39</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The findings obtained from comparing the mean gains between older and younger females for both the experimental and control groups are summarized in Table 4. The results indicate that there were no significant differences between the two age groups.

**TABLE 4**

**COMPARISON OF MEAN GAINS BETWEEN OLD VS YOUNG FEMALES IN BOTH GROUPS**

<table>
<thead>
<tr>
<th>Group I (Experimental)</th>
<th>Subjects</th>
<th>Mean Gains</th>
<th>S.D.</th>
<th>diff.</th>
<th>t Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Females (13-16)</td>
<td>5</td>
<td>18.80</td>
<td>10.65</td>
<td>9.02</td>
<td>37</td>
</tr>
<tr>
<td>Young Females (8-11)</td>
<td>6</td>
<td>22.17</td>
<td>15.85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group II (Control)</th>
<th>Subjects</th>
<th>Mean Gains</th>
<th>S.D.</th>
<th>diff.</th>
<th>t Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Females (13-15)</td>
<td>9</td>
<td>11.67</td>
<td>15.50</td>
<td>5.25</td>
<td>1.01</td>
</tr>
<tr>
<td>Young Females (10-12)</td>
<td>10</td>
<td>6.40</td>
<td>9.40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Discussion

One statistic that was of major concern was the difference in pre-test means. The rather large difference of 9.21 might indicate that significant difference existed between the groups at the pre-test, even though the groups were randomly assigned. This mean difference resulted in a \( t \) score of 1.81 with 36 degrees of freedom. Since this score did not attain a value of 2.03, for the .05 level, it is concluded that the two groups did in fact come from the same population and were not significantly different. However, because mean gains for the experimental group were twice as large as for the control group, analysis of covariance was used to attempt to compensate for the pre-test differences.

It is interesting to note that when initial differences were not accounted for, and mean gains analyzed, the differences between the two groups were almost significant at the .05 level. This supported the decision to utilize analysis of covariance. However, when taking into consideration the initial mean differences through analysis of covariance, it was found that there was a significant difference between the two groups on the final adjusted post-test means. This supports the contention that sensory input, such as auditory feedback, does enhance learning. Sage succinctly states the role of feedback:

> It has been repeatedly emphasized that there are numerous factors which affect the efficiency of motor skill learning and performance. Certainly one of the most critical of these factors is feedback (30:411).
The study by Nobel and Nobel (24) indicated that the use of visual plus auditory feedback resulted in the best performance when performing a pursuit tracking task. The findings of Nobel and Nobel were supported by this investigation. This finding indicates that the combination of the subject both hearing and feeling when he had made correct contact on the sweetspot of the tennis racket, and then seeing the outcome of his shot, resulted in superior performance.
SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

The problem of this study was to determine the effectiveness of a teaching aid utilizing the principles of biofeedback in learning tennis ground strokes.

Subjects selected for this investigation were beginning tennis players, ranging from 8 to 16 years of age, with no previous organized instruction. Subjects were selected from the summer tennis clinic offered at California State University at Northridge. The subjects were allowed to select the days of the week to participate in the clinic (either Monday-Wednesday or Tuesday-Thursday), and this random selection resulted in two groups of 19 subjects each.

Group I was the experimental group, and subjects in this group used their own tennis rackets with the Klic-Klac teaching aid attached. Subjects in Group II, the control group, used their own tennis rackets throughout the study. The study lasted four weeks with the subjects training twice weekly for one hour at the same time of day.

The findings of this study indicate that there was a significant difference in favor of the Klic-Klac instructional aid in tennis
backhand performance between the groups utilizing the Klic-Klac instructional aid and those not using the Klic-Klac.

**Conclusion**

The null hypothesis used in this study was rejected. The following alternate hypothesis was accepted: the use of the Klic-Klac instructional aid resulted in significantly better performance on the backhand tennis drive for beginning students between the ages of 8 and 16.

**Recommendations For Future Studies**

As a result of this study the following recommendations for future study are made:

1. A similar study might investigate the utilization of intermediate tennis players. It is conceivable that once students have mastered the beginning skills, they might benefit more by auditory input.

2. Apply this experimental design with college-age subjects.

3. Design a study which would compare beginners with intermediates in a particular age group.

4. Future research might be conducted with a larger N and a longer experimental period.


APPENDICES
### APPENDIX A

**SCORE CARD**

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Test Scores</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>11.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>12.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>13.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>15.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>16.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>17.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>18.</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>19.</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>20.</td>
<td></td>
</tr>
</tbody>
</table>

Total _____

Total _____
APPENDIX B

RAW SCORES
### APPENDIX B

**INDIVIDUAL RAW SCORES FOR THE EXPERIMENTAL GROUP**

<table>
<thead>
<tr>
<th>Group I</th>
<th>Pre-Test</th>
<th>Post-Test</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.H.</td>
<td>33</td>
<td>62</td>
<td>29</td>
</tr>
<tr>
<td>L.M.</td>
<td>37</td>
<td>46</td>
<td>9</td>
</tr>
<tr>
<td>K.S.</td>
<td>28</td>
<td>62</td>
<td>34</td>
</tr>
<tr>
<td>J.B.</td>
<td>2</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>S.B.</td>
<td>28</td>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>F.B.</td>
<td>42</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>M.S.</td>
<td>4</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>K.W.</td>
<td>17</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>A.M.</td>
<td>51</td>
<td>63</td>
<td>12</td>
</tr>
<tr>
<td>J.F.</td>
<td>26</td>
<td>18</td>
<td>-8</td>
</tr>
<tr>
<td>J.J.</td>
<td>23</td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td>M.M.</td>
<td>53</td>
<td>75</td>
<td>22</td>
</tr>
<tr>
<td>C.N.</td>
<td>8</td>
<td>58</td>
<td>50</td>
</tr>
<tr>
<td>C.F.</td>
<td>24</td>
<td>60</td>
<td>36</td>
</tr>
<tr>
<td>L.F.</td>
<td>28</td>
<td>54</td>
<td>26</td>
</tr>
<tr>
<td>S.L.</td>
<td>47</td>
<td>56</td>
<td>9</td>
</tr>
<tr>
<td>T.A.</td>
<td>20</td>
<td>58</td>
<td>38</td>
</tr>
<tr>
<td>A.F.</td>
<td>47</td>
<td>46</td>
<td>-1</td>
</tr>
<tr>
<td>L.C.</td>
<td>54</td>
<td>75</td>
<td>21</td>
</tr>
</tbody>
</table>
APPENDIX B

INDIVIDUAL RAW SCORES FOR
THE CONTROL GROUP

<table>
<thead>
<tr>
<th>Group II</th>
<th>Pre-Test</th>
<th>Post-Test</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>L.C.</td>
<td>51</td>
<td>49</td>
<td>-2</td>
</tr>
<tr>
<td>P.T.</td>
<td>57</td>
<td>67</td>
<td>10</td>
</tr>
<tr>
<td>J.C.</td>
<td>63</td>
<td>70</td>
<td>7</td>
</tr>
<tr>
<td>L.S.</td>
<td>44</td>
<td>36</td>
<td>-8</td>
</tr>
<tr>
<td>C.M.</td>
<td>36</td>
<td>37</td>
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</tr>
<tr>
<td>S.W.</td>
<td>34</td>
<td>34</td>
<td>0</td>
</tr>
<tr>
<td>S.W.</td>
<td>52</td>
<td>65</td>
<td>13</td>
</tr>
<tr>
<td>R.E.</td>
<td>41</td>
<td>55</td>
<td>14</td>
</tr>
<tr>
<td>C.K.</td>
<td>26</td>
<td>23</td>
<td>-3</td>
</tr>
<tr>
<td>N.W.</td>
<td>20</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>E.A.</td>
<td>0</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>C.C.</td>
<td>44</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>L.B.</td>
<td>53</td>
<td>62</td>
<td>9</td>
</tr>
<tr>
<td>G.S.</td>
<td>45</td>
<td>40</td>
<td>-5</td>
</tr>
<tr>
<td>D.B.</td>
<td>38</td>
<td>75</td>
<td>37</td>
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<td>S.M.</td>
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<td>34</td>
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</tr>
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</table>
Memorandum

To: Dr. Charles Bearchell, Dean
Graduate Studies

Date: July 5, 1984

Subject: Master's Thesis Error

This memo is written to inform you that subsequent computer analysis of data has revealed a mathematical error in the Master's thesis of Mr. John David Munroe titled "The Effectiveness of the Klic Klac Instructional Aid in Learning the Tennis Backhand Drive", submitted in June of 1979.

On page 40 of the thesis, Table 2 indicates an F score for analysis of co-variance of 8.47, P<.01. The correct F score should be 2.21, P<.146. This difference would also change the conclusion from rejection of the null hypothesis to acceptance of the null hypothesis.

I am convinced that the error was inadvertent, and that there was no attempt to falsify data. Please note these errors in the library copy of the thesis so future readers will have correct information on which to base their evaluations of the study. I have made the appropriate corrections in the department copy.

WJV:cl

cc: David Munroe
    Eleanor Walsh
    Nick Breit
    Sam Winningham