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THE EFFECTS OF AUGMENTED VISUAL CUES ON THE PERFORMANCE OF GROUNDSTROKE CONSISTENCY FOR BEGINNING COLLEGE-AGE TENNIS CLASSES

The University of Arizona M.S. 1982

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THE EFFECTS OF AUGMENTED VISUAL CUES
ON THE PERFORMANCE OF GROUNDSTROKE CONSISTENCY
FOR BEGINNING COLLEGE-AGE TENNIS CLASSES

by

Steven Charles Cormier

A Thesis Submitted to the Faculty of the
DEPARTMENT OF PHYSICAL EDUCATION
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF SCIENCE
In the Graduate College
THE UNIVERSITY OF ARIZONA

1982
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This thesis has been approved on the date shown below:

[signature] Patricia C. Fairchild
Associate Professor of Physical Education

Date: April 19, 1982
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TABLE OF CONTENTS

| LIST OF TABLES                        | vi  |
| LIST OF ILLUSTRATIONS                | vii |
| ABSTRACT                              | viii|

CHAPTER

I. INTRODUCTION

Statement of the Problem                2
Hypotheses                              3
Definition of Terms                     4
Scope of Study                          5
Significance of Problem                 5

II. REVIEW OF LITERATURE

Feedback                                 7
Adams' Closed Loop Theory               10
Error Detection                         12
Intrinsic and Extrinsic Knowledge of Results 13
Concurrent and Terminal Feedback        14
Augmented Feedback                      16
Tennis Groundstrokes                     20
An Analysis of the Groundstrokes        24
Ready Position                          24
Grip                                     24
Backswing                               26
Point of Contact                        27
Followthrough                           28
Tennis Groundstroke Skills Test         29
The Miller and Broer Groundstroke Test  29
The Kemp-Vincent Rally Test             30
The Hewitt Revised Dyer Backboard Test  31

III. PROCEDURES

Subjects Participating in the Study     33
Design of Study                         34
TABLE OF CONTENTS—Continued

<table>
<thead>
<tr>
<th>Selection and Administration of Skill Tests</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hewitt Revised Dyer Backboard Test</td>
<td>36</td>
</tr>
<tr>
<td>Kemp-Vincent Rally Test</td>
<td>36</td>
</tr>
<tr>
<td>Visual Cues</td>
<td>37</td>
</tr>
<tr>
<td>Experimental Treatment Sessions</td>
<td>40</td>
</tr>
<tr>
<td>Method of Analyzing and Treating Data</td>
<td>42</td>
</tr>
</tbody>
</table>

IV. ANALYSIS OF DATA .................................. 44

Discussion ............................................. 51

V. SUMMARY AND CONCLUSIONS ......................... 56

Findings ............................................... 58
Conclusions ........................................... 59
Recommendations for Further Study ............... 59

APPENDIX A: HUMAN SUBJECTS CONSENT FORM .......... 60
APPENDIX B: QUESTIONNAIRE ........................... 62
LIST OF REFERENCES ................................. 64
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Group Means and Standard Deviation Scores for the Hewitt Revised Dyer Backboard Test</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>(Pretest, Post-Test and Post-Detraining)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and the Kemp-Vincent Rally Test (Post-Test and Post-Detraining Test)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Analysis of Covariance of the four classes</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Post and Post-Detraining Performance Scores</td>
<td></td>
</tr>
<tr>
<td></td>
<td>on the Hewitt Revised Dyer Backboard and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the Kemp-Vincent Rally Test, Using Pretest Scores from the Revised Dyer as the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Covariate</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Paired t Test for Post and Post-Detraining Tests Feedback Groups</td>
<td>50</td>
</tr>
<tr>
<td>4.</td>
<td>Paired t Test for the Hewitt Revised Dyer</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Backboard Pretest and Post-Test</td>
<td></td>
</tr>
<tr>
<td>Figure</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>1. Proper Ball Flight Pattern During Baseline to Baseline Rally</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>2. Hewitt Revised Dyer Backboard Test</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>3. Revised Kemp-Vincent Rally Test</td>
<td>48</td>
<td></td>
</tr>
</tbody>
</table>
ABSTRACT

The study compared the skill performance attained by University men and women (N=82) in learning forehand and backhand groundstrokes in four beginning tennis classes under three different augmented visual feedback devices (rope; covered net; and a combination of the rope and covered net). Three testing sessions were employed (pretest, post-test and a post-detraining test) using the performance scores on The Revised Dyer Backboard Test (1965) and the Kemp-Vincent Rally Test (1968) to compare the performance levels of each class. Although all groups except one improved (pretest to post-test) on the Revised Dyer Backboard Test, ANCOVA revealed no significant F ratios among the groups on any of the performance tests. Findings indicate that using augmented feedback in teaching forehand and backhand groundstrokes to beginning tennis players is no more effective than using the traditional teaching method.
CHAPTER I
INTRODUCTION

Since the mid-nineteenth century when education emerged as a modern profession, educators have sought to understand and facilitate the learning process. Over the past years, a multitude of teaching techniques have been introduced in attempts to develop protocols of instruction which were distinctly and reliably superior to randomly chosen methods of teaching. Within the field of education, motor skill learning has merited specific investigation. Here, researchers have sought answers to many basic questions: 1) Is one type of teaching method more effective than others? 2) Is one sensory modality, i.e., vision, auditory or proprioception more significant to the learning process than others? 3) Is one type of feedback more beneficial for the learning of motor skills than another type?

Most teaching situations have limitations: the number of class periods available for teaching a given unit, the length of the class period, the number of students in the class and the amount of instructional materials available. Given these limiting factors, it becomes an urgent matter for the teacher to find as many ways to facilitate learning as possible. By utilizing knowledge concerning the more efficient approaches to the teaching
of motor skills, the teacher should be able to maximize for each student the value of a given course in the limited time available.

Feedback has been recognized by educators to be of great importance to learning. For the purpose of this study, feedback in any source of information which conveys to the students information about their level of achievement in relation to a desired goal. Many researchers have contributed significantly to the body of knowledge concerning feedback, and their findings have been reinforced by the general opinion that students need to receive information concerning their responses in order to improve and ultimately to achieve their goals. Robb (1972) concluded that the physical educator's role is to help students recognize errors and then provide information which would help them to reduce or correct these errors. Many authorities believe that of all the factors that affect the learning and performance of motor skills, the most critical is feedback.

Statement of the Problem

The purpose of this study was to investigate the effect of augmented visual feedback on learning tennis groundstroke consistency. More specifically, the study was designed to compare the performance levels of individuals after an eight-week exposure to specific forms of augmented
visual cues. These cues consisted of three separate forms of net manipulation set up as follows: 1) a cover placed over the tennis net making the opposite side baseline invisible to the students; 2) a rope placed 3½ feet above the net, with the goal that all balls would be hit above the rope; 3) a court set up with conditions number one and two in combination and 4) a standard net and court situation used as a control condition.

Hypotheses

The following research hypotheses, tested at the .05 level of significance, were the basis for the statistical analysis of this investigation:

1) The post-test groundstroke performance scores of all experimental groups will be significantly greater than the control group.

2) The post-test groundstroke performance scores of the combination group (rope and covered net) will be significantly greater than those of the other two experimental groups.

3) The post-detraining performance scores will show no significant differences between the covered net group, rope group and the control group.

4) The post-detraining groundstroke performance scores of the combination group (rope and covered net) will be significantly greater than those of the other two
experimental groups and the control group.

5) The post-detraining groundstroke performance scores will be equal to or less than the post-test groundstroke performance scores of the four groups.

6) The post-test scores on the Hewitt Revised Dyer Backboard Test of the three experimental groups and the control group will be significantly greater than the pre-test scores for the groups.

Definition of Terms

For the purpose of this study, the following definitions were employed.

Beginning Tennis Players. Beginning tennis players were students enrolled in a beginning tennis class with little or no previous experience with groundstrokes.

Groundstroke. A ball stroked with either a forehand or backhand, after it bounces within the boundaries of the tennis court, would constitute a groundstroke.

Intrinsic Feedback. Information which is present in the usual form of the task as a result of ones own action. An example would be a tennis player who can feel the bail rebound off of the tennis racket.

Knowledge of Results. Used synonymously with feedback and abbreviated KR.

Augmented Feedback or Visual Cues. Information that is not usually available in the performance of a task.
It is supplemental information that is added by the teacher for training purposes. The types of augmented feedback or visual cues in this study include: 1) a covered tennis net, which forms a visual barrier, making the net appear as a greater obstacle; 2) a rope placed $3\frac{1}{2}$ feet above the net, which was placed there as a visual target over which to hit the ball and 3) a net set up with conditions one and two in combination.

**Scope of Study**

The subjects were beginning level male and female tennis players attending the University of Arizona. They had little or no previous experience concerning proper groundstroke mechanics. Their ages ranged from 18 to 23 years old. The students could not be randomly assigned to classes; however, experimental treatments were randomly assigned to the classes. The study was limited to eight weeks, which included thirteen learning sessions and three testing sessions. No attempt was made to control the subject's activities prior to testing. Therefore, factors such as fatigue, personal problems or motivation could have some affect on the results.

**Significance of the Problem**

While much research has been done on the use of feedback as an aid to the learning process, most studies
of feedback have dealt with some type of accuracy on fine, discrete and motor tasks; few studies on this topic have been conducted using gross motor skills. It also appears, from past studies, that early motor learning is primarily under visual control, with control gradually shifting to kinesthesis as learning progresses. Drowatzky (1975) and Rushall and Siedentop (1972) support the concept that vision is the primary sensory path in learning motor skills.

Visual feedback is available to participants in all sports. For example, the basketball player knows at once whether the ball has gone through the hoop, and the badminton player sees whether the serve lands in the correct service area. The perceptual motor process of judging results and then using the information to improve subsequent performance is part of the learning process.

More research is needed in the area of visual feedback. Particularly lacking are studies involving the effect of visual feedback on learning gross motor skills. For this reason, tennis groundstrokes were selected for analysis in the present study.

In summary, this study attempted to determine whether learning tennis groundstrokes would be aided with the use of augmented visual feedback. It was hoped that results of the study would help teachers to develop an effective tennis groundstroke teaching method which would facilitate optimum learning.
CHAPTER II
REVIEW OF LITERATURE

The review of literature was divided into two sections: 1) the use of feedback and its value in aiding the learning process and 2) tennis forehand and backhand ground-strokes as the particular skill chosen for this study.

Feedback

Learning is a very complex process with many factors affecting its outcome. Two of the factors affecting the learning process include the learner's attitude toward the learning and the motivational level of the learner. In learning situations that involve motor skills other factors are also influential in affecting the learning process. These factors include body structure and age of the learner and the fatigue level which may be experienced. All of these factors work interdependently. Therefore, it becomes the role of the educator to provide a learning atmosphere which offers students the opportunity to utilize their ability to the fullest in order to learn as much as possible in the limited time available.

Robb (1972) has defined feedback as "information that arrives constantly during, and as the consequences of one's own response, or that arrives as new information
input from external sources" (p. 93). A basketball player making a jump shot from the top of the key receives kinesthetic feedback and visual information during and after the shot as a result of his own response. Whereas, if the same player making the same shot uses some type of electronic device to shape his shooting style or pattern, this feedback device would be an external source, used in improving shooting styles.

Bilodeau and Bilodeau (1969) indicated that feedback served several purposes. It could be used for association building, strengthening the relationship between stimulation and the response made. It could serve as a cueing mechanism, serving as a selector guide to already learned patterns. It could serve as a source of motivation to the learner.

In addition, Bilodeau and Bilodeau indicated that feedback was the most important variable affecting one's learning and performance levels. They concluded that "without feedback, little or no improvement takes place. More specifically, they found that the use of feedback aids improvement, and upon its removal, the learner's progress deteriorates" (1961, p. 250). Atwater reported that "perfection of a skill will not necessarily result from mere repetition. In order for a skill to be learned, the subject must have some knowledge as to the correctness
of the response. Without this knowledge of performance, improvement is unlikely" (1965, p. 10).

Spaeth (1972) reported that performers used feedback to assess the effectiveness of their responses. If feedback indicated that the response was correct, the performer would repeat the response. If feedback indicated that the response was incorrect, the performer would alter the response. Beebe (1974) concluded that if the student received prompt and accurate knowledge of results, the response would reflect the benefits of this knowledge, and the performance would improve progressively.

Robb (1972) stated that during the learning of most tasks, knowledge of results or feedback is usually provided during the initial stages of learning. According to Atwater "The most efficient learning takes place when the skill is presented in an orderly fashion with each step leading in a specific sequence to the final goal. KR should be immediately available to the learner at each step so that he/she is aware of whether the response made was successful or not" (1965, p. 18). Beebe (1974) found that feedback was important during the early stages of learning. However, the use of feedback would not be beneficial if the goal of the motor task was too broad or if the sequence of learning patterns for the task was not uniform.

Additional studies have also been conducted on the effectiveness of different types of feedback. Robb stated
that "in the beginning stages of skill acquisition, the learner relies primarily on vision to guide the responses" (1972, p. 6). Spaeth concluded that "performers who have learned to utilize spatial-visual information efficiently showed the greatest level of improvement" (1972, p. 347). Drowatzky (1975), Rushall and Siedentop (1972) also supported the concept that vision is the primary sensory path in learning motor skills.

Lastly, Bilodeau and Bilodeau made the statement "without contradiction studies of feedback or knowledge of results show it to be the strongest, most important variable controlling performance and learning ..." (1961, p. 250).

**Adams' Closed Loop Theory.** Adams' Closed Loop Theory for motor learning is a two-state theory. The first state is the perceptual trace, which contends that a person develops a trace or image of a certain stimulus in the mind which accounts for specific stimulus recognition. Adams stated that "the ability to recognize a picture seen yesterday is recognition based on the arousal and matching of a perceptual trace of the stimuli that was imprinted when the picture was originally seen" (1971, p. 124). Therefore, the subject can recognize a response which he has made before when the feedback stimuli is matched with the perceptual trace laid down by the previous experiences.
The theory makes the assumption that all impinging stimuli operate in the same way.

The second main construct of the theory is called the "memory trace," whose role is to select and initiate the response, following the use of the perceptual trace. The memory trace must be cued to action, and the strength of it grows as a function of the practice trials.

Adams (1971) concluded that the learning of motor movements is not as simple as acquiring a perceptual trace and matching current feedback stimuli. When the subject is making errors early in learning, he is not responding on the basis of movements that he recognizes as having made before. This would cause him to repeat his past errors. For learning to occur, the subject must use KR to make the next response different from the previous ones. He must used the perceptual trace in relation to KR from experience, and adjust the response accordingly on the next trial. This early stage of motor learning is called the Verbal-Motor Stage.

The Verbal-Motor Stage comes to an end at an advanced stage of training when the error reported for KR has been acceptably small for some time, meaning that the correct response has been repeated for some time and its perceptual trace is strong. For continuing success at this advanced stage the subject need only recognize the present
movement as having zero error when it matches its perceptual trace. The subject can now ignore KR because on a trial he continues his movement until it matches the perceptual trace. Adams called this the "motor stage."

**Error Detection.** Evidence has indicated that error detection is mainly dependent upon the use of feedback from various receptors such as eyes, ears, joints and muscles. Since feedback is received through the various sensory systems, studies have been done to compare the effectiveness of using the different modalities for the reception of feedback. Many of the studies have focused on fine motor skills, and from these studies varying conclusions have resulted.

Schmidt and White's study (1972) supported the theory that subjects can develop a capacity to determine their own errors on the basis of a learned, internal error detection mechanism. If this is true, then the subjects could use their own error information as a substitute for the KR. Schmidt and White referred to this concept as subjective reinforcement. An advantage of subjective reinforcement would be that learners could provide their own KR; therefore, learning could continue even when the teacher is not present.

In Schmidt and White's error detection study, the subjects learned a simple task involving moving a slide a
distance of nine inches in an allotted time. After each attempt, the subject would guess how far he/she had moved the slide, and then the experimenter would tell the exact distance the slide had been moved. Schmidt and White examined the correlations between the subjective score (what the subject thought he/she had done) and the objective score (what the subject actually did) as a measure of strength of the error detection mechanism. As the subjects progressed from trial to trial, they became increasingly sensitive to the direction and magnitude of their errors. Schmidt stated "that if KR is no longer available through any of the various receptors, the learner can still compare the response with the perceptual trace, thus providing the basis for the error detection mechanism" (p. 94).

Robby concluded that the type of skill being learned determined which type of sensory input is most important. She said that "aiming tasks required good visual feedback, whereas tasks involving gross body movements can be improved more effectively with the application of good kinesthelic information" (1972, p. 100).

Intrinsic and Extrinsic Knowledge of Results

Intrinsic KR is defined as response produced feedback that is supplied to the performer as an inherent consequence of the performance. Extrinsic KR is another name for augmented feedback. It is information that is not
normally inherent in the task. Undoubtedly, task performance in many cases has to be performed without extrinsic KR. In these situations, the learner must shift the source of his/her error information from that of the teacher-provided KR (Extrinsic Feedback) to some form of self-generated error information (Intrinsic Feedback). The individual must learn to use the feedback information obtained from the senses and try to develop an error score that closely describes the actual performance.

**Concurrent and Terminal Feedback.** When feedback is being supplied while the performer is moving, it is said to be concurrent. When it is supplied after the performance is completed, it is called terminal feedback. In general, both concurrent and terminal augmented feedback has been found to enhance learning and performance.

In motor tasks in which intrinsic concurrent feedback can be used in a task performance, any delay, even a delay as short as a fraction of a second, seriously hampers, or even makes impossible, appropriate execution. K.U. Smith (1962) has demonstrated the effects of delaying concurrent visual feedback on motor activities. Employing complex television camera video-tape arrangements, Smith modified the visual feedback so that performers saw themselves doing tasks shortly after they were actually done. Time delays as brief as 1/5 of a second produced an entire breakdown of performance.
Terminal augmented feedback is that information which is provided to the learner after a trial or performance, and this commonly takes the form of KR. From an instructional standpoint, there is no compelling evidence for delaying feedback. The principle that information about the correctness of performance should be administered quickly has been used successfully in teaching a wide variety of verbal and motor tasks. While it appears the KR should be provided as soon as possible after a response is completed, if a delay must occur, the instructor need not be overly concerned because the delay will not have disastrous results (Fitts, 1951).

Studies by Adams, Goetz and Marshall (1972 and 1973) have shown that learning improves as the amount of feedback available during presentation increases. The types of feedback supplied were auditory, visual and kinesthetic. The studies indicated that the visual concurrent feedback was significant in both fine and gross motor skills as compared to terminal feedback.

Another study on the role of visual feedback in short term motor memory using a linear positioning task was done by Faust and Adams (1975). The study used 20 females and 40 males who were college students at Tulane University. Subjects were placed into one of four treatment groups which were classified as follows: 1) group received visual feedback prior to the start of the
movement, 2) group received no visual feedback prior to
the start of the movement, 3) group received visual con­
current feedback during the movement and 4) group received
no visual feedback during the movement. Results indicated
that visual feedback, either prior to the movement or
during the movement, did not produce better results than
absence of visual feedback. This experiment provided evi­
dence contrary to Adams' Closed Loop Theory of motor learn­
ing, indicating that subjects did not rely on a perceptual
trace to aid their performance, nor did they rely on con­
current augmented feedback.

Augmented Feedback. Augmented Feedback is the pro­
vision of special information which is not ordinarily
present in the task. It is extrinsic to the individual
and takes the form of either verbal information by an in­
structor or an external stimulus, such as a feedback cir­
cuit from a machine, which supplements the feedback ob­
tained from the senses.

Howell (1956) studied the effect of providing
visual feedback to subjects by showing them force-time
graphs after each trial of a sprint start. A control
group did not receive this information. The results showed
that the experimental group successfully learned and im­
proved its speed and momentum whereas the control group
did not.
Bell (1971) conducted a study comparing the effects of visual and verbal feedback upon the acquisition and retention of a handball toss skill. College women were used as subjects. The subjects were placed in one of two treatment groups. The visual group members could see whether their actions were correct or not. The verbal group members were blindfolded and received verbal feedback as to the correctness or error in their responses. There were no significant differences in performance levels between the two groups on the pretest, post-test or the retention test.

In another study, Bell (1968) manipulated the visual cues available to subjects as they learned the long serve in badminton. Her study involved three experimental groups and one control group randomly selected and assigned into four badminton classes. The groups were further subdivided on the basis of sex. Subjects were 42 males and 36 females.

The same test was administered as a pretest, post-test and a retention test over the course of the study which lasted 10 weeks. All groups were given the same instruction related to the badminton serve following the pretest. Mechanical principles related to force production and accuracy were visually and verbally demonstrated, providing the subjects with information useful in correcting errors. The feedback device used in the study, for the
treatment groups, consisted of a 15 foot high restraining rope. The subjects used the rope as a target to aim for during the twenty trials, where the outcome of each trial was recorded and revealed to the subject either concurrently or terminally, depending on the treatment group. Bell concluded that "where sufficient KR is inherent in the task, the direction of practice through the use of additional KR does not further affect the acquisition or retention of gross motor skill at the beginning levels of performance" (p. 29).

Robertson (1972) analyzed group feedback conditions as well as individual feedback in learning the basic skills of volleyball. The results indicated that feedback provided concurrently or on an individual basis immediately following the various trials was significantly better than a treatment where no augmented feedback or only group feedback was provided.

James (1971), in a study comparing verbal instruction to visual instruction using video feedback in learning trampoline skills, found that the group receiving the visual feedback had better scores, but that the differences between means were not significant.

Gray and Brumback (1967) investigated the use of motion picture film in learning badminton skills. The subjects in the experimental group viewed film loops showing
a skilled player executing the basic badminton strokes. The control group received no visual feedback. At the end of ten weeks of instruction, there were no differences in performances between the two groups.

Lloyd (1968) studied the effect of audio and visual feedback, presented via super-8 slow motion pictures, on the learning of forehand and backhand drives in tennis. Results showed that viewing super-8 slow motion pictures during the middle stages of instruction appeared to aid in the learning of tennis skills; however, viewing the pictures in other stages, beginning and advanced, did not aid in learning and performance of the strokes.

Tesch (1972) completed a study on the effect of visual aids versus conventional instruction on learning gymnastics skills. Analysis of variance statistical treatment indicated that there were no significant differences among the groups.

Johnson (1961) studied the effects of augmented feedback upon the learning of tennis groundstrokes. No differences were found between the groups following the post-test.

Feedback or KR appears to be a factor affecting the learning process under some circumstances and with certain kinds of learning and skills. Whitehill (1964) suggested that the greater the amount of feedback a subject
received, and the more varied these types of feedback, the greater the amount of improvement that could be expected.

Although there does not appear to be one particular perceptual mode through which feedback produces the best results, most researchers feel that during the early stages of learning, visual feedback is the most beneficial. Studies conducted in this area also suggest that some type of feedback or KR during the learning process was a worthwhile supplement to traditional demonstration methods of teaching physical education classes. Fitts (1951, pp. 1323-24), concerned with the role of visual and proprioceptive feedback, stated "... visual control is important when an individual is learning a new perceptual motor task. As performance becomes habitual, however, it is likely that proprioceptive feedback or feel becomes more important."

In summary, the studies reviewed indicated that feedback is used to compare present behavior to a reference response or movement pattern and allows the individual to correct his/her response. Consequently, if the student learns how to use feedback, more correct responses can be made.

Tennis Groundstrokes

It may be that, psychologically, beginning and low intermediate players visualize the tennis net as being of little consequence, therefore, less of an obstruction than
it really is. This perception reinforces one of the most prevalent myths destroying good tennis: the concept that tennis balls should be hit on a horizontal plane, with hard, line drive shots. Professional tennis players, on the other hand, have an entirely different approach. They know that tennis is not just a driving game, but a lifting game; that to hit the ball hard and still make it come down inside their opponent's court, they must develop an ability to hit underspin or flat balls clearing the net by a foot or two, which is very difficult when balls are hit hard. The majority of professionals, however, develop the most consistent net clearing strategy of all, a topspin drive, which clears the net by four to six feet and lands deep in the opponent's side of the court, when both players are rallying from the baseline (Braden, 1977).

Undoubtedly, hitting the tennis ball over the net would not be a difficult task if it were not for the requirement that the ball land inside the opponent's court. How to keep the ball from going out of the court or into the net is a technical problem involved in hitting groundstrokes. Understanding some of the physical laws which govern the flight of a tennis ball makes it easier for the beginner to appreciate what is being taught. Bernoulli's Principle is one such law. It states that in any horizontally moving fluid the pressure increases as the velocity
decreases. Air is a fluid that moves horizontally in respect to a tennis ball moving from one side of the net to the other. The pressure of that air on the ball affects its flight. When the ball is hit with topspin the relative velocity of air will be least at the top of the ball, creating a high pressure zone there. Thus, in accordance with Bernoulli's Principle, the higher pressure will tend to push the ball toward the ground.

A smooth low backswing and high follow-through is the key to achieving topspin, and should be the first component taught for this stroke. Gallwey (1974) observed that most of the bad habits which players accumulate in their groundstrokes are caused by their trial and error attempts to keep their shots from hitting the net or sailing out of bounds. Contrary to common sense, it is a low backswing which helps to keep groundstrokes from sailing out. If a player takes his racket back below the level of the ball to produce medium topspin, it frees him from the need to complicate his stroke with other devices for controlling the ball flight.

The stroke mechanics for this increased arc are put forth by Blagenhoef (1970) who contends that for the novice to hit in an arced flight pattern, the racket face, for this low to high stroke must be held firmly at the desired angle at impact. To get the ball to move upward, the racket
face must be aimed at the top of the net, also the slower the follow-through the more the racket face is opened upward. The racket face angle is maintained as long as it is comfortable, before and after impact, to assure accuracy.

According to Braden to impart topspin on the forehand or the backhand, you must contact the backside of the ball with a racket head that is vertical at impact and traveling from low to high in the direction of your target" (1977, p. 29). When the racket face brushes against the ball, the ball is lifted up until gravity and air pressure on top of the ball begin to generate the downward force that produces a rainbow arc.

Barnaby (1969) contends that a high arcing drive is nothing more than a low forward lob. Many players do not realize this; their mental picture of a drive is a horizontal line from their racket to the court beyond the net. "This novice conception ignores the physical laws of gravity, that the ball must rise to miss the net and then must arc down if it is to strike the court. The idea of the low lob takes these factors into account. One merely thinks of lobbing three to six feet above the net instead of twenty to thirty feet above it" (pp. 88-89). This likening of the drive to the lob is a method of getting pupils out of that most common of all faults in tennis; hitting the net. Once they start lobbing they are aiming away from the net
so they stop hitting it. While this produces low velocity tennis at first, it also produces sound consistent stroking and aiming, and playing harder and lower is comparatively easy to acquire later on. An illustration of the proper ball flight pattern recommended by Braden is presented on Figure 1.

**An Analysis of the Groundstroke**

This section contains mainly forehand analysis, however, many of the points carry over to the backhand as well.

**Ready Position.** The first component involved in hitting proper groundstrokes is the ready position, by definition, (Plagenhoef, 1970) a body position that facilitates immediate reaction to the ball as it leaves the opponent's racket. The ready position is attained by spreading the feet slightly beyond the hips, with the knees slightly bent and the body weight shifted towards the balls of the feet. The elbows are slightly forward of the hips, with the racket head placed dead center, pointing upward and across the net. The non-racket hand should be placed on the throat of the racket.

**Grip.** For grips Degutis stated that "the hand is either positioned in the Eastern Forehand or Eastern Backhand grips. Emphasis, however, is on spreading the fingers
Figure 1

Proper Ball Flight Pattern During Baseline to Baseline Rally.
and palm across the surface and behind the racket handle to secure more control and so that the racket face is thought of as the hand surface extended" (1966, p. 89).

**Backswing.** According to Plagenhoef "the backswing is started as soon as the opponent hits the ball" (1970, p. 10). For a right handed player, the movement of the racket is initiated with the left hand (which should be located at the throat of the racket via the ready position), and turning of the correct foot (right foot for the forehand and left foot for the backhand) must occur simultaneously. Degutis (1966) contends that the left hand is in control until the racket is about halfway back (this helps to rotate hips and shoulders). At this time the face of the racket should be fairly perpendicular to the ground. The direction of the arm during the backswing should not be high and looping as Braden (1977) recommends, but straight back. This straight backswing almost always results in a slight circular swing unless the ball is struck exactly at the height of the starting position. Therefore, when the ball is to be contacted at waist height or lower, the racket head drops slightly when in the back position and the arm follows the path of a flattened loop. Lastly, the backswing should stop once the racket is pointed directly at the fence or wall behind the player.
**Point of Contact.** Degutis (1966) believed that the point of contact can be visualized as including the distance between the mid-line of the body and the front hip, at about the height of the net. When the racket face is placed in the correct contact area (even with the front foot for the forehand, 12 inches in front of the lead foot for the backhand) the butt of the racket is close to the front surface of the body, and the following segmental relationships (Degutis, 1966) of the limb are observed:

1) the elbow is in about ninety degrees flexion, 2) the forearm is parallel to the court surface and 3) the wrist is in a lay-back or hyperextended position to the extent of approximately sixty degrees (for the forehand). The bent arm position should be thought of as somewhat fixed, as if the elbow and wrist were locked in the position described.

From the point of contact position, with the elbow and wrist fixed, Degutis (1966) pointed out that the arm is moved at the shoulder joint only, much like the opening of a door on well oiled hinges, to a position so that the shaft of the racket is parallel to the net at contact, with the elbow only a few inches away from the rear hip.

For better balance, and as an aid to concentration, the arm nearer the net should be in easy extension pointing toward the net (except for the backhand, where it is held at the throat of the racket). As the player shifts
his/her weight forward toward the net, the racket is moved forward on an inside out course (butt end slightly forward of the racket face) to the beginning of the hitting area. The movement occurs at the shoulder joint only, and the position of the elbow and wrist previously described is maintained. When the hitting area is entered, the racket face begins to follow a course coincident with the direction of the intended line of flight. As the racket face continues on the directional line to a position well out in front of the body, some extension of the elbow will occur. This pattern facilitates a much extended hitting area.

**Follow-Through.** Plagenhoef (1970) contends that stepping toward the net (rather than the sideline), and maintaining level shoulder and knee bend will permit a follow-through to a finish position which will find the racket well out in front of the body and above the head. The hips should come around to a net facing position. Lastly, the most important part of the whole forward swing and follow-through is that the whole racket must be lower than the ball before impact and higher after impact, thus moving upward during contact from below the midline of the ball. This low to high follow-through will impart topspin to the ball.

To summarize, many teachers and coaches believe that beginning tennis players should be taught to hit
forehand and backhand groundstrokes with a low to high follow-through so that the ball clears the net by three to six feet. This philosophy of teaching groundstrokes also enables the beginner to hit tennis balls with top-spin.

**Tennis Groundstroke Skills Tests**

The *Miller and Broer Groundstroke Test* (1950) was designed to measure students' ability to place forehand and backhand drives into the backcourt area. It consisted of hitting a given number of balls so that they would pass between the top of the net and a restraining rope placed 4 feet above the top of the net with the ideal ball being hit into the back nine feet of the court.

The player taking the test stands behind the baseline, bounces the ball to herself and hits it. Each player is allowed fourteen trials on the forehand and fourteen trials on the backhand. Balls which go over the rope score one-half the value of balls that go between the rope and the top of the net. If a player misses the ball or if it is a let ball, it is considered a trial and taken over.

The reliability of the test was computed by correlating the total score of the first seven balls on the forehand plus the first seven balls on the backhand with the total score of the second seven balls on the forehand.
plus the second seven balls on the backhand. The reliability for the beginning group was shown to be .80.

The validity of the test was computed by correlating the ratings given to the student by the various judges with the students' performance on the test. For beginners the correlation between the combined subjective rating of the three judges and the test was .61.

The Kemp-Vincent Rally Test (1968) was designed to classify students and rate achievement in playing skill as measured by rally ability in a simulated tennis game. The equipment consisted of a tennis court, stop watch, four good tennis balls per court and tennis rackets for each student. Time of the test period was 3 minutes.

It begins by taking two players of similar ability and placing them on opposite sides of the net on a singles tennis court, with each player having two tennis balls on that side of the court. Both players are tested simultaneously. On the signal "Go" of the command, "ready go," one player drops a ball and with a courtesy stroke puts the ball into play. The two players keep the ball in play, or rally, as long as possible within the three-minute test period. When a ball is hit into the net or out of bounds, either player starts another ball into play with a courtesy stroke from behind the baseline. At the start of the test and whenever a new ball is put into play,
it must be started from behind the baseline with a courtesy stroke. Any groundstroke may be used during the rally.

Players are responsible for retrieving their own balls to continue the test after the four original balls have been used. Scoring consists of combining the total number of hits (contacts of ball and racket) for the two players, regardless of whether an error is made on that hit. The courtesy stroke to put a ball in play counts as a hit. The errors committed by each individual player are counted. From the combined total number of hits for both players, each individual player subtracts the number of his errors to arrive at a final rally score for each of the players.

The validity of the test was found to be .84 for beginners when correlated with round robin tournament rankings. When validated against the Iowa Revision of the Dyer test, the validity coefficient was .80. Test-retest reliability coefficients were .86 for beginners.

The Hewitt Revised Dyer Backboard Test (1965) was designed to assess the level of performance of students learning to hit groundstrokes. The test is first set up by drawing a 25 foot parallel line 20 feet from the backboard. The subjects are then instructed not to step on or over the line while hitting the ball during the test. A line is then drawn three feet above the ground on the backboard. One point is counted by the tester each time
the ball is hit above the three foot mark, and all balls that hit the line are counted good. No point is recorded for hitting below the three foot mark. Double bounces and volleying are legal. The subjects are instructed to hit the ball in the prescribed hitting zone as quickly and efficiently as possible. Extra balls are kept behind the student for him to use when balls are mis-hit. Each student completes three consecutive 30 second trials, which are timed to start when the first ball hits the backboard. No warm-up is given and the subjects should understand the scoring system. Lastly, at the end of each trial the number of points are added up and recorded. The mean is then taken from the three trials and this score constitutes the students' performance.

Using round robin tournament rankings, Hewitt found validity coefficients of .71 to .73 and a reliability estimate of .82 for beginning players. Lindquist and Witte (1977) also used the Hewitt Revised Dyer Backboard Test and found the reliability coefficient to be .54 for beginning tennis players.
CHAPTER III
PROCEDURES

The purpose of this study was to investigate the role of augmented visual feedback in learning tennis groundstrokes. Three different types of visual cues were used with three experimental groups for comparison purposes with a control group. This chapter includes information concerning the sample used in the study, the skills tests administered, the administration of the various experimental and control treatments and the statistical treatment of the data collected.

Subjects Participating in the Study

The subjects for this experiment were 82 male and female students enrolled in four beginning tennis classes at the University of Arizona. Although a maximum of 30 students were admitted to each class, dropouts and excessive absenteeism (four absences eliminated student from study) reduced the class enrollments to 16, 17, 28 and 21, respectively for each class. The students enrolled for the classes under the usual registration procedure and were not physical education majors. Each intact class was randomly assigned to receive one of the three experimental treatments or to serve as the control group.
On the first meeting the subjects were informed that they had enrolled in an experimental class, and they all voluntarily signed informed Human Subjects Consent Forms (Appendix A). Although the students were not assigned randomly to classes, it was believed that each class was representative of a cross section of students who usually enroll in these classes.

**Design of Study**

The study was set up using three experimental treatments: 1) a covered net, 2) a rope set $3\frac{1}{2}$ feet above the net and 3) a combination of a covered net and the rope. A control group was taught in the same manner as the other groups except for the use of the visual feedback devices. The investigator was the instructor of all four tennis classes and made every effort to hold instruction, testing, and course content constant across all conditions.

On the first day of the experiment, The Hewitt Revised Dyer Backboard Test (1965) was used as a pretest to determine the initial skill level of the four classes. The four classes were then given ten instructional sessions devoted to the development of forehand and backhand groundstrokes. A post-test was given on the twelfth class meeting which consisted of The Hewitt Revised Dyer Backboard Test and a revision of the Kemp-Vincent Rally Test. The purpose of the post-tests was to ascertain the
performance levels of the three experimental groups after receiving the individual treatments and the progress of the control group.

A post-detraining test, consisting of the same two skill tests used in the post-test, was then administered to all four groups on the sixteenth meeting. A period of three weeks had elapsed since the post-test. None of the groups received augmented feedback, nor did any group receive information or demonstrations concerning groundstrokes after the post-test was administered. The purpose of the post-detraining test was to determine the degree of retention experience by each group.

The subjects were given no instructions on the amount of tennis they could play outside of class during the study. However, at the conclusion of the study a questionnaire was administered to the students. Its purpose was to ascertain the amount of outside tennis activity the students had participated in during the study (Appendix B).

Selection and Administration of Skill Tests

Two skills tests, the Revised Dyer Backboard Test as Modified by Hewitt (1965) and a revision of the Kemp-Vincent Rally Test (1968), were given to subjects in the study. The Revised Dyer Backboard Test measures the student's ability to hit consistent groundstrokes in a prescribed area and distance from the backboard, in a
measured amount of time. The Revised Dyer was given for the pretest, post-test and post-detraining test. The Kemp-Vincent Rally Test measures the student's ability to hit groundstrokes with an expert player from baseline to baseline and was given for the post-test and post-detraining measurements.

**Hewitt Revised Dyer Backboard Test**

The test was selected for the study due to its ease of test administration (only one tester is needed), plus its efficiency in testing large numbers of subjects in short periods of time (three minutes total per subject). Lastly, it was chosen as a time tested method, that has yielded reliable results both in classroom and research testing.

**Kemp-Vincent Rally Test**

The test was selected for its unique ability, compared to other tests, to actually test the student's groundstroking ability in a game-like situation. However, one revision was made by the investigator that differs from the original testing protocol set-up by Kemp and Vincent. The revision consisted of assigning to an advanced player, who was also part of the testing team, the task of rallying with the subject being tested. The purpose of this was to manipulate the rally to test thoroughly the
subject's ability to hit groundstrokes. The original test was designed with two subjects rallying between themselves. However, in this study it was believed that for added control, an expert player would take the place of one of the subjects on the court. The instructions to the expert, were to keep the ball in play at whatever speed or pace that particular subject being tested could handle, so as to obtain the best performance from the subject.

On the two testing dates (post-test and post-detraining test) when the revised Kemp-Vincent Test was used, the subjects were instructed to perform with the same tester as the previous time. This helped to control for extraneous variables that could affect test results that could occur using a different tester with a different subject.

Visual Cues

In the present study two visual feedback devices were used to determine their effectiveness at the beginning levels of tennis. One of the feedback devices was a cover placed over the net, so as to block the view of part of the opposite court from the subject. This device was chosen as a treatment from the investigator's personal experience as a player and teacher and from Vic Braden (1977) who has used this device successfully in his teaching sessions with beginners. The device was chosen for this
study because it was assumed that beginners do not correctly perceive the net to be as large an obstacle as the intermediate or advanced player does. In a normal situation, having the ability to see clearly through the net makes it seem very easy to just simply hit the ball straight over. Advanced players make it a special point in their strategy to avoid hitting the net as much as possible. This, in turn, allows them to be more consistent, by giving their practice partner a chance to hit the ball back, even if it goes long or wide. In the beginning tennis player's case less attention is paid to clearing the net. Beginners do not perceive that a ball which is hit after it bounces and descends below the level of the net, must be hit from below the mid-line of the ball in order for it to rise. For if the ball is not hit from below the mid-line, the ball's trajectory will carry it into the net due to the affects of gravity. By placing a solid net before them, they suddenly take greater notice that the net is indeed an obstacle to overcome. Consequently, they will usually place greater emphasis on getting the ball over this solid structure by bending their knees and hitting below the mid-line of the ball. In order to achieve this, they learn through demonstrations, coaching, and practice to widen their stance and get their racket below the level of the incoming ball. This lowers their center of gravity and
gives them greater stability, thus improving their ability to hit balls higher over the net.

Braden has made the observation that when a solid net is used, people suddenly start bending their knees and elevating the ball because "they can't see their opponent's feet, let alone the court" (1977, p. 52).

The investigator used a rope with a chosen height of 3½ feet above the net as the other visual feedback device. The rope was used as a target or reference point to help the students to judge the proper height that their balls should clear the net. Also, the intent of this rope height of 3½ feet was to force the students to give up trying to hit the ball flat and in a straight line and instead to try to hit the ball in an arcing flight pattern, which a number of educators, tennis coaches and teaching professionals advocate as being beneficial at the beginning levels of play.

In addition, the rope acts as a guide to let the novice player perceive the actual height of the ball as it passes over the net. A coach or teacher might emphasize a certain height to hit over the net, but to the novice, this verbal height can only be imprecisely estimated.

Lastly, the investigator chose the height of the rope at 3½ feet from the average consensus of other teachers and coaches who use this recommended height for their
beginners (Braden, 1977; Barnaby, 1969; and Gallwey, 1974). In addition, the current men's and women's varsity tennis coaches and teachers at the University of Arizona 1982, coaches Ted Kissell and Ann Lebedeff, are in mutual agreement that when two beginners are rallying from the baseline to baseline the preferred height of the tennis balls clearing the net should be three to six feet above the net.

To summarize, these visual cues were used to help students achieve success more quickly, by keeping the ball in play and out of the net. By emphasizing getting the ball over the net the student will have a better chance at developing the skills necessary to play the game.

**Experimental Treatment Sessions**

The experimental treatment (instructional sessions using the selected visual cues) consisted of ten sessions, with each session lasting 50 minutes. This time period allowed a minimum of 35 minutes of actual practice per session. On each of the ten instructional sessions, practice sessions for both the control and experimental groups were designed to help the students learn forehand and backhand ground-strokes.

During these sessions all experimental groups used the assigned augmented visual cue devices. Each session began with a five minute lecture and demonstration focusing on the various components and teaching points highlighted
previously for hitting proper groundstrokes. Once the lecture was completed and all questions answered, the students then practiced the groundstroke.

During the study, several recommendations regarding points of form in stroke production were taught. It was explained that adherence to these suggestions would eliminate undesirable functional relationships between involved muscle groups and bones, and conversely, encourage the following: 1) a vertical racket face (net facing racket position) through the hitting area; 2) a much lengthened hitting area (by keeping the racket face parallel to the net, the chances of hitting the ball in the intended direction are increased, thereby, lengthening the hitting area); 3) hitting harder with less effort; 4) greater accuracy and consistency; and 5) hitting with topspin.

During both sessions ten and eleven the students were told to make an extra special point of being at class on the twelfth day for testing. Those that had to leave early for Spring Break were rescheduled to take the test prior to the break and after the eleventh lesson. All students who did not take the tests prior to Spring Break were dropped from the study.

On returning from Spring Break, volleying and serving were introduced during sessions thirteen, fourteen and fifteen, and the students practiced only these two
skills. The change from groundstrokes to these skills during the three classes, plus the Spring Break, served the purpose of providing a retention phase for the groundstrokes used in the study.

On the sixteenth session of the study, subjects were given both the Dyer and the Kemp-Vincent as post-detraining tests to ascertain the retention level of the groundstrokes. Both tests were administered in one class period for each group. Subjects who were absent during this time were tested during the next class period.

Method of Analyzing and Treating Data

The study employed a one-way analysis of covariance (ANCOVA) design, using the pretest scores on the Hewitt Revised Dyer Backboard Test as the covariate. The purpose was to control statistically any initial differences in tennis skills which might have been present, and which might confound post-test and post-detraining test comparisons among the four groups. Moreover, the ANCOVA was used to test the null hypothesis for the post-test and post-detraining test scores at the .05 significance level.

In addition, t tests were done to ascertain if improvement occurred between testing sessions on each group's test scores for both the Revised Dyer (pretest to post-test and post-test to post-detraining test) and the Kemp-Vincent Rally Test (post-test to post-detraining test).
Lastly, pertaining to the questionnaire handed out at the conclusion of the study, group means were calculated and the average amount of time each class played outside of class was determined.
CHAPTER IV
ANALYSIS OF DATA

This study was designed to investigate the effect of augmented visual feedback on learning forehand and backhand groundstrokes in tennis. The subjects were male and female University of Arizona students enrolled in four beginning tennis classes.

Separate analyses of covariance were conducted on the post and post-detraining test scores on the Hewitt Revised Dyer Backboard Test and the Revised Kemp-Vincent Rally Test to identify any significant differences (p< .05) among the three experimental groups and the control group. The pretest scores of the Hewitt Revised Dyer Backboard Test were used as the covariate to account for any initial performance differences among the groups.

Table 1 presents the mean scores and the standard deviations achieved by the three experimental groups and the control group for the three testing sessions. Figures 2 and 3 illustrate the mean scores of each group for the three testing sessions for the Hewitt Revised Dyer Backboard Test and the Revised Kemp-Vincent Rally Test, respectively.
The ANCOVA revealed no significant differences \((p < .05)\) among the four groups for either the Hewitt Revised Dyer Backboard Test or the Revised Kemp-Vincent Rally Test for the post-test and post-detraining test scores. The F ratios obtained, with their level of significance, on the post and post-detraining tests are presented in Table 2. The null hypotheses concerning differences among groups were retained; the post-test groundstroke performance scores and the post-detraining performance scores for the three experimental groups were equal to the control group; and the post-test groundstroke performance scores and the post-detraining scores of the experimental combination group and the other two experimental groups and the control group were equal.

In addition, paired t-tests were performed on all four groups for both the Hewitt Revised Dyer Backboard Test and the Revised Kemp-Vincent Rally Test to determine whether skill performance improved between the post-tests and the post-detraining tests. The results presented in Table 3 indicate that no significant changes occurred between the two testing sessions for any of the groups. The null hypothesis which stated that the post-detraining groundstroke performance scores would be equal to the post-test groundstroke performance scores for the four groups was retained.
Table 1

Group Means and Standard Deviation Scores for the Hewitt Revised Dyer Backboard Test (Pretest, Post-Test and Post-Detraining) and the Kemp-Vincent Rally Test (Post-Test and Post-Detraining Test)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Pre-Dyer Scores Mean (SD)</th>
<th>Post-Dyer Scores Mean (SD)</th>
<th>Post-Detraining Test Scores Mean (SD)</th>
<th>Post Kemp-Vincent Test Scores Mean (SD)</th>
<th>Post-Detraining Kemp-Vincent Scores Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rope</td>
<td>16</td>
<td>12.56 (1.87)</td>
<td>13.31 (2.63)</td>
<td>13.31 (3.23)</td>
<td>59.25 (11.07)</td>
<td>65.63 (9.19)</td>
</tr>
<tr>
<td>Covered Net</td>
<td>17</td>
<td>10.55 (2.73)</td>
<td>13.08 (2.97)</td>
<td>12.92 (2.17)</td>
<td>54.76 (13.18)</td>
<td>56.94 (13.79)</td>
</tr>
<tr>
<td>Combination</td>
<td>28</td>
<td>10.61 (2.93)</td>
<td>12.32 (2.77)</td>
<td>12.52 (2.49)</td>
<td>53.46 (10.47)</td>
<td>55.39 (9.95)</td>
</tr>
<tr>
<td>Control</td>
<td>21</td>
<td>11.67 (2.36)</td>
<td>13.84 (2.11)</td>
<td>13.82 (3.33)</td>
<td>62.52 (11.47)</td>
<td>59.95 (8.38)</td>
</tr>
</tbody>
</table>
Figure 2

Hewitt Revised Dyer Backboard Test

(□) Rope, (〇) Covered Net, (×) Combination and (▲) Control
Figure 3

Revised Kemp-Vincent Rally Test

(□) Rope, (○) Covered Net, (×) Combination and (▲) Control
Table 2

Analysis of Covariance of the Four Classes Post and Post-Detraining Performance Scores on the Hewitt Revised Dyer Backboard Test and the Kemp-Vincent Rally Test, Using Pretest Scores From the Revised Dyer as the Covariate

<table>
<thead>
<tr>
<th>Skill Test</th>
<th>df</th>
<th>F Ratio</th>
<th>Level of Significance Obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Test Revised Dyer</td>
<td>3</td>
<td>1.11</td>
<td>.350</td>
</tr>
<tr>
<td>Post Test Kemp-Vincent</td>
<td>3</td>
<td>2.017</td>
<td>.118</td>
</tr>
<tr>
<td>Post-Detraining Revised Dyer</td>
<td>3</td>
<td>.39</td>
<td>.761</td>
</tr>
<tr>
<td>Post-Detraining Kemp-Vincent</td>
<td>3</td>
<td>1.408</td>
<td>.247</td>
</tr>
</tbody>
</table>
Table 3

Paired t Test for Post and Post-Detraining Tests Feedback Groups for the Hewitt Revised Dyer Backboard Test and the Revised Kemp-Vincent Rally Test

<table>
<thead>
<tr>
<th>Feedback Groups</th>
<th>Mean Post-Test</th>
<th>SD</th>
<th>Mean Post-Detraining</th>
<th>SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyer Combination</td>
<td>12.32</td>
<td>2.77</td>
<td>12.52</td>
<td>2.49</td>
<td>.29</td>
</tr>
<tr>
<td>Dyer Covered Net</td>
<td>13.08</td>
<td>2.97</td>
<td>12.92</td>
<td>-2.17</td>
<td>.18</td>
</tr>
<tr>
<td>Dyer Rope</td>
<td>13.31</td>
<td>2.63</td>
<td>13.31</td>
<td>3.23</td>
<td>.00</td>
</tr>
<tr>
<td>Dyer Control</td>
<td>13.84</td>
<td>2.11</td>
<td>13.82</td>
<td>-3.33</td>
<td>.02</td>
</tr>
<tr>
<td>K-V Combination</td>
<td>53.46</td>
<td>10.47</td>
<td>55.39</td>
<td>9.95</td>
<td>.71</td>
</tr>
<tr>
<td>K-V Covered Net</td>
<td>54.76</td>
<td>13.18</td>
<td>56.94</td>
<td>13.79</td>
<td>.47</td>
</tr>
<tr>
<td>K-V Rope</td>
<td>59.25</td>
<td>11.07</td>
<td>65.63</td>
<td>9.19</td>
<td>1.77</td>
</tr>
<tr>
<td>K-V Control</td>
<td>62.52</td>
<td>11.47</td>
<td>59.95</td>
<td>-8.38</td>
<td>.83</td>
</tr>
</tbody>
</table>
Paired t-tests were also performed on all four groups using the pretest and post-test Hewitt Revised Dyer Backboard Test scores to determine whether performance improved significantly (p < 0.05) from the pretest to the post-test. The results indicated that all groups, except the rope group, improved significantly. The t-ratios are presented in Table 4. Therefore, the null hypothesis of equal scores on the pretest and post-test was rejected for all the treatment groups, except the rope treatment group.

The questionnaire that was completed by each subject at the end of the study to ascertain the students' outside of class tennis playing time was analyzed. The results are as follows (the mean score given is the amount of time the students practiced outside of class per week): 1) The covered net group averaged 1.6 hours; 2) The rope group averaged 1.9 hours; 3) The combination group averaged 1.6 hours and 4) The control group averaged 1.8 hours. Since each group practiced essentially the same amount of time outside of class, it would seem unlikely that this factor could affect group results.

Discussion

Since all groups, including the control group, scored equally well on both the post and post-detrieving Hewitt Revised Dyer Backboard Test and the Revised Kemp-Vincent Rally Test, it must be concluded that the use of
Table 4
Paired t Test for the Hewitt Revised Dyer Backboard Pretest and Post-Test

<table>
<thead>
<tr>
<th>Feedback Groups</th>
<th>Mean Pretest</th>
<th>SD</th>
<th>Mean Post-Test</th>
<th>SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combination</td>
<td>10.61</td>
<td>2.93</td>
<td>12.32</td>
<td>2.77</td>
<td>2.25*</td>
</tr>
<tr>
<td>Covered Net</td>
<td>10.55</td>
<td>2.73</td>
<td>13.08</td>
<td>2.97</td>
<td>2.59*</td>
</tr>
<tr>
<td>Rope</td>
<td>12.56</td>
<td>1.87</td>
<td>13.31</td>
<td>2.63</td>
<td>.93</td>
</tr>
<tr>
<td>Control</td>
<td>11.67</td>
<td>2.36</td>
<td>13.84</td>
<td>2.11</td>
<td>3.14*</td>
</tr>
</tbody>
</table>

*p < .05
the augmented visual feedback devices used in this study were not any more effective than the traditional approach in teaching the forehand and backhand groundstrokes.

Two studies have indicated that the use of augmented visual feedback was effective in various learning situations and did produce significantly better results than teaching methods which did not include augmented visual feedback (Howell, 1956; and Lloyd, 1968).

While it was anticipated that significant differences would be found with the use of the visual feedback devices, results similar to this study have been found in several other studies (Bell, 1971; Gray and Brumbach, 1967; and James, 1971). Furthermore, the results of Bell's 1968 study parallel the present study closely. She also found no significant treatment effects using augmented feedback and concluded that "where sufficient knowledge of results is inherent in the task, the direction of practice through the use of additional knowledge of results does not further affect the acquisition of retention of gross motor skill at beginning levels of performance" (p. 29). It may be that sufficient knowledge of results was also available to the students in the tennis situation, making the additional feedback unnecessary.

Failing to find significant group differences may have been partly due to the skills tests selected for the
study. The use of the Hewitt Revised Dyer Backboard Test for this study may be an inappropriate testing device for measuring the performance goal given to the students, namely hitting the ball in a high arc flight pattern. In order to score high on the Revised Dyer, the students had to disregard what was taught to them in class. Instead of hitting balls in a high arc flight pattern (which takes longer in time duration) the students would attempt to hit the balls straight and hard so as to facilitate the number of ball returns they could complete in order to improve their scores. This may explain why the experimental rope group did not improve from the pretest to the post-test on the Hewitt Revised Dyer Backboard Test, since their specific task was to aim their stroke at the high rope.

Although the reported reliability of the Kemp-Vincent Rally Test for beginners (.84) was at an acceptable level, an attempt was made to further increase accuracy in measuring the student's rallying ability by having a skilled player manipulate the rally with the students to get the best possible performance scores. Even though this revision was added to the Kemp-Vincent Rally Test, the test itself may still be inadequate for measuring precisely groundstroke performance as taught to the students. A diagnostic tool to measure ball clearance over the net during the rally may be needed.
Tennis is a difficult sport to master. Many physical as well as mental forces are involved when attempting to hit a tennis ball across the net during a match. Trying to develop a test that would measure a player's ability is also a difficult task. Even the United States Tennis Association, whose work on the amateur level is vast, has no testing protocol for measuring ability accurately.

The purpose of the post-detraining test was to determine how much skill in groundstroke consistency would be retained over a period of no practice, in an effort to measure learning effects. As anticipated, the performance scores for the post-detraining test for both skills tests remained at the level of the post-test.

In conclusion, even though two of the experimental groups (covered net and combination) plus the control group improved significantly in performance from the pretest to the post-test on the Hewitt Revised Dyer Backboard Test, no significant differences were found among the groups for the post and post-detraining test scores, on either the Revised Dyer or the Revised Kemp-Vincent Rally Test.
CHAPTER V

SUMMARY AND CONCLUSIONS

The main purpose of the present study was to analyze the effect of augmented visual feedback upon the learning of forehand and backhand groundstrokes. The sample used for the study consisted of 82 male and female college students enrolled in four beginning tennis skill classes at the University of Arizona. The four classes were randomly assigned treatment groups and a control group.

In past studies using augmented feedback, Lloyd (1968) found the effects of audio and visual feedback (via super-8 movies) for tennis groundstrokes significantly improved the performance of intermediate players. However, the beginning and advanced players showed no significant differences in learning and performance compared to their respective control groups.

Howell (1956) used a sprint start as the motor task. Subjects in the experimental group were shown a force time graphic analysis of each start and were allowed to compare this to an ideal graph. During the first three days, there were no differences between experimental and control groups. During the remaining nine days, however, the experimental group performed significantly better.
Johnson (1961) investigated the effects of augmented feedback upon the learning of tennis. She found no differences between the groups following the post-test and suggested that this might have been due to a high level of motivation among the classes.

Bell (1968) designed a novel visual feedback device, a rope strung across the court, to study the effects of varying knowledge of results during the practice of the badminton long serve in a classroom situation. All groups improved in performance during the skill acquisition phase, however, no treatment effect was found on the experimental groups following a post-test and a retention test.

Bell (1971) designed a novel handball toss for use in a second study. Two groups of college students practiced the skill under visual or verbal knowledge conditions. Although the visual group improved significantly, there were no significant differences between the groups on a post-test.

Robb (1968) found that subjects who practiced a tracking task with concurrent visual feedback learned the task better than subjects who practiced with terminal visual feedback.

The present experiment was a learning study involving sixteen teaching and testing sessions, over a span of eight weeks. The control group was taught via a
conventional teaching method which used demonstration, verbal instruction, and teacher correction. The three experimental groups were taught using the above plus the following visual feedback devices: Group One used a covered tennis net, so the subjects were unable to see through it; Group Two used a rope, set $3\frac{1}{2}$ feet above the net, which served as a guide for the correct height the ball should pass over the net; and Group Three received a combination of the above two devices to ascertain the total effect.

Each subject was pretested with the Hewitt Revised Dyer Backboard Test to determine if all groups were starting at the same performance level. Each subject then performed two tennis groundstroke skill tests (Revised Kemp-Vincent Rally Test and the Hewitt Revised Dyer Backboard Test) on lessons twelve and sixteen to assess learning.

**Findings**

The data were analyzed using separate analyses of covariance for the post-test and post-detraining Hewitt Revised Dyer Backboard Test and the Revised Kemp-Vincent Rally Test, using the Revised Dyer pretest as the covariate to account for the initial differences in the groups. The results of the statistical analysis showed no significant mean differences on performance levels among the
experimental treatment groups and the control group on the two groundstroke post and post-detraining skill tests.

The findings resulted in the retention of the null hypothesis that there would be no significant differences in performance test scores among students who were taught tennis using the three different visual cues used in the study and those students who were taught by the traditional lecture-demonstration method.

**Conclusions**

Within the limitations of this study, it was concluded that while the use of augmented visual cues can be used effectively in facilitating the learning of tennis forehand and backhand groundstrokes, they are not more effective than the traditional method of teaching without visual cues. The additional expense and time required for setting up the visual aids may not be warranted.

**Recommendations for Further Study**

More research is needed on the effects of augmented feedback on gross motor skills comparing different ages, skill levels, and sex differences utilizing true field settings. Very little research has been completed on tennis skill development. However, a skills test which accurately measures tennis groundstroke skills should be developed before further experimentation is done in this area.
APPENDIX A

HUMAN SUBJECTS CONSENT FORM

THE EFFECTS OF AUGMENTED VISUAL CUES ON GROUNDSTROKE CONSISTENCY FOR BEGINNING COLLEGE AGE STUDENTS

You are invited to take part in a study using different forms of augmented visual cues; covered net, restraining rope or a combination of the two. The purpose of the study is to determine whether or not the added feedback would or would not improve groundstroke consistency at a faster pace.

The daily routine of the class will not change only the manipulation of the net will differ from any other tennis class setting. The study will run for eight weeks or sixteen class sessions.

You the student shall benefit from the study if the added stimulus works as expected. At any point during the study questions may be asked and withdrawal from the experiment is optional. All data will be confidential only to be seen or used by the tester or the individual who took part in the study.

In the event of physical injury resulting from the research procedures, financial compensation for wages or time lost and the costs of medical care and hospitalization is not available and must be borne by me. Your
individual results in this study will remain confidential. All reports of this study will be given anonymously.

I have read the above subjects consent. The nature, demands, risks and benefits of the project have been explained to me. I understand that I may ask questions and that I am free to withdraw from the project at any time without incurring ill will (or affecting my course grade). I also understand that this consent form will be filed in an area designated by the human subjects committee with access restricted to the principle investigator or authorized representatives of the Physical Education Department. A copy of this consent form is available to me upon request.

SUBJECT SIGNATURE LINE

DATE
APPENDIX B

QUESTIONNAIRE

The purpose of this questionnaire is to determine your outside of class tennis activities during the period of the experiment.
Circle or underline one of the responses.

Before Spring Break - not counting class time and on the average, how many hours a week did you play?

- Less than one hour.
- Between one and two hours.
- Between two and four hours.
- More than four hours.

During the Spring Break, how many hours for the entire break did you play?

- Less than one hour.
- Between one and two hours.
- Between two and four hours.
- More than four hours.

Since the two weeks after Spring Break, how many hours a week did you play?

- Less than one hour.
- Between one and two hours.
Between two and four hours.
More than four hours.

Print your name above
LIST OF REFERENCES


64


