

To the Graduate Council:

I am submitting herewith a dissertation written by Michael Terry Sanders entitled "Effects of Augmented Feedback on the Acquisition of a Motor Skill in Two Environmental Conditions." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Physical Education.

Patricia A. Beitel

Patricia A. Beitel, Major Professor

We have read this dissertation  
and recommend its acceptance:

Mark A. Hester

Craig A. Whisberg

Ralph E. Jones

Accepted for the Council:

Law Minkel

Vice Provost  
and Dean of The Graduate School

EFFECTS OF AUGMENTED FEEDBACK ON THE ACQUISITION  
OF A MOTOR SKILL IN TWO ENVIRONMENTAL CONDITIONS

A Dissertation  
Presented for the  
Doctor of Education  
Degree  
The University of Tennessee, Knoxville

Michael Terry Sanders

August 1985

## ACKNOWLEDGEMENTS

Special thanks to Dr. Craig Weisberg, Dr. Ralph "Buck" Jones, and Dr. Mark Hector, for their valuable assistance during completion of this study. Dr. Patricia Beitel, my chairperson, deserves special recognition for providing her wisdom, guidance and constant encouragement during my entire doctoral program, and to my most ardent supporter, my wife, Barbara, who without none of this could be possible.

## ABSTRACT

The purpose of this study was to investigate the effects of three forms of feedback on the learning/performance of a motor skill in two environmental conditions. One hundred twenty female subjects were randomly assigned to an open or closed task in one of four groups ( $n = 15$ ). Each subject threw 10 sets of 5 darts at either a fixed target (closed task) or moving target (open task) following procedures designated for the treatment groups: (1) control--no augmented feedback; (2) augmented KR; (3) augmented KP; and (4) combined augmented KR/KP. All were videotaped. The individual scores were grouped into 10 blocks of 5 trials for: (1) goal attainment; (2) goal attainment consistency; (3) movement performance; and (4) movement consistency. Simple main effects analysis on blocks one and two was performed to determine if the groups were significantly different at the beginning of the study. The Bonferroni planned comparisons were performed at Blocks 9 and 10. Results indicated that: (1) at Block 9 the group receiving KR performed significantly better ( $p < .01$ ) on goal attainment and goal attainment consistency than the control group for the open task; (2) at Block 9 and 10 the group receiving KR/KP performed significantly better ( $p < .01$ ) on movement performance than did the control group for the open task; (3) at Block 10 the group receiving KR/KP performed significantly better ( $p < .01$ ) on movement performance than did the control group for the closed task; and (4) there were no significant differences at Blocks 9 or 10 between groups on movement consistency for either the open or closed task.

In conclusion, the primary contributions of the study are that (1) KR/KP produced significantly better movement performance than the control group for open and closed tasks, and (2) KR produced significantly greater performance on goal attainment and consistency of goal attainment than the control group on the open task.

## TABLE OF CONTENTS

| CHAPTER                                                           | PAGE |
|-------------------------------------------------------------------|------|
| I. INTRODUCTION . . . . .                                         | 1    |
| Statement of the Problem . . . . .                                | 6    |
| Delimitations . . . . .                                           | 8    |
| Scope of the Study . . . . .                                      | 9    |
| Definition of Terms . . . . .                                     | 9    |
| Significance of the Study . . . . .                               | 12   |
| II. REVIEW OF LITERATURE . . . . .                                | 14   |
| Augmented Feedback Theory . . . . .                               | 14   |
| Knowledge of Results . . . . .                                    | 17   |
| Knowledge of Results Versus Knowledge<br>of Performance . . . . . | 21   |
| Summary of the Review of Literature . . . . .                     | 27   |
| III. PROCEDURES . . . . .                                         | 29   |
| Selection of Subjects . . . . .                                   | 29   |
| Selection of Task . . . . .                                       | 30   |
| Selection of Performance Apparatus . . . . .                      | 31   |
| Task Administration . . . . .                                     | 34   |
| Testing Methodology . . . . .                                     | 35   |
| Statistical Treatment . . . . .                                   | 38   |
| IV. RESULTS . . . . .                                             | 40   |
| Goal Attainment . . . . .                                         | 41   |
| Goal Attainment Consistency . . . . .                             | 44   |
| Movement Performance . . . . .                                    | 47   |
| Movement Consistency . . . . .                                    | 50   |
| V. DISCUSSION . . . . .                                           | 54   |
| Goal Attainment . . . . .                                         | 55   |
| Goal Attainment Consistency . . . . .                             | 58   |
| Movement Performance . . . . .                                    | 57   |
| Movement Consistency . . . . .                                    | 59   |
| Summary . . . . .                                                 | 60   |
| VI. SUMMARY, CONCLUSIONS, AND IMPLICATIONS . . . . .              | 62   |
| Summary . . . . .                                                 | 62   |
| Conclusions . . . . .                                             | 64   |
| Implications for Future Research . . . . .                        | 65   |

|                                                     | PAGE |
|-----------------------------------------------------|------|
| REFERENCES . . . . .                                | 66   |
| APPENDICES . . . . .                                | 71   |
| A. KNOWLEDGE OF PERFORMANCE QUESTIONNAIRE . . . . . | 72   |
| B. KNOWLEDGE OF RESULTS QUESTIONNAIRE . . . . .     | 74   |
| C. TARGET . . . . .                                 | 76   |
| D. INFORMED CONSENT . . . . .                       | 78   |
| E. TESTING ROOM LAYOUT . . . . .                    | 80   |
| F. PRELIMINARY AND GROUP INSTRUCTIONS . . . . .     | 82   |
| VITA . . . . .                                      | 85   |

## LIST OF FIGURES

| FIGURE                                                                      | PAGE |
|-----------------------------------------------------------------------------|------|
| 1. Goal Attainment Mean Score for the Open Task . . . . .                   | 42   |
| 2. Goal Attainment Mean Scores for the Closed Task . . . . .                | 43   |
| 3. Goal Attainment Consistency Mean Scores for<br>the Open Task . . . . .   | 45   |
| 4. Goal Attainment Consistency Mean Scores for<br>the Closed Task . . . . . | 46   |
| 5. Movement Performance Mean Scores for the<br>Open Task . . . . .          | 48   |
| 6. Movement Performance Mean Scores for the<br>Closed Task . . . . .        | 49   |
| 7. Movement Consistency Mean Scores for the<br>Open Task . . . . .          | 52   |
| 8. Movement Consistency Mean Scores for the<br>Closed Task . . . . .        | 53   |
| C-1. Target . . . . .                                                       | 77   |
| E-1. Testing Room Layout . . . . .                                          | 81   |

## CHAPTER I

## INTRODUCTION

There are many factors contributing to the acquisition of motor skills. Numerous investigators (Adams & Goetz, 1973; Ammons, 1956; Baker, 1960; Bilodeau, 1969; Fitts, 1964; Robb, 1968) have reported that motor skills can be effectively learned through incorporation of feedback. Higgins (1972, 1977) stipulated that optimal skill acquisition is achieved in terms of the performers consistency of movement and efficiency of goal attainment; and feedback plays a key role in controlling human movement for effective goal attainment (Adams, 1971; Annett, 1969; Gentile, 1972, 1975; Kleinman, 1983; Singer, 1980; Schmidt, 1982). The importance of feedback according to Barbarich (1980, p. 12) stems from the following assumptions:

1. Feedback allows the learner to attend to proper cues.
2. Feedback may provide information otherwise not available to the learner.
3. Feedback allows the learner to attend to information that is available, but may not be otherwise processed.

Many terms have been used in the literature and in research to label the functions of feedback. Bilodeau (1969) identified six terms to describe what feedback provides to the learner, i.e.: (a) knowledge of results, (b) information feedback, (c) movement reinforcement feedback, (d) psychological feedback, (e) reinforcement, and (f) reward. Annett (1969) added knowledge of performance as another label for feedback. Robb (1972) developed a definition of feedback which provides a theoretical framework for researchers:

Feedback is information that arrives constantly during and as a consequence of one's own response; or arrives as new information input from external sources; in both cases feedback is used to compare present behavior with referent responses, or a movement pattern; i.e., a goal or standard. (Robb, 1972, p. 93)

The exact way feedback functions is not yet clear, and enigmas surrounding the role of feedback in the acquisition of motor skills still remain. This is partially due to: (a) the variety of feedback methods, and (b) the complexities and specific task demands of motor skills. According to Del Rey (1971), the type of feedback administered to the performer should be related to the environmental condition in which the skill is performed. Higgins (1972, 1977) indicated that for effective goal attainment to occur, the spatial and temporal elements must be matched by the performer's movements.

Schmidt (1982) has identified two broad classes of feedback: extrinsic and intrinsic. Extrinsic feedback is further subdivided into categories, i.e., knowledge of results (KR), and knowledge of performance (KP). According to Dukelow (1979), KR is information concerning the success or failure of an attempted performance of a given task, in terms of the objective measure of the end product, such as force and distance, or combinations thereof. In contrast, Dukelow indicates KP is information about the actual movements made in the performance of the task. KR has information about temporal/spatial relationships to the specific environmental constraints of the task. Schmidt (1982) has illustrated the difference between KR and KP using the task of batting in baseball. He contends that: "KP refers to the verbal terminal feedback that the batter's stride was too long, while

KR refers to the outcome of that stride in terms of hitting the baseball" (Schmidt, 1982, p. 531).

The multiple influences of feedback upon the learning of motor skills has attracted the attention of a large number of investigators. Most research has attempted to determine the best type of feedback to be administered in the particular environmental condition in which the motor skill is to be performed (Adams & Goetz, 1973; Ammons, 1956; Carre, 1972; Del Rey, 1971; Dukelow, 1979; Lavery, 1964; Malina, 1969; Newell, 1976). Some of these research studies have employed different modalities for the delivery of KR (Bell, 1970; Malina, 1969; Robertson, 1972; Smode, 1958). Others have compared the effectiveness of KP and/or KR on the improvement of open and/or closed skills (Beitel, 1983; Hampton, 1970; Stewart, 1980; Thompson, 1969; Wallace & Hagler, 1979). Such extrinsic augmented information supplied by the teacher, coach, or researcher can assume a variety of forms or methods, e.g., verbal, visual, or videotape replay. However, Gentile (1972) in her model of skill acquisition expressed the idea that various types of feedback differentially affect performance of motor skills.

Gentile proposed that performers must attend to certain regulatory cues that are specific to the environmental conditions and movement demands specific to the task. Consequently, the proper type of feedback employed can be useful in attaining the desired goal, i.e., the movement response must conform to the spatial/temporal characteristics of the environment in which it takes place (Higgins, 1972, 1977).

The result of investigations (Beitel, 1983; Beitel & Ferguson, 1981; Del Rey, 1971; Gentile, 1972; Richard, 1984) that have examined this issue suggest that the nature of the task is a primary determinant of the type of feedback needed for optimal motor skill acquisition.

As evidenced by the aforementioned research on augmented KR and KP there is little question as to the importance of these types of feedback on the acquisition of motor skills. However, numerous gaps still exist in the research. Annett (1971), Gentile (1972), Newell (1976), and Stewart (1980) have concluded that much of the past research investigating KR and KP used closed tasks that were performed in stable and predictable temporal/spatial environments. In contrast, open motor tasks are performed with variable changing environmental conditions. Newell (1976), Stewart (1980), and Whiting (1969, 1972) further indicated that most of the experimental results on KR and KP come from artificial laboratory experiments, so that inferences made do not necessarily transfer to actual sport motor skills. If useful inferences are to be established on a firm basis there is a need to conduct motor behavior research with actual sport motor skills.

Gentile (1972, 1975) and Higgins (1972, 1977) contended that in the initial learning of a skill the ability to analyze one's own performance in relation to environmental demands may facilitate the acquisition of that skill. Body parts, body position, temporal/spatial adjustments, and a changing environment can all contribute to the quality of performance. If an efficient motor pattern is developed in

the early stages of skill acquisition, then goal attainment and movement will be enhanced (Gentile, 1972; Higgins, 1972; Kleinman, 1983; Schmidt, 1982). Further projections by Gentile (1972) and Higgins (1977) indicated:

1. Both KP and KR are important in the acquisition of motor skills.
2. Different environmental conditions may demand either KP or KR.
3. KP is the most effective feedback for a motor skill performance in a consistent, unchanging or closed environment.
4. KR is the most effective feedback for a motor skill performed in different environmental conditions.
5. KP and KR together may be an effective type of feedback for motor skills performed in open and/or closed environmental conditions.

More specifically what Gentile (1972) and Higgins (1972) suggested was that performers must attend to certain regulatory cues that are specific to the environmental conditions and movement demands inherent in the task. Fleishman and Hempel (1955) identified this phenomenon by stating that at later stages of performance/learning the performers direct their attentional focus toward kinesthetic and proprioceptive cues. However, during the initial stages of skill learning/performance the acquisition is similar for open and closed skills: the learner is trying to find the general motor organization that works to produce the outcome/goal attainment and the attention is best focused on environmental cues (Gentile, 1972, 1975). This was supported by Del Rey (1971) who found that during the initial stages

of skill acquisition of open tasks, subjects made a quick response to the varied environmental conditions rather than developing a consistent form of the motor response. Consistent with these earlier findings (Del Rey, 1971; Gentile, 1972, 1975), Beitel (1980) indicated that the contribution of independent visual-perceptual abilities to successful task performance was important in early performance/learning for open and closed tasks. Richards (1984) also suggested that during the early stages of task mastery, performers depend upon visual spatial information to facilitate performance, and that attention to regulatory cues in closed skills warrants an external environmental focus of attention (KR).

Existing research related to the acquisition of motor skills employing KP and KR has primarily incorporated closed skills with stable environments. It appears justifiable then to determine the most effective type of augmented feedback (KP/KR) for consistency of movement and goal attainment of a multidimensional task with different environmental conditions.

#### Statement of the Problem

The purpose of this study was to investigate the effects of receiving three forms of feedback (knowledge of results and/or knowledge of performance) on the learning/performance of dart-throwing in two environmental conditions. More specifically the study attempted to determine if there were significant differences in dart-throwing goal attainment and movement under two different environmental conditions

(stable and moving), as a result after a period of practice with KP and/or KR.

Based upon the theoretical projections of Gentile (1972, 1975) and Higgins (1972) the hypotheses for this study were developed to determine the effects of four feedback treatments on skill acquisition: a control group, KR group, KP group, and a combined KR/KP group. The dependent variables for the open and closed task were objective test scores on goal attainment, goal attainment consistency, movement performance, and movement consistency. Thus the following hypotheses were tested in this study.

1. The mean goal attainment performance scores of the subjects receiving augmented KR will be significantly better on the open task than those subjects receiving (a) augmented KR/KP, (b) augmented KP, and (c) no augmented feedback (control).
2. The mean goal attainment performance scores of the subjects receiving augmented KP will be significantly better on the closed task than those subjects receiving (a) augmented KR/KP, (b) augmented KR, and (c) no augmented feedback (control).
3. The goal attainment consistency scores of the subjects receiving augmented KR will be significantly better on the open task than those subjects receiving (a) augmented KR/KP, (b) augmented KP, and (c) no augmented feedback (control).

4. The goal attainment consistency scores for the subjects receiving augmented KP will be significantly greater on the closed task than those subjects receiving (a) augmented KR/KP, (b) augmented KR, and (c) no augmented feedback (control).
5. The mean movement performance scores for the subjects receiving augmented KR/KP will be significantly better on the respective open or closed task than those subjects receiving (a) augmented KP, (b) augmented KR, and (c) no augmented feedback (control).
6. The movement consistency scores for the subjects receiving augmented KR/KP will be significantly better on the respective open or closed task than those subjects receiving (a) augmented KP, (b) augmented KR, and (c) no augmented feedback (control).

#### Delimitations

This study was delimited as follows:

1. Subjects for this study were 120 college age females.
2. All subjects used their dominant arm to perform the motor skill.
3. All subjects were volunteers with limited or with beginning skill level in dart-throwing.
4. The subjects were randomly assigned to the 8 treatment groups.

### Scope of the Study

The time period encompassing collection of the data was Winter Quarter, 1985. The 120 subjects were female university students with limited or beginning skill level in dart-throwing.

### Definition of Terms

Augmented feedback. "Feedback that is added to that typically received in the task, extrinsic feedback" (Schmidt, 1982, p. 562). In this study there were three types: augmented knowledge of results (KR), augmented knowledge of performance (KP), and combined augmented knowledge of results and knowledge of performance (KR/KP).

Augmented knowledge of performance. "Augmented feedback related to the nature of the movement pattern produced" (Schmidt, 1982, p. 562); was defined in this study as the kinesthetic and proprioceptive related cues concerning total body transport and limb transport manipulation, and the completion of a questionnaire focusing attention on the actual movements made during task performance (Appendix A).

Augmented knowledge of results. "Augmented feedback related to the nature of the results produced in the environment" (Schmidt, 1982, p. 562); was defined in this study as the visual environmental cues that provide task relevant information concerning the dart, the target, the point values of the target, and the completion of response accuracy questions focusing attention on the results of the task performance (Appendix B).

Augmented KP/KR. "Feedback which provides information about the nature of the results produced in the movement (accuracy), and the resultant environmental consequences" (Schmidt, 1982, p. 562); was defined in this study as visual environmental cues, kinesthetic and proprioceptive related cues that provide task relevant information concerning the dart, the target, and the point values on the target, and completing questionnaires focusing attention on goal attainment (KR) and the actual movements (KP) made during the task performance (Appendices A and B).

Blocks. Five attempts (trials) to perform the dart-throwing task. There was a total of 10 blocks of 5 trials (50 total trials).

Baseline Data Phase. The initial 2 blocks of 5 trials where the subjects threw darts at a circular white target to orient them to the task.

Closed task. A task with a stable environment, defined in this experiment as the overhand throwing of a specified number of darts (10 blocks of 5 trials) with the dominant hand at a fixed target 3 meters from the subject, at a height of 1.6 meters from the floor to the top of the target.

Extrinsic feedback. "Feedback that is added to that typically received in the task, augmented feedback" (Schmidt, 1982, p. 561).

Feedback.

Feedback is information that arrives constantly during and as a consequence of one's own response; or arrives as new information input from external sources, in both cases feedback is used to compare present behavior with referent responses, or a movement pattern, i.e., a goal or standard. (Robb, 1972, p. 93)

Intrinsic feedback. "That feedback normally received in the conduct of a particular task, dictated by the performer of the task" (Schmidt, 1982, p. 562).

Open task. A task with a moving environment defined in this study as the overhand throwing of a specified number of darts (10 blocks of 5 darts) with the dominant hand at a circular moving target (12 rpm), 3 meters from the subject, at a height of 1.6 meters from the floor to the top of the target.

Performance. "The outcome of a person's movement, it may be thought of as a temporary occurrence, fluctuating from time to time because of various operating factors" (Singer, 1980, p. 11).

Target. A circular piece of paper 17.5 centimeters in total diameter, marked in three concentric circles increasing by a radius of 3.5 centimeters. The "bull's eye" had a diameter of 3.5 centimeters, and the center was black followed by alternating white and black rings. This color scheme continued to the edge of the target (Appendix C).

Task performance scores. Total point value accumulated by an individual as a result of dart-throwing. There were four task performance scores: (1) goal attainment, (2) goal attainment consistency, (3) movement performance, and (4) movement consistency.

Goal attainment. Task performance scores tabulated by scoring blocks of 5 darts with the numerical values assigned to the rings on the target. A "bull's eye" was 10 points, the second ring scored 5 points, and the last ring scored 3 points. No

points were given for missing the target. The goal attainment task performance scores were the average of numerical values of the 5 darts for each block.

Goal attainment consistency. The standard deviation of goal attainment task performance scores for each block of 5 darts.

Movement performance. Repeated consistent execution of a single movement pattern. In this study the task performance scores were tabulated by the average number of yes responses of a 5-item questionnaire (Appendix A) for each block of 5 darts.

Movement consistency. The standard deviation of movement performance scores for each block of 5 darts.

Treatment trials. After the Baseline Data Phase the subjects threw 8 blocks of 5 darts at various circular targets while receiving various (KP/KR) treatments.

### Significance of the Study

Annett (1971) indicated that the most important variable that can be manipulated in motor skill acquisition is the provision of feedback. Human movements are both spatially and temporally regulated and coordinated (Higgins, 1972); and feedback plays a key role in controlling these movement patterns for effective goal attainment (Adams, 1971; Annett, 1969; Gentile, 1975; Kleinman, 1983; Schmidt, 1982). Because the exact way in which feedback functions is not clear, many questions surrounding the role of feedback in the acquisition of types of motor skills still remain. Partially because of the variety of feedback functions and the complexities of some motor skills, employment of

the proper type of feedback regimens are not completely understood (Schmidt, 1982).

The multiple influences of feedback upon the learning of motor skills have attracted the attention of a large number of investigators. Most research has attempted to determine the best type of feedback to be administered in the particular condition in which the motor skill is to be performed (Adams & Goetz, 1973; Ammons, 1956; Carre, 1972; Del Rey, 1971; Lavery, 1964; Malina, 1969; Newell, 1976; and Robertson, 1972). Investigations conducted by Beitel (1983), Beitel and Ferguson (1981), Del Rey (1971), Gentile (1972), Higgins (1972), and Richards (1984) that have examined this issue and suggest that the nature of the task demands should be a primary determinant of the type of feedback for optimizing motor skill acquisition. Therefore it appears there was a need to determine the most effective type of extrinsic augmented feedback, KP and/or KR, on both the nature of the movement and the goals attained of a multidimensional task with different environmental conditions.

## CHAPTER II

## REVIEW OF LITERATURE

The purpose of this chapter was to synthesize the literature pertaining to the effects of receiving two forms of feedback, KP and KR on the acquisition of sport motor skills. The research was organized under the following subtopics: (a) augmented feedback theory, (b) knowledge of results, (c) knowledge of results versus knowledge of performance, and (d) summary.

Augmented Feedback Theory

In the past five decades there have been many theoretical statements made and many experimental studies completed concerning the relationship/effect of feedback on motor skill acquisition and performance. Investigators from various fields have been cognizant of the role of augmented feedback (Annett, 1969; Bilodeau, Bilodeau & Schumsky, 1959; Beitel, 1983; Dukelow, 1979; Gentile, 1972; Higgins, 1972; Robb, 1969; Rothstein & Arnold, 1976) in motor skill acquisition and have consequently studied the area in some depth. Several definitions of augmented feedback have been proposed by the aforementioned investigators. These definitions have all included the basic concept that augmented feedback is information coming to the organism which gives the organism a way to compare a response to a predetermined goal (Dukelow, 1979). Annett (1969) described the functions of feedback as: (a) incentive, (b) reinforcement, and (c) information

functions. Fitts and Posner (1967, p. 28) indicated that feedback should provide: (a) knowledge, (b) motivation, and (c) reinforcement. Each of these theorists recognize the motivational and informational functions whereby feedback could regulate or direct ongoing or subsequent performance (Dukelow, 1979). Confusion exists, however, in the specific role of feedback as it is utilized in the acquisition of motor skills. This is partially due to: (a) the variety of feedback methods, and (b) differences in the complexities and specific task demands of motor skills.

The procedures employed by teachers, coaches, and researchers for correcting movement patterns is referred to as augmented feedback (Stewart, 1980). Such extrinsic, augmented information supplied by the instructor can assume a variety of forms or methods, e.g., verbal, visual, videotape replay. Individuals learning new skills want to understand how they are moving relative to the goals of the task. Fleishman and Hempel (1955) stated that the nature of the task changed over practice from the subject's point of view. At later stages of performance/learning, performers directed their attentional focus toward kinesthetic and proprioceptive cues, producing a more operationally effective knowledge of performance (Fleishman & Hempel, 1955; Richards, 1984). Theoretically, feedback can be useful in matching movement demands to the environmental conditions resulting in goal attainment and consistency of movement (Higgins, 1972, 1977).

Further extending this tenet, Gentile (1972), in her model of skill acquisition, expressed the need for both KP and KR in the evaluative

process. Gentile suggested that performers must attend to certain regulatory cues that are specific to environmental conditions and movement demands inherent in the task. She concluded that the use of different kinds of error feedback (KR and KP) are required for the different kinds of environmental conditions in which a skill is performed. According to Gentile, KP is viewed as the most effective form of feedback for the acquisition of a closed motor skill performed in a consistent, unchanging, or stable environment. In contrast, KR is viewed as more appropriate for performance of an open skill in an environment with moving objects or with a moving type of environment.

Both Gentile (1972, 1975) and Higgins (1972, 1977) suggested that if the proper type of KP and/or KR relative to the nature of the task and the temporal/spatial adjustments required is developed in the early stages of skill acquisition, then feedback can be useful in assisting the learner to evaluate the matching of movement demands to the environmental conditions. Higgins (1972, 1977) projected that this would facilitate goal attainment and consistency of movement.

The literature has shown an overall consensus that augmented feedback is an important factor in motor skill acquisition and performance, however, according to Newell (1976) and Stewart (1980) a number of areas still exist in which our understanding of feedback could be expanded. Newell and Stewart have suggested that the majority of tasks employed in augmented feedback research have been unidimensional. The specific motor tasks utilized in most studies have required responses to be made in relation to a single criterion. Single

criterion refers to distance (in the case of positioning tasks, time (linear timing tasks), and/or accuracy (throwing at a target)). Newell (1976), Stewart (1980), and Whiting (1969), add that the task used in prior experimental studies have served their purpose in demonstrating the effectiveness of feedback. However, there is still a need for making the transition from laboratory experiments where major sources of variance are controlled, to the activities and sport motor skills exhibited in the physical education environment, the sports arena, and recreational pursuits which require responses that include both temporal and spatial criteria. Newell (1976) stated that it would be appropriate to conduct inquiries into how KR and KP operate in multidimensional tasks. Such a multidimensional approach would also have the advantage of increasing the complexity of the motor task for the subject, and as a consequence would provide a better forum for evaluating KR and KP as learning/performance aids. Therefore it appears there is a need to conduct research to assess the specific type of augmented feedback (KP and/or KR) which may facilitate the learning/performance using multidimensional measures on sport tasks with different environmental demands.

### Knowledge of Results

The term knowledge of results (KR) is information concerned with the relative success or failure of an attempted task in terms of the end product such as, force, time, distance, or a combination of these (Dukelow, 1979). In the view of some researchers (Bilodeau,

Bilodeau, 1969) feedback was the single most important variable governing the acquisition of motor skills. Following are studies utilizing KR in the acquisition of motor skills.

Robb (1968) investigated the course of learning a specified movement pattern under conditions that varied as to the type and frequency of feedback information. Male and female subjects ( $n = 40$ ) were divided into five groups that received the following treatments: (a) concurrent visual feedback, (b) concurrent proprioceptive feedback and terminal knowledge of results, (c) a combination of a and b, (d) concurrent visual feedback interspersed with passive watching, and (e) concurrent visual feedback at two different speeds. The subjects in all of the groups were individually administered five practice sessions on a pursuit tracking task. Each practice session consisted of forty trials and lasted for approximately thirty minutes. The group which received the greatest variety of feedback, (c), was found to be significantly ( $p \leq .05$ ) better in learning the movement pattern of the pursuit tracking task than any other group.

Malina (1969) varied feedback and practice conditions in analyzing speed and accuracy of the overarm baseball throw (closed task) and the effect of practice conditions on performance. KR about accuracy was available to each subject by their direct observation of the target; this could be restricted for groups not receiving accuracy feedback. KR about speed was provided verbally as the time of ball flight. The subjects were fifty-five male high school students assigned to one of five groups: (a) control, no practice, (b) verbal speed information

only, (c) accuracy feedback information only, (d) speed-accuracy information feedback, and (e) no information feedback. Pre- and posttests consisted of speed and accuracy measurements throwing a baseball at a target and recording the results with a photoelectric vibration system with an electric timer. Each group was given an initial and final test and all groups except the control group participated in twelve practice sessions under specified feedback conditions. Results of the study revealed that for the speed variable, the speed-accuracy group was not significantly greater in the throwing speed information group, but that they both were significantly greater in throwing speed than the control and accuracy groups. Examination of the accuracy results, revealed that the speed-accuracy group was not significantly greater than the accuracy information group but that they were both significantly ( $p \leq .05$ ) greater in accuracy than the other three groups. Malina concluded that the subjects apparently directed their attention towards the factor for which augmented feedback was readily available with the neglect of the factor for which augmented feedback was withheld.

Research conducted by Bell (1970) examined the use of verbal and visual KR feedback on a novel handball toss (closed skill). Subjects ( $n = 30$ ) receiving visual KR feedback viewed the flight of the handball as it was tossed between ropes suspended seven and eight feet high at a two foot target. The verbal KR group ( $n = 30$ ) received verbal information from the instructor concerning where the handball first hit the court or wall. A pretest, a posttest, and a

retention test after a five week period were given to both groups. Significant improvement ( $p \leq .05$ ) was shown by the visual group in the posttest. However, there was no significant difference ( $p \leq .05$ ) between the groups on the retention test.

An experiment conducted by Barbarich (1980) studied the effects of visual feedback on learning the volleyball forearm pass (open task) and the learning rate of males and females. The subjects ( $n = 160$ ) were assigned to either a control or an experimental group. Both groups received verbal instructions as to the performance of the skill and a skill demonstration. But the experimental group received visual augmented feedback (KR) by a target which consisted of a circular hoop at which the subjects could aim while performing the volleyball forearm pass. The effect of visual feedback as measured by the learning rate of the volleyball forearm pass was significantly greater ( $p \leq .05$ ) for boys with visual feedback than for girls with visual feedback, or the control group.

Extending the work of Gentile (1972, 1975) and Higgins (1972) Beitel and Ferguson (1981) sought to determine the effect of two types of KR (a) videotape viewing (VTR), and (b) focused attention on KR, on the learning rate, performance time, and response accuracy of a complex open motor task (soccer). The forty-four women subjects were required to manipulate a soccer ball through a fixed environment, kicking the ball at specific times and moving to the finish line. The subjects were divided into four experimental groups: (a) no KR, (b) immediate viewing of VTR, (c) completing a questionnaire focusing

attention on the results of performance (KR), and (d) both immediately viewing of VTR and then completing a questionnaire focusing attention on the results of performance (KR). A significant VTR x blocks effect was produced for change in performance time, which indicate that the subjects who viewed the videotape had better performance times than those subjects who did not see the VTR. Additional results of the study revealed that by the end of practice: (a) the group who received KR had significantly ( $p \leq .05$ ) better performance accuracy than the control groups; and (b) the groups who received KR had significantly better ( $p \leq .01$ ) accuracy learning rate than the control group. Performance time and response accuracy were unrelated ( $p > .05$ ) and were differentially affected by the type of augmented feedback. The results of the study supported Gentile's theory that augmented KR facilitates the acquisition of open skills.

#### Knowledge of Results Versus Knowledge of Performance

From the previous section it is evident that there has been much research conducted utilizing KR. There exists however a sparsity of research on the issue of KP in motor skill acquisition and performance. The term knowledge of performance (KP) is information about the actual movement(s) made in the performance of the task (Dukelow, 1979). KP is information about the type or nature of movement (form) by the performer. No distinction was made between KR and KP until Annett (1969) defined them. Most of the subsequent research has distinguished and utilized either KP or KR, but many questions still

remain concerning whether KP and/or KR is the most effective type of feedback to facilitate the acquisition of motor skills with different environmental conditions. Following are studies utilizing KR and/or KP.

Thompson (1969) examined the effect of providing immediate KP on the acquisition of golf skills (closed tasks) employing a graph-check sequence camera. The investigator provided immediate KP by providing the subjects with photos illustrating their strengths in performances. Using a control group, and a group receiving KP (photos), Thompson (1969) found that the group receiving KP showed significant ( $p \leq .05$ ) improvement in performance over the control group. He concluded that immediate KP via the use of the graph-check sequence camera facilitated the learning of golf skills.

Two types of feedback (KP, KR) were systematically manipulated by Hampton (1970) to examine the effect upon throwing the shot put (closed task). The subjects were randomly assigned to one of four treatment groups in which feedback consisted of: (a) an eight-sequence photograph of performance, (b) intrinsic visual KR from the subject's direct observation of the distance of the throw, (c) decreased KR by screening out part of the subject's view of results, and (d) intrinsic KP by the subject during performance from the skill itself. The results indicated a significantly ( $p \leq .05$ ) better performance for the group receiving KP when using the camera than for any other feedback group. Hampton concluded that KP with VTR provided a relatively immediate visual picture of the whole movement pattern which was beneficial to the learner.

Del Rey (1971) provided knowledge of performance through videotape replay to subjects who performed a modified fencing lunge during either an open or closed condition. Two experimental groups were established: (a) a group that received augmented KP via videotape replay of the subject's last performance, and (b) a group that received no augmented feedback. Both groups were assumed to be able to experience intrinsic KP of their own movement, although no specific attention was called to this phenomenon. The subjects ( $n = 40$ ) attempted to learn a modification of the classical fencing lunge. The dependent variables were latency, accuracy, and form. A  $2 \times 2 \times 3$  (task  $\times$  feedback  $\times$  practice session) analysis on the data indicated that subjects who viewed their own performances or videotape replays (KP) produced significantly ( $p \leq .05$ ) higher accuracy and had significantly better form than subjects who were denied viewing experience.

Carre (1972) analyzed the effects of employing different feedback conditions in learning the discus throw (closed task). All groups received one live demonstration and a filmed demonstration of the task. The groups were designated: (a) control, (b) videotape replay, (c) instructor assistance, subjects received one corrective comment on performance, and (d) combination, where subjects received both videotape replay and corrective comment. The results revealed no significant difference ( $p \leq .05$ ) between the four feedback conditions in the initial stages of learning the task. Carre concluded that there was enough feedback inherent in the task itself for improvement in performance to be shown through practice alone. Additionally the author

felt there was no evidence to support the use of any augmented feedback in the initial learning of the discus throw.

Wallace and Hagler (1979) successfully tested Gentile's (1972) predictions that knowledge of performance (KP) is the most effective form of information for the acquisition of a closed skill. The subjects ( $n = 24$ ) were randomly assigned to two groups and required to perform the basketball set shot. One group received a KP suggestion from the instructor concerning readjustment of stance and motion of the body after each trial. For the second group verbal encouragement (social reinforcement) was provided after each trial. There were two phases in the experiment, an acquisition phase consisting of fifty trials and a performance phase consisting of twenty-five trials. Both groups received instructions on how to perform the basketball set shot and KR by visually observing the results of each shot. Analysis of the data revealed the group receiving both KP and visual KR performed significantly ( $p \leq .05$ ) better than the group receiving only KR and verbal encouragement. Wallace and Hagler concluded that KP is a strong feedback source in the acquisition of a closed motor skill.

Stewart (1980) investigated the effects of receiving two forms of feedback on the learning of a baseball throw (closed task). Fifty-one female subjects were randomly assigned to one of three groups. The subjects in the first group received augmented KP after each practice trial from the investigator concerning her movements while performing the baseball throw. Subjects in the second group (KR, SR) received visual KR by directly viewing the distance and accuracy of

the baseball throw, and augmented social reinforcement (SR) in terms of verbal encouragement. The subjects in the visual KR group received both augmented KP and KR. Skill improvement as measured by mean total distance of the overhand baseball throw was significantly ( $p \leq .05$ ) better for all groups, i.e., practice was a significant factor. Results revealed that the KP group performed significantly ( $p \leq .05$ ) better than the KR/SR group. No other significant differences existed between the groups. The author noted that augmented KP is a beneficial type of feedback in learning a complex motor task (closed task).

In a later study, Beitel (1983) sought to determine the relative effect of: (a) focusing attention in four ways on KR, KP, KP/KR, or no focus, and (b) the presence or absence of viewing videotape replay (VTR) on the performance with practice of a complex open gross motor task. The subjects ( $n = 88$ ) were randomly assigned to eight attention and VTR conditions wherein performance measures were recorded over eighteen trials for: (a) length of time to complete the task, and (b) the subjects accuracy in assessing the degree to which they achieved the desired movement, and the goal. The task was a self-paced skill requiring the subjects to manipulate a soccer ball through a fixed environment. The results of the study indicated that over four blocks of practice trials, focus of attention was the most critical factor. At blocks three and four, all three focused-attention groups (KP, KR, KP/KR) were significantly ( $p \leq .05$ ) more accurate in assessing the degree to which the desired movement was achieved than the other control groups. At block 4, the KR and KP/KR feedback

groups assessed their goal attainment with greater accuracy ( $p \leq .01$ ) than did either the KP or control groups. Videotape viewing proved to be the most effective feedback when combined with attention focused on KR. Beitel suggested that the primary contributions of the study were that: (a) focus of attention was the most important of the two augmented feedback factors on performance and goal attainment, (b) combined KR/KP was the best type of attention to attain overall efficiency of performance, and (c) KR was the second best facilitator of the acquisition of an open motor task. The results supported Gentile's (1972) tenet and extended the projection to incorporate KR and combined KP/KR as important types of feedback for the acquisition of skills in gross open motor tasks.

Richards (1984) investigated the effects of augmented attentional focus on the performance of a closed perceptual-motor task (bowling) for individuals who differ in task mastery. The subjects ( $n = 64$ ) were assigned to two groups based on bowling averages. The beginning task mastery group had a bowling average less than or equal to 130, while the advanced task mastery group had an average greater than or equal to 150. Each subject rolled 30 balls at a full ten-pin set-up, but received one of four augmented focus of attention conditions, i.e., focus on: (a) environmental results of the movement that was performed (KR); (b) the movement that was performed (KP); (c) self, via presence of VTR camera and monitor; or (d) nothing by experimental manipulation. The pinfall and distance from target scores were averaged and grouped into six blocks of five trials each. The

results of the study partially supported Gentile's (1972) theoretical projections by revealing that: (a) bowling accuracy of beginning bowlers who received an augmented attentional focus to KR was significantly better ( $p \leq .004$ ) than that of the beginning control group, (b) the distance from target scores of the advanced bowlers who received augmented attentional focus to KP were more accurate ( $p \leq .038$ ) than those of the KR focus or of the control groups.

### Summary of the Review of Literature

The major implications of the feedback studies reviewed indicated that augmented feedback is a significant factor in improving performance (Bell, 1970; Beitel, 1983; Carre, 1972; Gentile, 1972, 1975). There appeared ample evidence to justify Bilodeau and Bilodeau's (1969) statement that a literature review showed feedback to be the strongest most important variable controlling performance. In general the results of feedback theorists and researchers' studies seem to indicate:

1. There may be an optimum amount and type of feedback for every task, stage of learning, and learning situation (Stewart, 1980).
2. Different environmental conditions may demand either KP and/or KR (Gentile, 1972; Higgins, 1972, 1977).
3. For effective goal attainment to occur the spatial and temporal elements must be matched by the performers movements (Gentile, 1972, 1975; Higgins, 1972, 1977).

Based upon the research which supported the use of feedback in the acquisition of sport motor skills, the findings were rather consistent that when KR and/or KP is provided and then withdrawn, performance deteriorated in succeeding trials. However, Gentile (1972, 1975) and Higgins indicated that certain types of feedback are more appropriate for tasks with certain environmental conditions.

Carre (1972), Del Rey (1971), Hampton (1970) and Wallace and Hagler (1979) indicated that KP is the most effective feedback for a motor skill performance in a consistent, unchanging environment (closed task). Other researchers (Barbarich, 1980; Beitel & Ferguson, 1981) indicate that KR is the most effective feedback for a motor skill performance in changing environmental conditions (open task). Relative to KR/KP researchers (Beitel, 1983; Gentile, 1972, 1975) indicate that this type of feedback will result in greater consistent interactive movement leading to more efficient performance.

In summary it has been established that both KP and/or KR are important factors in motor skill acquisition and performance. There remains a question concerning the appropriate feedback to use with different tasks. However, it appears there is a need to determine the most effective type of extrinsic augmented feedback, KR and/or KP on performance/learning with assessment of both goal attainment and movement consistency of a multidimensional task with different environmental demands.

## CHAPTER III

## PROCEDURES

This chapter explains the procedures utilized to investigate the effects of receiving three forms of feedback on the learning of a motor skill. Contained in this chapter are sections covering the following topics: (a) selection of subjects, (b) task selection, (c) selection of the performance apparatus, (d) procedures for task administration, (e) testing methodology, and (f) statistical treatment of the data.

Selection of Subjects

The subjects were 120 college females, attending The University of Tennessee, Knoxville, during the Winter Quarter of 1985. All of the subjects were volunteers who had little or no experience in the task to be performed (dart throwing). All were informed that: (a) their practice would be videotaped for later use, and (b) they would not be viewing their tapes. Upon volunteering for the study the subjects were asked to read and sign an Informed Consent Statement (Appendix D).

Following recruitment, all participants were randomly assigned to one of four treatment groups ( $n = 30$ ) performing either a closed or an open task. The groups for both the closed task and the open task were designated: (a) control, (b) KR, (c) KP, and (d) KR/KP.

### Selection of Task

The purpose of this study was to investigate the effects of receiving three forms of feedback (knowledge of results and/or knowledge of performance) on the learning of a sport task under two different environmental conditions. Dart throwing was selected as the sport task for this study for a variety of reasons: (a) dart throwing is a basic limb transport/manipulation sport task (Gentile, 1975); (b) dart throwing is a novel skill to the experimental subjects and the outcome of the task can be measured with minimal amount of interference and bias (Witt, 1979); and (c) dart throwing allows the same performance goals (goal attainment and movement consistency) to be used under both closed and open environmental conditions (Higgins & Spaeth, 1972).

Specifics concerning the target height, target size, and the distance of the subject from the target were determined, based on several previous studies. Mendoza and Wichman (1978) and Wichman and Lizotte (1983) conducted studies incorporating target heights of 1.6 meters (from the floor to the top edge of the target). Target size and distance of the subjects from the target were identical in the previous two studies, and were also replicated in a study by Moore (1984). The target was a circular piece of paper which could be presented either as a white disk or as a disk marked in alternate black and white concentric rings. The white target was used to control the extrinsic KR the subjects would receive from the black and white target (Stewart, 1980). When marked concentrically the "bull's

eye" was 3.5 centimeters in diameter and the concentric rings were increased in radii 3.5 centimeters until the total diameter of the target was reached. The subjects in all three groups stood 3 meters from the target.

To examine the effects of receiving three forms of feedback (KR and/or KP) in two different environmental conditions (open and closed), it was necessary to select an experimental task for which the temporal/spatial demands could be appropriately altered, but controlled. Additionally, it was essential that the goal of the open and closed tasks be the same with the exception of temporal demands (Higgins & Spaeth, 1975).

#### Selection of Performance Apparatus

A review of literature and pilot study were conducted to establish consistencies for the target height, target size, and the subject's distance from the target. The data from a pilot study using targets with three concentric rings were examined (Sanders, 1984). Mendoza and Wichman (1978) and Wichman and Lizotte (1983) utilized targets with five concentric rings. However, a three ring target was selected for this study based on the results of the pilot study. In the pilot study sessions with a changing variable environment (open task), 61.3% of the practice throws landed on the middle three rings and 4% landed on the outer two rings; and during the practice on the closed task with a fixed stationary target, 56.3% of the practice throws

landed on the middle three rings and 6% on the outer two rings. Consistent with Moore's (1984) rationale, the two outer concentric rings were deemed unnecessary.

The rationale for making the "bull's eye" 3.5 centimeters and increasing the radius of each ring in the target by 3.5 centimeters was based upon the pilot study (Sanders, 1984) and previous investigations (Mendoza & Wichman, 1978; Moore, 1984; Wichman & Lizotte, 1983).

The target height of 1.6 meters from the floor to the top edge of the target was based upon past research (Mendoza & Wichman, 1978; Wichman & Lizotte, 1983), and the participants in the pilot study indicated that the height of the target was suitable. Procedures for selecting the distance of the subject from the target (3 meters) were also based on a review of the literature (Mendoza & Wichman, 1978; Moore, 1984; Wichman & Lizotte, 1983) and the results of the pilot study.

Additional pilot testing (Sanders, 1984) and examination of past research was conducted to determine: (a) administration of feedback, (b) length of treatment session, and (c) determination of assistant's duties. In past research (Beitel, 1983; Beitel & Ferguson, 1981; Richards, 1984) feedback was administered to the subjects immediately following each performance trial. In these studies some groups completed questionnaires focusing attention on the results of performance. Richards (1984) incorporated a 4-item questionnaire relative to KP and KR in bowling. Beitel (1983) and Beitel and Ferguson (1981) utilized a 17-item questionnaire to focus attention on the performance of an

open sports skill (soccer). As a result of pilot testing (Sanders, 1984), a 5-item questionnaire focusing attention on KR and KP of dart throwing was determined to be suitable and minimize feedback overloading (Stewart, 1980). The length of the total treatment session (30 minutes) was specifically chosen because it was sufficient time to administer all forms of feedback and to have control over subject distraction (Richardson, 1967). A female assistant was utilized during the study to change the subject identification board (Appendix E), recover darts, change targets and block numbers after each block of 5 darts. The investigator operated the VTR and the moving target. The testing sessions relative to the time of day and day of the week were controlled by random assignment across subjects and treatment groups (Beitel & Ferguson, 1981). No extrinsic motivation was provided to the subjects.

Task performance scores for goal attainment scores were the sum of numerical values of the 5 darts. Each "bull's eye" was scored 10, the second ring was scored 5, and the outer ring was scored 3 (Appendix C). Movement performance scores were tabulated from the number of yes results of the dart throwing task as determined by the researcher scoring each trial of the subject's videotaped performance using the 5-item KP questionnaire (Appendix A). Prior to actual testing, the researcher recorded a 95% reliability rating on scoring the pilot study's videotape performances. Goal attainment and movement consistency were calculated for all trials (Treatment and baseline data phase). Mean and standard deviation scores were calculated for each block of 5 trials for both goal attainment and movement consistency.

### Task Administration

Optimal performance of certain throwing skills often included goal attainment (Higgins, 1977; Stewart, 1980) and movement consistency (Higgins, 1972; Witt, 1979) as important components. Therefore, the task selected for this study was to throw darts at a target displayed by a Variable Target Apparatus (VTA). The target is similar to the one used by Mendoza and Wichman (1978), Moore (1984), and Wichman and Lizotte (1983). An example of the target used in the study is shown in Appendix C. The stable environment was provided by the target fixed at a height of 1.6 meters from the floor to the center of the target. Variable environmental conditions were provided by the presentation of a moving target (12 rpm). The subjects attempted to strike the target with a dart thrown with the dominant arm. The dominant arm was identified by the participants when they were completing the Informed Consent Statement (Appendix D).

The specifics relative to target size and distance from the subject were based on a review of the literature (Mendoza & Wichman, 1978; Moore, 1984; Wichman & Lizotte, 1983) and the results from the pilot study. The target was a circular piece of paper 17.5 centimeters in total diameter, marked in three concentric rings, increasing by a radius of 3.5 centimeters. The "bull's eye" had a diameter of 3.5 centimeters, and the center was painted black followed by a white ring. The color scheme continued until the edge of the target was reached. The paper target was affixed to a  $\frac{1}{4}$  inch thick piece of plywood, (37 centimeters in diameter) by masking tape. The plywood was

painted black. Each of the target rings were given a numerical value. A "bull's eye" was scored as 10, the second ring 5, and the last ring 3. A dart that landed on the plywood but missed the target received a value of 0. Height of the target was 1.6 meters from the floor to the top edge of the target. Subjects in the study were positioned 3 meters from the target face, and stood behind a red restraining line.

The  $\frac{1}{4}$  inch piece of plywood was attached to a 16 millimeter reel of film, which was subsequently looped through a Kodak Analyst<sup>tm</sup> Film Projector. The projector and target were flanked by  $\frac{1}{2}$  inch sheets of plywood which were painted black.

The darts were brass tipped, 12.7 centimeters long and weighed 7/16 ounces, with four blue plastic vanes comprising the tail. The darts were placed on a table approximately 2 feet away from the subject's dominant arm side. A videotape camera was located at a diagonal position from the subject (Appendix E).

### Testing Methodology

Prior to the testing session all of the subjects were randomly assigned to one of the two tasks and one of the four experimental groups. Each of the 120 subjects were individually tested in one 30 minute session as scheduled by the investigator. Upon entrance to the testing area the subjects were instructed that the task was to throw darts at a target. Preliminary instructions were consistent for all groups (Appendix F).

The subjects stood 3 meters from the target behind a red restraining line. Based upon the pilot study it was determined that

the first 10 trials (2 blocks of 5 darts) were needed to orient the subjects to the task. The initial 2 blocks of the 5 darts were designated as the baseline data phase for the groups. During the first 10 throws all the subjects threw darts at a white target 17.5 centimeters in diameter, but with temporal/spatial demands of their group incorporated. The assistant retrieved the darts, changed the target, and changed the block number after the subject threw five darts. All 50 practice trials were videotaped by the investigator, who also controlled the stability or movement of the target. Immediately after the 10 practice trials without feedback, each subject threw 8 sets of 5 darts (treatment trials) following the procedures designated by the respective treatment group specifications:

#### Group I--Control

Closed task. The subjects ( $n = 15$ ) assigned to this group performed the same procedures as outlined for practice without feedback, but during the treatment trials the subjects threw 8 blocks of 5 darts at a fixed stable white target. No augmented feedback was provided to the subjects in this group.

Open task. The subjects ( $n = 15$ ) assigned to this group performed the same procedures as outlined for practice without feedback, but during the treatment trials the subjects threw 8 blocks of 5 darts at a white target moving at 12 rpm. No augmented feedback was provided to the subjects of this group.

### Group II--Knowledge of Results

Closed task. The subjects ( $n = 15$ ) assigned to this group performed the same procedures as outlined for practice without feedback, but during the treatment trials the subjects threw 8 blocks of 5 darts at a fixed black and white target (Appendix C). Immediately after the practice without feedback and at the completion of each subsequent trial the subjects received augmented KR by returning to the table adjacent to their dominant side and responding to a 5-item questionnaire focusing attention on the results for the particular task (Appendix B). Additional KR was provided by the black and white concentric circles.

Open task. The subjects ( $n = 15$ ) assigned to this group performed the same procedures as outlined in Group II closed task, but during the treatment trials the subjects threw 8 blocks of 5 darts at a black and white target moving at 12 rpm.

### Group III--Knowledge of Performance

Closed task. The subjects ( $n = 15$ ) assigned to this group performed the same procedures as outlined in practice without feedback, but during the treatment trials the subjects threw 8 blocks of 5 darts at a fixed white target. Immediately after practice without feedback and at the completion of each subsequent trial, the subjects received augmented KP by returning to the table adjacent to their dominant side and responding to a 5-item questionnaire focusing attention on their performance (KP) for the particular task (Appendix A).

Open task. The subjects ( $n = 15$ ) assigned to this group performed the same procedures as outlined in Group III closed task, but during the treatment trials the subjects threw 8 blocks of 5 darts at a white target moving at 12 rpm.

#### Group IV--KR/KP

Closed task. The subjects ( $n = 15$ ) assigned to this group performed the same procedures as outlined in Groups II and III receiving both KR and KP by answering the questionnaire focusing attention on performance and on related results. During the treatment trials the subjects threw 8 blocks of 5 darts at a fixed stable black and white target.

Open task. The subjects ( $n = 15$ ) assigned to this group performed the same procedures as outlined in Group IV--closed task. But, during the treatment trials, each subject threw 8 blocks of 5 darts at a moving black and white target.

#### Statistical Treatment

Task performance scores of each subject were recorded for each trial in the baseline and treatment phases of the experiment. The mean and standard deviation were calculated for the four dependent performance measures: (a) goal attainment, (b) goal attainment consistency, (c) movement performance, and (d) movement consistency. The individual scores for the dependent performance measures were grouped in 10 blocks of 5 trials. On blocks 1 and 2 simple main

effects were utilized to determine if the groups were or were not significantly different at the beginning of the study (Winer, 1971). Bonferroni planned comparisons were also performed on blocks 9 and 10 on the four dependent measures to test the hypotheses.

## CHAPTER IV

## RESULTS

The primary purpose of this study was to investigate the effects of receiving three forms of feedback (knowledge of results and/or knowledge of performance) on the learning/performance of dart-throwing in two environmental conditions, an open and a closed task. The data analyses included: (a) calculation of the block scores for the dependent performance measures: goal attainment, goal attainment consistency, movement performance, and movement consistency, (b) a post hoc simple main effects procedure was calculated at Blocks 1 and 2 to identify if significant differences exist between the treatment groups at the beginning of the study, and (c) calculation of Bonferroni comparisons to identify at Blocks 9 and 10 to test the specific hypotheses (Chapter I, pp. 7 and 8). The results were organized in relation to: (a) goal attainment for the open and the closed task, (b) goal attainment consistency for the open and the closed task, (c) movement performance for the open and the closed task, and (d) movement consistency for the open and the closed task.

At Blocks 1 and 2 a post hoc simple main effects procedure was utilized to determine if the treatment groups (KR/KP, KP, KR, control) were or were not significantly different on the four dependent measures. The results revealed there were no significant differences between treatment groups on the dependent measures at the beginning of the study and prior to treatment.

### Goal Attainment

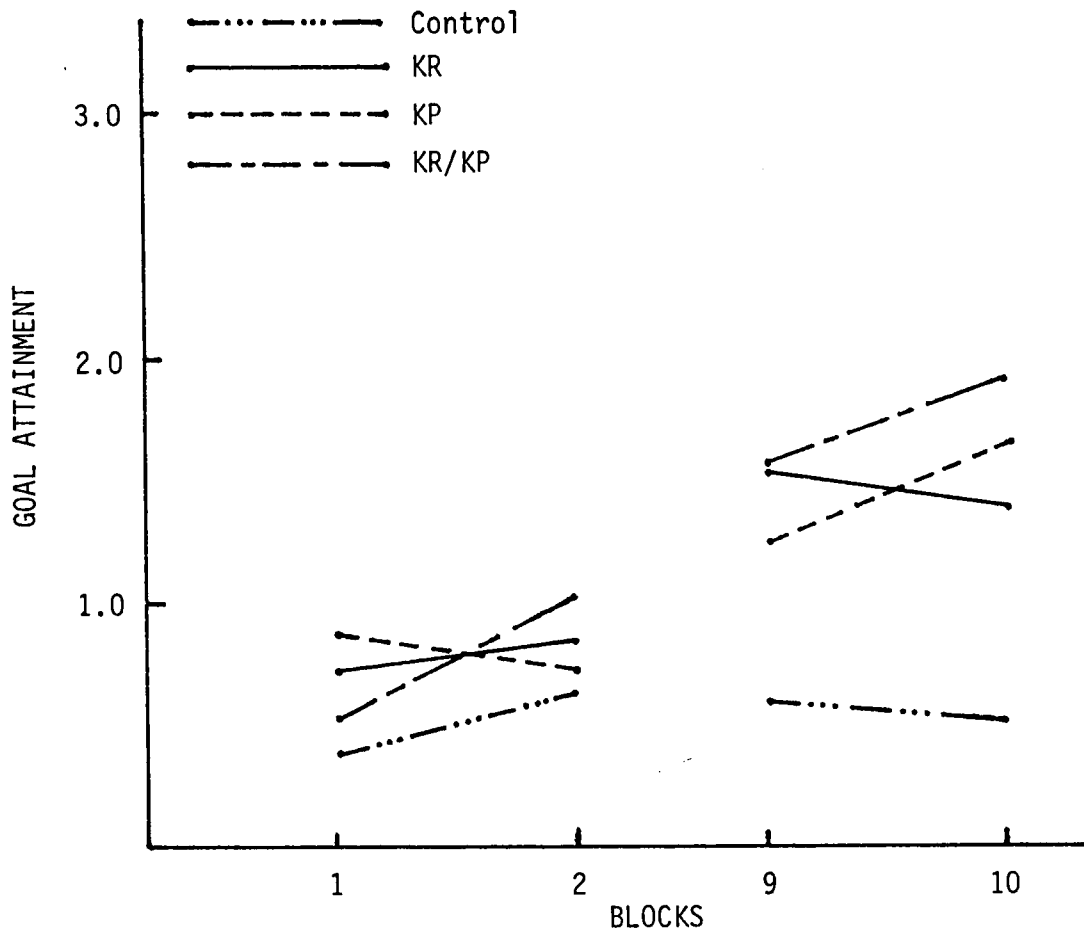
The Bonferroni planned comparisons (Neter & Wasserman, 1974) were performed on the dependent measure goal attainment (Figures 1 and 2) for the open and closed task to test the first two hypotheses (Chapter 1, p. 7).

#### Open Task

The results revealed at Block 9 that the KR treatment group had significantly ( $F_{1,112} = 8.75, p < .01$ ) better goal attainment than did the control group. There were no significant differences in goal attainment between the KR group, and the KR/KP or KP groups (Figure 1). At Block 10 the planned comparison results revealed there were no significant differences in goal attainment between the KR group and the KR/KP, KP, or no augmented feedback (control) group (Figure 1). The findings lend only partial support to the hypothesis that beginners who received KR would have significantly better goal attainment performance than those subjects who received KR/KP, KP, or no augmented feedback (control).

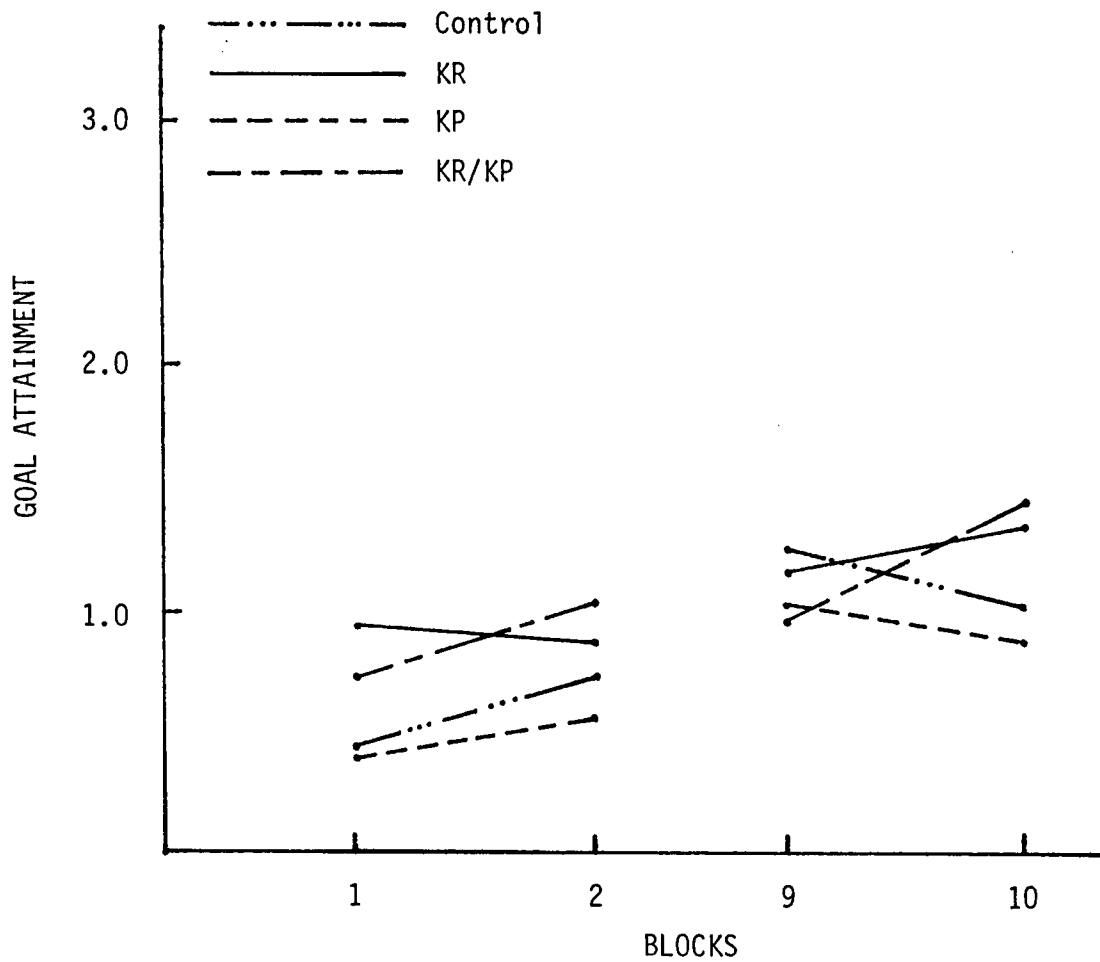
#### Closed Task

The results revealed at Block 9 there were no significant differences in goal attainment performance between the KP group, KR/KP group, KR group, or no augmented feedback (control) group (Figure 2). At Block 10 the results revealed there were no significant differences in goal attainment performance between the KP



| Note:   | Means                  |                         |                        |                         |
|---------|------------------------|-------------------------|------------------------|-------------------------|
|         | (Std. Dev.)            |                         |                        |                         |
| Control | <u>.386</u><br>(.410)  | <u>.640</u><br>(.771)   | <u>.600</u><br>(.871)  | <u>.506</u><br>(.579)   |
| KR      | <u>.706</u><br>(.627)  | <u>.840</u><br>(.764)   | <u>1.546</u><br>(.998) | <u>1.400</u><br>(.965)  |
| KP      | <u>.880</u><br>(1.016) | <u>.733</u><br>(.683)   | <u>1.253</u><br>(.698) | <u>1.673</u><br>(1.331) |
| KR/KP   | <u>.520</u><br>(.594)  | <u>1.040</u><br>(1.212) | <u>1.560</u><br>(.917) | <u>1.933</u><br>(1.561) |

Figure 1. Goal attainment mean score for the open task.



Note:

|         | Means<br>(Std. Dev.)  |                         |                         |                         |
|---------|-----------------------|-------------------------|-------------------------|-------------------------|
| Control | <u>.440</u><br>(.442) | <u>.706</u><br>(.704)   | <u>1.266</u><br>(1.044) | <u>1.066</u><br>(1.027) |
| KR      | <u>.946</u><br>(.850) | <u>.880</u><br>(.608)   | <u>1.186</u><br>(.899)  | <u>1.333</u><br>(.870)  |
| KP      | <u>.400</u><br>(.632) | <u>.573</u><br>(.667)   | <u>1.066</u><br>(.791)  | <u>.893</u><br>(.874)   |
| KR/KP   | <u>.720</u><br>(.549) | <u>1.026</u><br>(1.049) | <u>.986</u><br>(.783)   | <u>1.440</u><br>(1.556) |

Figure 2. Goal attainment mean scores for the closed task.

group, and the KR/KP, KR, or no augmented feedback (control) group (Figure 2).

### Goal Attainment Consistency

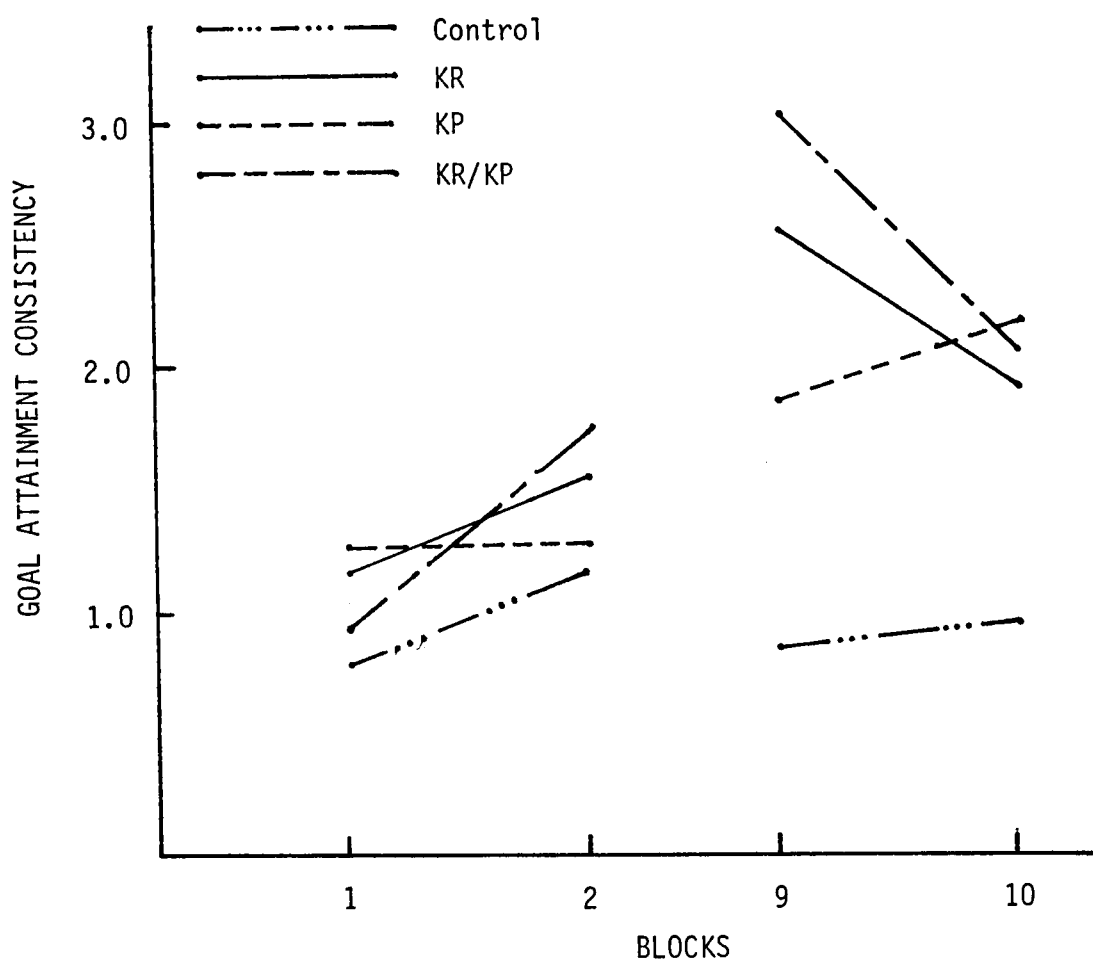
The Bonferroni planned comparisons (Neter & Wasserman, 1974) were performed on the dependent measure goal attainment consistency (Figures 3 and 4) for the open and closed task to identify performance differences between the groups who received KR/KP, KP, KR, or no augmented feedback (control).

#### Open Task

The results revealed that at Block 9 the KR treatment group had significantly ( $F_{1,112} = 13.855, p < .01$ ) greater goal attainment consistency than the control group. There were no significant differences in goal attainment consistency between the KR/KP, KP groups (Figure 3). At Block 10 the results revealed there were no significant differences in goal attainment consistency between the KR group, KR/KP, KP, or control groups (Figure 3). These findings only partially lend support to the hypotheses that beginners who received augmented KR would have significantly greater performance at Block 9 than those subjects who received KR/KP, KP, or no augmented feedback (control) (Figure 3).

#### Closed Task

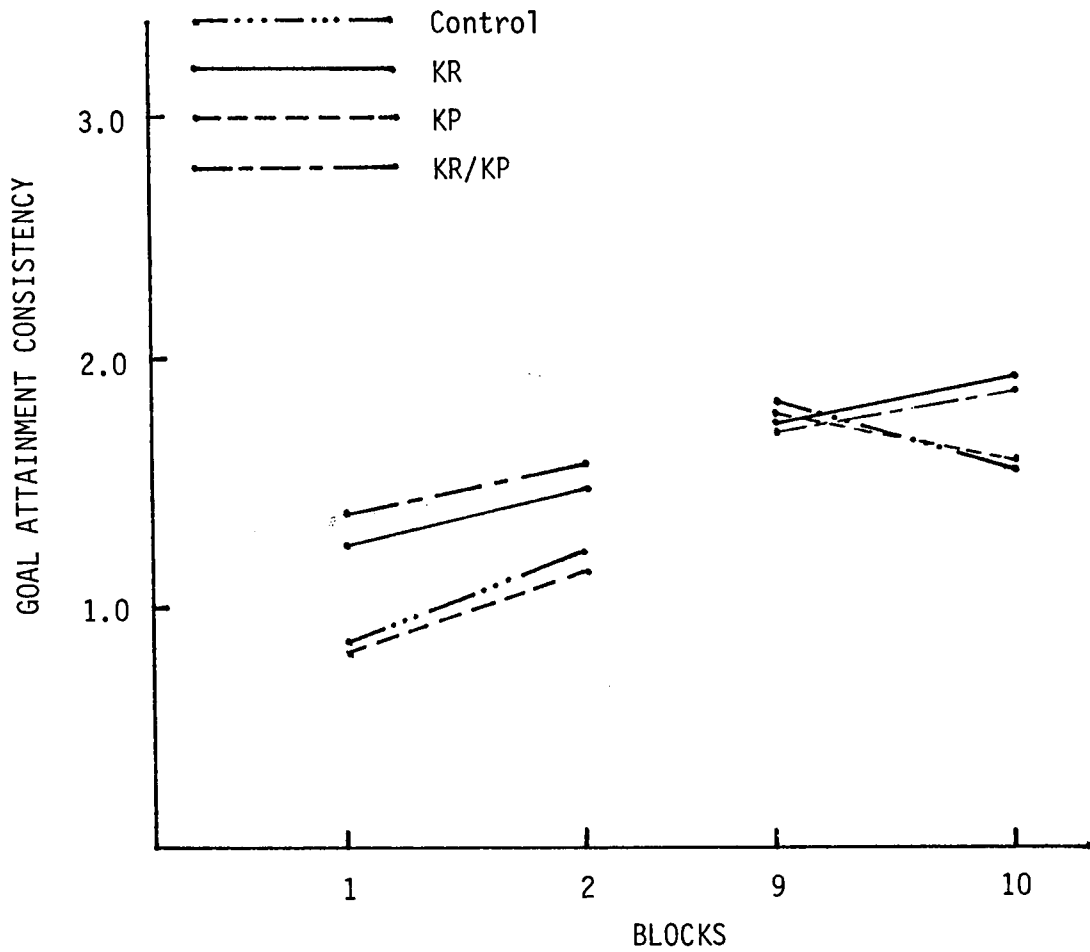
The results at Block 9 revealed there were no significant differences in goal attainment consistency between the KP group,



Note:

|         | Means<br>(Std. Dev.) |                  |                  |                  |
|---------|----------------------|------------------|------------------|------------------|
| Control | .795<br>(.802)       | 1.178<br>(1.324) | .846<br>(.863)   | .962<br>(.996)   |
| KR      | 1.186<br>(.940)      | 1.579<br>(1.236) | 2.542<br>(1.746) | 1.928<br>(.941)  |
| KP      | 1.276<br>(1.194)     | 1.295<br>(1.119) | 1.878<br>(.929)  | 2.171<br>(1.546) |
| KR/KP   | .923<br>(.952)       | 1.727<br>(1.307) | 3.025<br>(1.510) | 2.085<br>(1.143) |

Figure 3. Goal attainment consistency mean scores for the open task.



Note:

|         | Means<br>(Std. Dev.)   |                         |                         |                         |
|---------|------------------------|-------------------------|-------------------------|-------------------------|
| Control | <u>.845</u><br>(.721)  | <u>1.313</u><br>(.830)  | <u>1.810</u><br>(1.318) | <u>1.548</u><br>(1.245) |
| KR      | <u>1.257</u><br>(.849) | <u>1.484</u><br>(.863)  | <u>1.724</u><br>(.985)  | <u>1.930</u><br>(.934)  |
| KP      | <u>.809</u><br>(1.272) | <u>1.166</u><br>(1.278) | <u>1.746</u><br>(1.178) | <u>1.561</u><br>(1.472) |
| KR/KP   | <u>1.370</u><br>(.938) | <u>1.588</u><br>(1.129) | <u>1.720</u><br>(1.193) | <u>1.893</u><br>(1.544) |

Figure 4. Goal attainment consistency mean scores for the closed task.

KR/KP, KR, or control groups. At Block 10 the results revealed there were no significant differences in goal attainment consistency between the KP group, KR/KP, KR, or control groups (Figure 4).

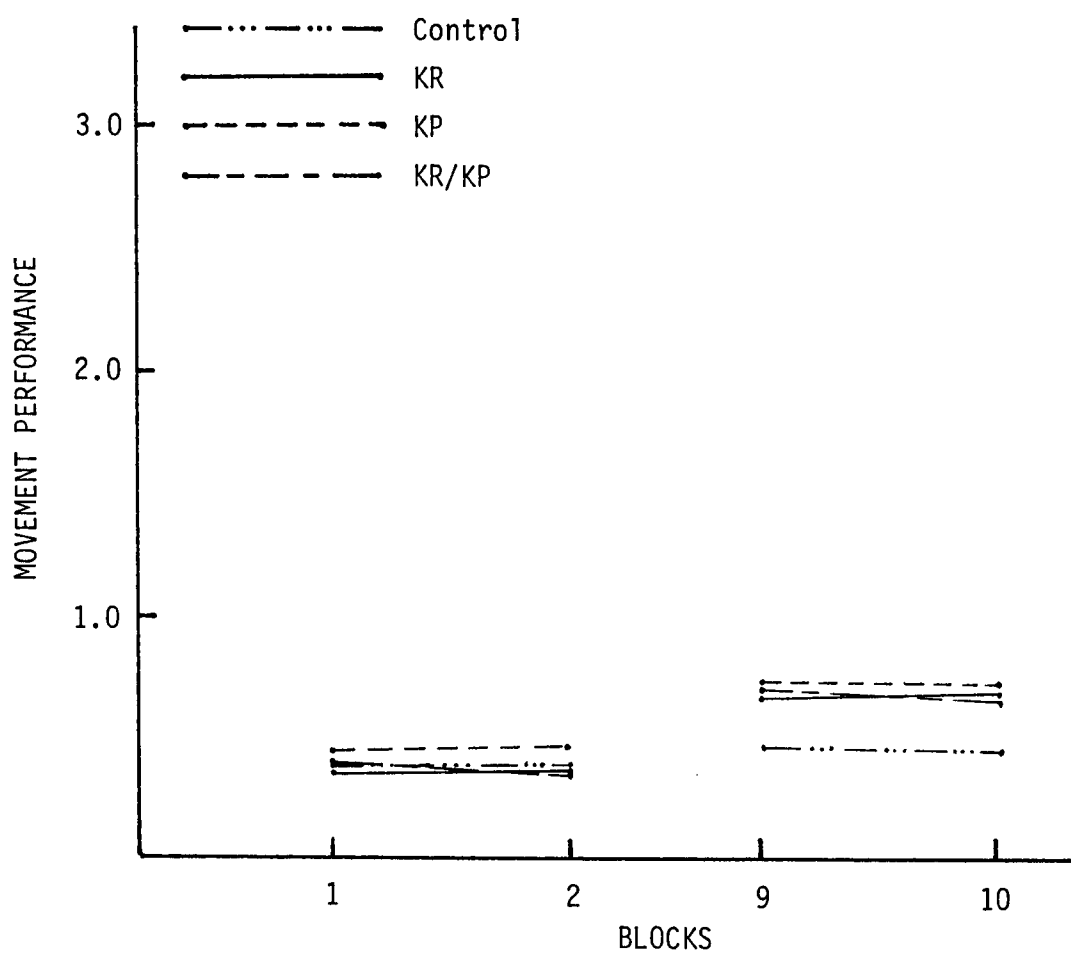
### Movement Performance

The Bonferroni planned comparisons (Neter & Wasserman, 1974) were performed on the dependent measure movement performance (Figures 5 and 6) for open and closed tasks to identify performance differences between the groups who received KR/KP, KP, KR, or no augmented feedback (control).

#### Open Task

The results revealed that at Block 9 the KR/KP treatment group had significantly ( $F_{1,112} = 11.07, p < .01$ ) better movement performance than did the control group. There were no significant differences in movement performance between the KP/KR and the KP or KR groups. These findings lend partial support to the hypothesis that beginners who receive augmented KR/KP would have significantly better movement performance than those subjects who received KP, KR, or no augmented feedback (control) (Figure 5).

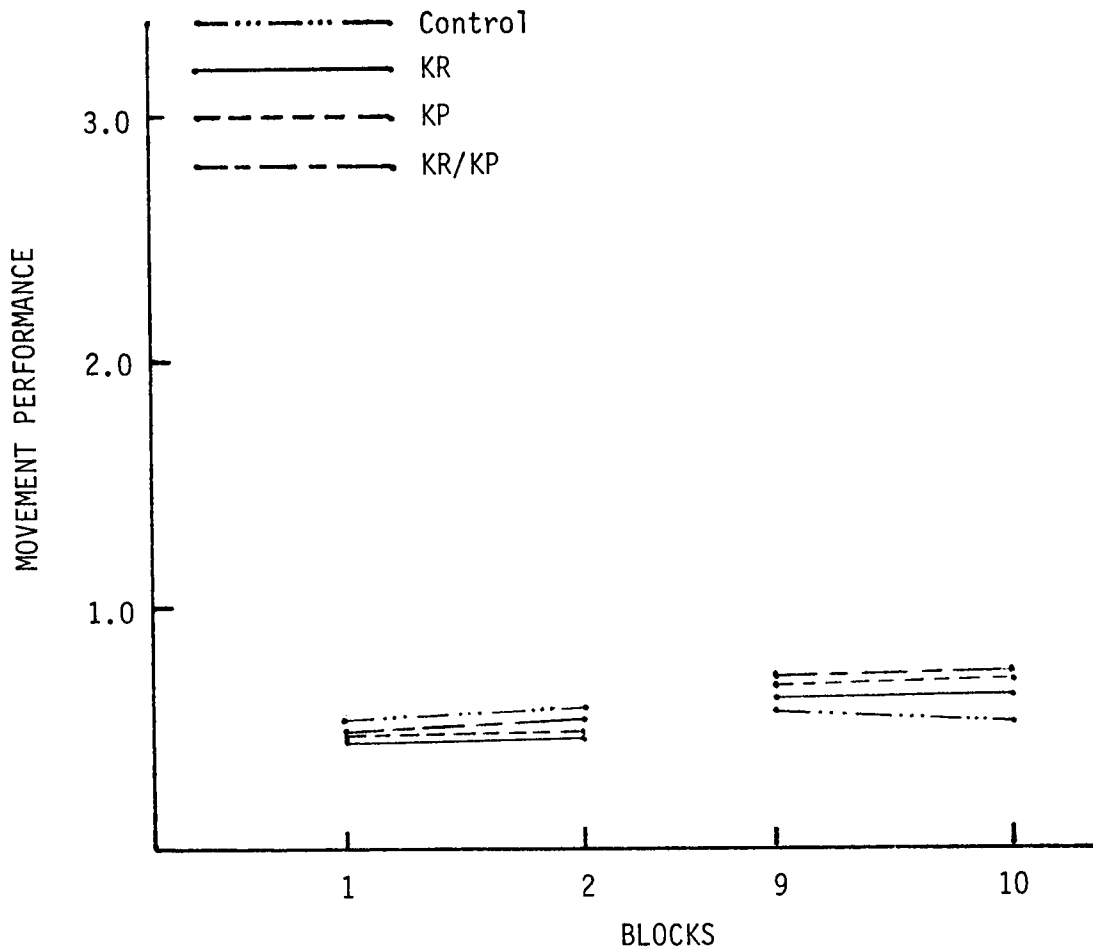
At Block 10 the results revealed that the KR/KP treatment group had significantly ( $F_{1,112} = 14.06, p < .01$ ) better movement performance than the control group. There were no significant differences in movement performance between the KR/KP group and the KP, or KR groups (Figure 5). These findings lend only partial support to the hypothesis that beginners who received augmented KR/KP would



Note:

|         | Means       |             |             |             |
|---------|-------------|-------------|-------------|-------------|
|         | (Std. Dev.) |             |             |             |
| Control | <u>.397</u> | <u>.397</u> | <u>.445</u> | <u>.429</u> |
|         | (.151)      | (.151)      | (.193)      | (.173)      |
| KR      | <u>.378</u> | <u>.381</u> | <u>.674</u> | <u>.685</u> |
|         | (.138)      | (.138)      | (.173)      | (.176)      |
| KP      | <u>.445</u> | <u>.461</u> | <u>.709</u> | <u>.706</u> |
|         | (.207)      | (.209)      | (.165)      | (.199)      |
| KR/KP   | <u>.394</u> | <u>.352</u> | <u>.682</u> | <u>.674</u> |
|         | (.232)      | (.213)      | (.177)      | (.201)      |

Figure 5. Movement performance mean scores for the open task.



Note:

|         | Means                 |                       |                       |                       |
|---------|-----------------------|-----------------------|-----------------------|-----------------------|
|         | (Std. Dev.)           |                       |                       |                       |
| Control | <u>.544</u><br>(.455) | <u>.498</u><br>(.202) | <u>.570</u><br>(.297) | <u>.506</u><br>(.180) |
| KR      | <u>.445</u><br>(.168) | <u>.461</u><br>(.206) | <u>.610</u><br>(.179) | <u>.624</u><br>(.164) |
| KP      | <u>.453</u><br>(.206) | <u>.466</u><br>(.214) | <u>.688</u><br>(.156) | <u>.698</u><br>(.149) |
| KR/KP   | <u>.456</u><br>(.209) | <u>.464</u><br>(.237) | <u>.690</u><br>(.193) | <u>.704</u><br>(.200) |

Figure 6. Movement performance mean scores for the closed task.

have significantly better movement performance than those subjects who received augmented KR or KP (Figure 5).

#### Closed Task

At Block 9 the results revealed there were no significant differences between the KR/KP group and the KP, KR, or control groups. These findings do not support the hypothesis that beginners who received augmented KR/KP would have significantly better movement performance than those subjects who received augmented KP, augmented KR, or no augmented feedback (control).

At Block 10 the KR/KP treatment group had significantly ( $F_{1,112} = 9.188$   $p < .01$ ) better movement performance than did the control group. There were no significant differences in movement performance between the KR/KP group and the KP or KR groups (Figure 6). These findings lend only partial support to the hypothesis that beginners who received augmented KR/KP would have significantly better movement performance than those subjects who received augmented KP, KR, or no augmented feedback (control).

#### Movement Consistency

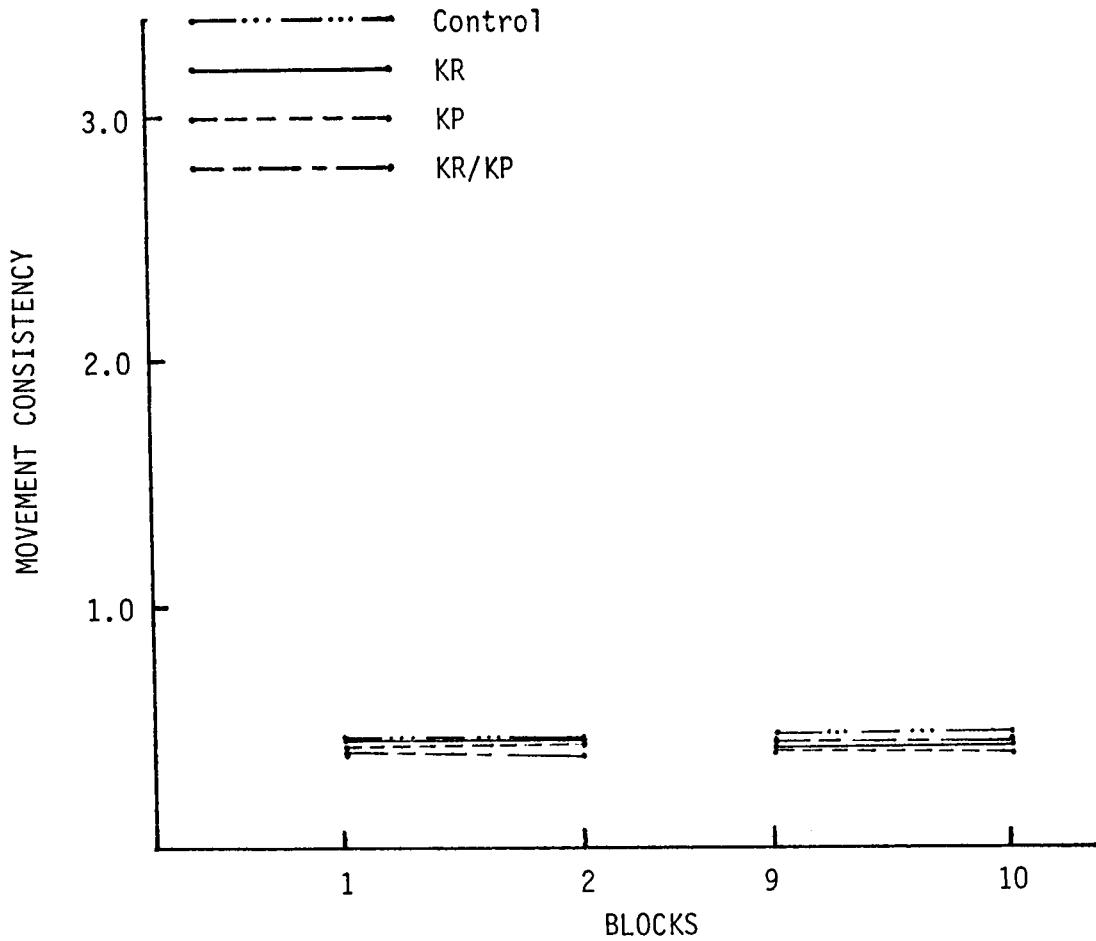
The Bonferroni planned comparisons (Neter & Wasserman, 1974) were performed on the dependent measure movement consistency for open and closed tasks to identify performance differences between the groups who received KR/KP, KP, KR, or no augmented feedback (control).

### Open Task

The results revealed that at Block 9 there were no significant differences in movement consistency between the KR/KP group, KP, KR, or no augmented feedback (control) groups. At Block 10 the results revealed there were no significant differences between the KR/KP group, KP, KR, or no augmented feedback (control) groups (Figure 7).

### Closed Task

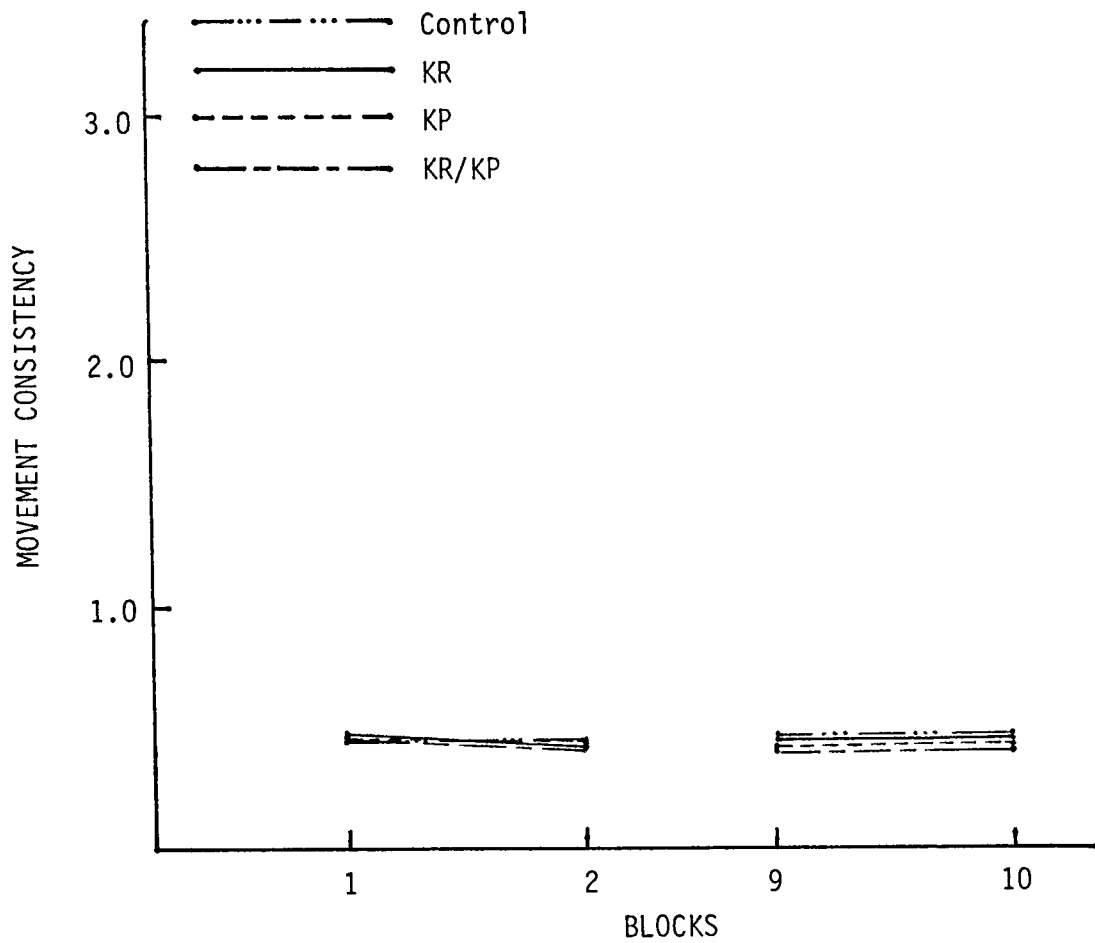
The results revealed that at Block 9 there were no significant differences in movement consistency between the KR/KP group, KP, KR, or no augmented feedback (control) groups. At Block 10 the results revealed there was no significant differences in movement consistency between the KR/KP, KP, KR, or no augmented feedback (control) groups (Figure 8).



Note:

|         | Means<br>(Std. Dev.)  |                       |                       |                       |
|---------|-----------------------|-----------------------|-----------------------|-----------------------|
| Control | <u>.474</u><br>(.041) | <u>.474</u><br>(.041) | <u>.468</u><br>(.040) | <u>.473</u><br>(.042) |
| KR      | <u>.474</u><br>(.042) | <u>.474</u><br>(.047) | <u>.429</u><br>(.125) | <u>.424</u><br>(.124) |
| KP      | <u>.456</u><br>(.087) | <u>.460</u><br>(.065) | <u>.412</u><br>(.137) | <u>.395</u><br>(.147) |
| KR/KP   | <u>.412</u><br>(.146) | <u>.386</u><br>(.169) | <u>.423</u><br>(.128) | <u>.415</u><br>(.135) |

Figure 7. Movement consistency mean scores for the open task.



Note:

|         | Means<br>(Std. Dev.) |                |                |                |
|---------|----------------------|----------------|----------------|----------------|
| Control | .452<br>(.044)       | .467<br>(.044) | .472<br>(.037) | .476<br>(.039) |
| KR      | .471<br>(.041)       | .449<br>(.128) | .461<br>(.062) | .462<br>(.065) |
| KP      | .462<br>(.054)       | .459<br>(.064) | .441<br>(.071) | .436<br>(.084) |
| KR/KP   | .462<br>(.046)       | .447<br>(.065) | .426<br>(.062) | .414<br>(.082) |

Figure 8. Movement consistency mean scores for the closed task.

## CHAPTER V

## DISCUSSION

The importance of feedback in the acquisition of sport motor skills is well documented (Adams, 1971; Annett, 1969; Gentile, 1972, 1975; Higgins & Spaeth, 1975). Feedback serves many functions for the learner, i.e.: (a) knowledge of results, (b) knowledge of performance, (c) information feedback, (d) movement reinforcement feedback, (e) psychological feedback, (f) reinforcement, and (g) reward (Annett, 1969; Bilodeau, 1969).

The multiple influence of feedback on learning/performance has precipitated numerous studies attempting to determine: (a) the best type of feedback to be administered in the particular environmental condition in which the motor skill is to be performed, (b) the most effective modality for delivering feedback, and (c) the effectiveness of KP and/or KR on the improvement of open and/or closed skills.

Gentile (1972) in her model of skill acquisition suggested that specific types of feedback differentially affect performance of motor skills with varied environmental demands. Higgins (1972) indicated that for effective goal attainment to occur the spatial/temporal environmental elements must be matched by the performer's movements. Empirical support for Gentile's and Higgin's predictions have been provided by studies with open and closed tasks. Del Rey (1971) indicated that augmented KP was not as effective for improving open skill performance as it is for closed skills. Additional research by Carre

(1972), Hampton (1970) and Wallace and Hagler (1979) indicated that KP is the most effective feedback for a motor skill performance in a consistent, unchanging environment (closed task). Other researchers (Barbarich, 1980; Beitel & Ferguson, 1981) indicated that KR is effective feedback for motor performance under changing environmental conditions (open task). Research by Beitel (1983) suggested that combined KR/KP was the best type of attention, followed by KR, to attain efficient performance of an open skill.

The review of literature suggested that both KR and KP were both important factors in sport motor skill acquisition and performance. However, it appeared there still remains a question concerning the appropriate feedback to use with tasks with different environmental and/or movement demands. This study was designed to determine the most effective type of augmented feedback, KR and/or KP on performance/learning of a multidimensional task with different environmental demands. There were six hypotheses set forth in this study concerning the effects of KR and/or KP on performance of dart throwing in an open and closed task. The results of each tested hypothesis is presented and discussed in relation to the theoretical framework and previous research findings.

### Goal Attainment

#### Open Task

The first hypothesis suggested that at the end of the practice time the goal attainment performance scores of the subjects receiving

augmented KR would be significantly ( $p < .05$ ) better for the open task than for those subjects receiving augmented KR/KP, KP, or no augmented feedback (control) (Figure 1, p. 42). Although the results of this study did not entirely support this hypothesis for beginners on the open task, the results indicated that the KR group performed significantly better ( $p < .01$ ) than the control group at Block 9. However, at Block 10, there were no significant differences in goal attainment between the KR group and the groups receiving augmented KR/KP or KP. These findings appear to support Gentile's prediction that KR will lead to the learning/performance for an open task, and a proper type of feedback employed can be useful in obtaining the desired goal, i.e., the movement response but conform to the spatial/temporal characteristics of the environment in which it takes place (Gentile, 1972; Higgins, 1972).

#### Closed Task

The second hypothesis in this study stated that at the end of the practice period the goal attainment performance scores of the subjects receiving augmented KP would be significantly ( $p < .05$ ) better on the closed task than for those subjects receiving augmented KR/KP, KP, or no augmented feedback (control). The results of this study did not support the hypotheses at beginners on the closed task (Figure 2, p. 43). These findings do not support the predictions of Del Rey (1971) and Gentile (1972), that augmented KP is the most effective type of feedback to use for closed tasks. According to Adams (1971),

it is possible that under the time and performance conditions of this skill that the learner has not yet developed an internal standard or perceptual trace of the desired movement to be learned. Consequently, the learner did not develop the proper mechanics of the skill to facilitate acquisition.

### Goal Attainment Consistency

#### Open Task

Hypothesis 3 suggested that at the end of this practice period the goal attainment consistency scores of the subjects receiving augmented KR would be significantly greater ( $p < .05$ ) on the open task than for those subjects receiving: (a) augmented KR/KP, (b) augmented KP, and (c) no augmented feedback (control). The results concurred with research by Beitel (1983), Beitel and Ferguson (1981), Gentile (1972, 1977), and Higgins (1972, 1977) that KR is an effective form of feedback for motor skill performance in changing environmental conditions (Figure 3, p. 45). The pattern of results ( $p < .01$ ) indicated that the augmented KR group was significantly better than the control group, but there was no difference between KR group and the groups receiving augmented KR/KP or KP. The results suggested that in the initial learning of a skill the ability to analyze one's own performance in relation to the environmental demands may facilitate the successful attainment of the goal and produce greater consistency of the goal attainment scores at this stage of learning.

### Closed Task

The fourth hypothesis indicated that at the end of the practice period, the goal attainment consistency scores of the subjects receiving augmented KP would be significantly better ( $p < .05$ ) for the closed task than the scores of subjects receiving: (a) augmented KR/KP, (b) augmented KR, and (c) no augmented feedback (control). Although the results were not statistically significant for augmented KP on goal attainment consistency for closed tasks further investigation is needed. Both past research and predictions stemming from skill acquisition theory suggest that further research is warranted concerning the relative effects of augmented KP and other forms of feedback on closed skill performance.

### Movement Performance

The fifth hypothesis suggested that after practicing at least 40 throws, the movement performance scores of the subjects receiving augmented KR/KP would be significantly better on the respective open or closed task than those subjects receiving: (a) augmented KP, (b) augmented KR, and (c) no augmented feedback (control).

### Open Task

The results at Block 9 and 10 indicated that the KR/KP group performed significantly better ( $p < .01$ ) than the control group. The results also lend partial support to the projection of Gentile (1972), Higgins (1972), and Stewart (1980) that KR/KP provides valuable information to help the learner develop a consistent movement pattern,

one that could increase the probability of achieving the desired outcome.

### Closed Task

The pattern of significant results indicated that the KR/KP treatment group was significantly ( $p < .01$ ) better than the control group, but there was no difference between the groups receiving augmented KP, or KR. The results partially concur with Gentile (1972) and Higgins' (1972, 1977) predictions that relative to KR/KP that this type of feedback may result in greater facilitation of actual movement during performance. These findings also support the theorists' projections that in the initial learning/performance of a skill the proper feedback can be useful in matching movement demands to the environmental conditions resulting in greater goal attainment and movement.

### Movement Consistency

The last hypothesis suggested that after practice for the designated time, the movement consistency scores of the subjects receiving augmented KR/KP would be significantly better on the respective open or closed task than those scores of subjects receiving: (a) augmented KP, (b) augmented KR, and (c) no augmented feedback (control).

### Open and Closed Task

The data for movement consistency revealed that there were no significant differences between the four treatment groups (Figures 7

and 8, pp. 52, 53). Therefore the hypotheses concerning differences among the KR/KP, KP, KR, and control groups in the enhancement of movement consistency were not supported. Based upon the results of the 50 trials of dart-throwing there may not have been enough time on the open and closed tasks to reveal treatment effects for practice. Although the results were not statistically significant it seems justifiable to conduct further investigations comparing the effects of receiving KR/KP, KP, KR, and no augmented feedback (control) on movement consistency for both open and closed tasks with a greater number of practice trials.

### Summary

The most important finding of this investigation was that the group receiving augmented KR/KP during the treatment trials reached a significantly higher level of movement performance on both open and closed skills than the groups receiving no augmented feedback (control). It appears that augmented KR/KP provided valuable information to help the learner develop a consistent, efficient movement pattern, one that increased the probability of achieving the desired outcome. If this is true, the learner needs information regarding the correct form for producing the desired outcome. In many of the complex motor skills the learner may have difficulty evaluating the mechanics of the movements produced and the environmental conditions in the early stages of skill acquisition. Consequently, it may be essential that the learner receive combined KR/KP so that skill acquisition can occur.

The findings of the present study supported the hypothesis that augmented KR/KP as a beneficial type of feedback in the initial stages of learning an efficient movement pattern (Gentile, 1972; Higgins, 1972).

Only partial support was provided for Beitel (1983), Beitel and Ferguson (1981), Del Rey (1971), and Gentile's (1972) predictions that augmented KR would be significantly better on goal attainment on the open task. Rationale for differences in the level of performance of goal attainment could be partially attributed to the conditions of the study; i.e., practice time. The performance was still fluctuating from trial to trial and block to block. As learners were refining a motor task, consciously attending to feedback, and attempting to integrate both performance and feedback, the degree of attainment of the goal and consistency continued to fluctuate.

## CHAPTER VI

## SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Summary

The purpose of this study was to investigate the effects of receiving three forms of feedback (knowledge of results and/or knowledge of performance) on the learning/performance of dart-throwing in two environmental conditions, i.e., as an open and closed task. The hypotheses tested the theoretical projections of Gentile (1972) and Higgins (1972, 1977) that at the end of the practice period: (a) the subjects receiving augmented KR would have significantly greater ( $p < .05$ ) goal attainment than those groups receiving augmented KR/KP, KP, or no augmented feedback (control) for the open task; (b) the subjects receiving augmented KP would have significantly greater ( $p < .05$ ) goal attainment than those subjects receiving augmented KR/KP, KR, or no augmented feedback (control) for the closed task; (c) the subjects receiving augmented KR would have significantly better ( $p \leq .05$ ) goal attainment consistency than those receiving augmented KR/KP, KP, or no augmented feedback (control) for the open task, (d) the subjects receiving augmented KP would have significantly better ( $p \leq .05$ ) goal attainment consistency than those receiving augmented KR/KP, KR, or no augmented feedback (control) for the closed task, (e) the subjects receiving augmented KR/KP would have significantly better ( $p < .05$ ) movement performance than those subjects receiving augmented KP, KR, and no augmented feedback

(control) for both the open and closed tasks, and (f) the subjects receiving augmented KR/KP would have significantly better ( $p < .05$ ) movement consistency than those subjects receiving augmented KP, KR, or no augmented feedback (control) for both the open and closed tasks.

Each subject was randomly assigned to the closed task or open task group and performed 50 practice trials of throwing darts respectively at either a fixed target or a moving target. All subjects practiced the first 10 trials with no augmented feedback and the remaining 40 trials with the treatment condition for their respective group assignment, i.e.: KP, KR, KP/KR, or no augmented feedback. The individual scores for the dependent performance measures (goal attainment, goal attainment consistency, movement, and movement consistency) were grouped in 10 blocks of 5 trials each and averaged within each block of treatment condition. A post hoc simple main effects procedure was calculated for Blocks 1 and 2 identify if there were or were not significant differences between the treatment groups at the beginning of the practice period. Bonferroni planned comparisons were utilized at Blocks 9 and 10 to determine whether there were significant differences in the dependent performance measures between groups as specified by the hypotheses.

The results of the study indicated that: (a) the goal attainment of the subjects who received augmented KR was significantly better ( $p < .01$ ) than the control group for the open task, (b) the goal attainment consistency for the subjects who received augmented KR

was significantly greater than the control group for the open task, (c) there were no significant ( $p < .05$ ) differences among treatment groups in goal attainment consistency for the closed task, (d) the movement performance of the subjects who received augmented KR/KP was significantly better ( $p < .01$ ) than the control group for the open task, (e) the movement performance of the subjects who received augmented KR/KP was significantly better ( $p < .01$ ) than the control group for the closed task, and (f) there were no significant differences ( $p < .05$ ) between treatment groups on movement consistency for either the open or closed tasks.

### Conclusions

The purpose of this study was to investigate the effects of receiving three forms of feedback (knowledge of results and/or knowledge of performance) on the learning/performance of dart-throwing in two environmental conditions, an open and closed task.

The primary contributions of the study were that providing: (a) combined knowledge of results and performance (KR/KP) produced effective movement performance of both an open and closed task, and (b) knowledge of results produced effective goal attainment and consistency of goal attainment performance of the open task. The results suggest that there are differences in the learning/performance of dart-throwing under two environmental conditions (open and closed) as a result of a period of practice with KP and/or KR.

### Implications for Future Research

The present study has provided partial support for the premise that the proper type of feedback can be useful in enhancing skill acquisition. Based upon the results of this study and previous research the following suggestions are recommended:

1. Further investigation should continue concerning the use of augmented KR and/or KP in the acquisition of motor skills with an emphasis on extending the number of practice trials.
2. Investigation should continue into the use of KR and KP in motor skill acquisition utilizing other motor skills in which movement performance, movement consistency, goal attainment, and goal attainment consistency are incorporated as dependent measures.
3. Investigation should continue into the use of KR and KP in motor skill acquisition utilizing highly skilled performers employing multidimensional tasks which require responses that meet both temporal and spatial criteria.

## REFERENCES

## REFERENCES

- Adams, J. A. (1971). A closed-loop theory of motor learning. Journal of Motor Behavior, 3(2), 11-149.
- Adams, J. A., & Goetz, E. T. (1973). Feedback and practice as variables in error detection and correction. Journal of Motor Behavior, 5, 217-224.
- Ammons, R. B. (1956). Effects of knowledge of performance: A survey of tentative theoretical formulation. Journal of General Psychology, 54, 279-299.
- Annett, J. (1969). Feedback and human behavior. Baltimore, MD: Penguin Books.
- Annett, J. (1971). Acquisition of skill. British Medical Bulletin, 27, 266-271.
- Baker, C. H., & Young, P. (1960). Feedback during training and retention of motor skills. Canadian Journal of Psychology, 14, 257-264.
- Barbarich, J. E. (1980). A study of visual feedback on learning the volleyball forearm pass. Unpublished doctoral dissertation, Springfield College, Springfield, Massachusetts.
- Beitel, P. A. (1980). Multivariate relationships among visual-perceptual attributes and gross-motor tasks with different environmental demands. Journal of Motor Behavior, 12, 29-40.
- Beitel, P. A. (1983, May). Attention as feedback: A test of Gentile's application to teaching open sport skills. Paper presented at the meeting of the North American Society for the Psychology of Sport and Physical Activity, Michigan State University, East Lansing.
- Beitel, P. A., & Ferguson, C. J. (1981). The effect of augmented knowledge of results on learning rate, performance, time, and response accuracy of an open skill. Paper presented at the meeting of Tennessee Association of Health, Physical Education and Recreation.
- Bell, V. L. (1970). Visual and verbal feedback and its effect upon acquisition and retention of a projectile skill. Research Quarterly, 41, 15-19.

- Bilodeau, I. M., Bilodeau, E. A., & Schumsky, D. A. (1959). Some effects of introducing and withdrawing knowledge of results early and late in practice. Journal of Experimental Psychology, 58, 142-144.
- Bilodeau, I. M. (1969). Information feedback. In E. A. Bilodeau (Ed.), Principles of skill acquisition. New York: Academic Press.
- Carre, F. A. (1972). Effect of imitative learning and augmented feedback on the initial stages of learning a novel complex motor skill. Unpublished doctoral dissertation, University of Oregon, Eugene, Oregon.
- Del Rey, P. (1971). The effects of videotaped feedback on form, accuracy, and latency in an open and closed environment. Journal of Motor Behavior, 3, 281-287.
- Dukelow, J. D. (1979). A comparison of the effects of three short delays of augmenting videotape feedback on the learning and retention of a novel motor skill. Unpublished doctoral dissertation, Temple University, Philadelphia.
- Fitts, P. M. (1964). Perceptual-motor skill learning. In A. W. Melton (Ed.), Categories of human learning. New York: Academic Press.
- Fitts, P. M., & Posner, M. I. (1967). Human performance. Belmont, CA: Brooks Cole.
- Fleishman, E. A., & Hempel, W. E., Jr. (1955). The relationship between abilities and improvement with practice in a visual discrimination task. Journal of Experimental Psychology, 49, 301-312.
- Gentile, A. M. (1972). A working model of skill acquisition with application to teaching. Quest, 17, 3-23.
- Gentile, A. M., Higgins, J. R., Miller, E. A., & Rosen, B. M. (1975). The structure of motor tasks. In C. Brad Fleury & J. Salmela (Eds.), Movement 7: Proceedings of Canadian psychomotor symposium. Quebec: Association of the professional in Physical Education of Quebec.
- Hampton, G. (1970). The effect of manipulating two types of feedback knowledge of performance and knowledge of results in learning a complex motor skill. Unpublished doctoral dissertation, Teacher's College, Columbia University, New York.

- Higgins, J. R. (1972a). Movements to match environmental demands. Research Quarterly, 43, 312-336.
- Higgins, J. R. (1977a). Human movement: An integrated approach. St. Louis: The C. V. Mosby Co.
- Higgins, J. R., & Spaeth, R. K. (1972b). Relationship between consistency of movement and environment condition. Quest, 17, 61-69.
- Kleinman, M. (1983). The acquisition of motor skill. Princeton: Princeton Book Co.
- Lavery, J. J. (1964). The effects of one-trial delay in knowledge of results on the acquisition and retention of a tossing skill. American Journal of Psychology, 77, 437-443.
- Malina, R. M. (1969). Effects of varied information feedback practice conditions on throwing speed and accuracy. Research Quarterly, 40, 134-145.
- Mendoza, D., & Wichman, H. (1978). "Inner" darts: Effects of mental practice on performance on dart throws. Perceptual and Motor Skills, 47, 1195-1199.
- Moore, J. O., Jr. (1984). The effects of different times of mental practice during the acquisition of a perceptual motor skill. Unpublished master's thesis, The University of Tennessee, Knoxville.
- Newell, K. M. (1976). Knowledge of results and motor learning. Exercise and Sport Sciences Reviews, 4, 195-228.
- Richards, J. A. (1984). The effects of augmented attentional focus on the performance with practice of a closed perceptual-motor task for individuals who differ in task mastery. Unpublished doctoral dissertation, The University of Tennessee, Knoxville.
- Richardson, A. (1967). Mental practice: A review and discussion (part II). Research Quarterly, 38, 95-107.
- Robb, M. D. (1968). Feedback and skill learning. Research Quarterly, 39, 175-184.
- Robb, M. D. (1972). The dynamics of motor-skill acquisition. Englewood Cliffs: Prentice-Hall, Inc.
- Robertson, B. L. (1972). The effects of varying feedback on learning a fine and gross motor skill. Unpublished doctoral dissertation, University of Oregon, Eugene, Oregon.

- Neter, J., & Wasserman, W. (1974). Applied linear statistical models, regression, analysis of variance and experimental designs. Homewood, IL: Richard D. Irwin, Inc.
- Rothstein, A. L., & Arnold, R. K. (1976). Bridging the gap: Application of research on videotape feedback and bowling. Motor Skills: Theory into Practice, 1(1), 35-62.
- Schmidt, R. A. (1982). Motor control and learning a behavioral emphasis. Champaign: Human Kinetics Publishers.
- Singer, R. N. (1980). Motor learning: Human performance on application to motor skills and movement behavior (3rd ed.). Dubuque: Macmillan Publishing.
- Smode, A. F. (1958). Learning and performance in a tracking task under two levels of achievement information feedback. Journal of Experimental Psychology, 58, 297-304.
- Stewart, J. E. (1980). Knowledge of results and knowledge of performance in learning a complex motor skill. Unpublished master's thesis, University of Oregon, Eugene, Oregon.
- Thompson, D. H. (1969). Immediate external feedback in the learning of golf skills. Research Quarterly, 40, 589-594.
- Wallace, S. A., & Hagler, R. W. (1979). Knowledge of performance and the learning of a closed motor skill. Research Quarterly, 50, 265-271.
- Whiting, H. T. A. (1969). Acquiring ball skills: A psychological interpretation. London: G. Bell & Sons, Ltd.
- Whiting, H. T. A. (1972). Overview of the skill learning process. Research Quarterly, 43, 266-291.
- Wichman, H., & Lizotte, P. (1983). Effects of mental practice and locus of control on performance of dart throwing. Perceptual and Motor Skills, 56, 807-812.
- Winer, B. J. (1971). Statistical principles in experimental design (2nd ed.). New York: McGraw-Hill Book Co.
- Witt, V. (1979). Skill acquisition under variable temporal constraints: The effect of practice conditions. Unpublished doctoral dissertation, Teacher's College, Columbia University, New York.

## APPENDICES

## APPENDIX A

### KNOWLEDGE OF PERFORMANCE QUESTIONNAIRE

# KNOWLEDGE OF PERFORMANCE QUESTIONNAIRE

INSTRUCTIONS: Respond to the following questions after every dart is thrown. Indicate your response using either: (Y) for YES, (N) for NO, or (?) for I DON'T KNOW. Please choose the answer that best represents your truest recollection of the events as they occurred.

|                                                                                                                      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|----------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|
| <b>STANCE/PRELIMINARY</b><br>Did you position your preferred foot with the toes close to the red tape?               |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| <b>GRIP</b><br>Did you grip the dart with the tips of the thumb and the first and second fingers on top of the dart? |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| <b>ELBOW/UPPER ARM</b><br>Did you hold the dart at an ear level position?                                            |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| <b>WRIST SNAP</b><br>Did you vigorously snap your wrist?                                                             |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| <b>RELEASE</b><br>Did you extend your forearm and index finger toward the center of the target?                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|                                                                                                                      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |

21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

## APPENDIX B

### KNOWLEDGE OR RESULTS QUESTIONNAIRE

INSTRUCTIONS: Respond to the following questions after every dart is thrown. Indicate your responses using either: (Y) for YES, (N) for NO, or (?) for I DON'T KNOW. Please choose the answer that best represents your truest recollection of the events as they occurred.

|                          |                                                                              |
|--------------------------|------------------------------------------------------------------------------|
| TARGET SPOT              | Did the dart hit the intended area on the target?                            |
| TARGET ACCURACY          | Did the dart hit the target's "bull's eye"?                                  |
| SPOT ACCURACY            | By how many rings on the target did the dart miss the "bull's eye"? (1,2, ?) |
| ANGLE OF THE THROWN DART | Did the dart follow a good flight pattern to the target?                     |
| VELOCITY OF THE DART     | Did the dart stick in the target and not fall out?                           |

[illegible]

## APPENDIX C

### TARGET

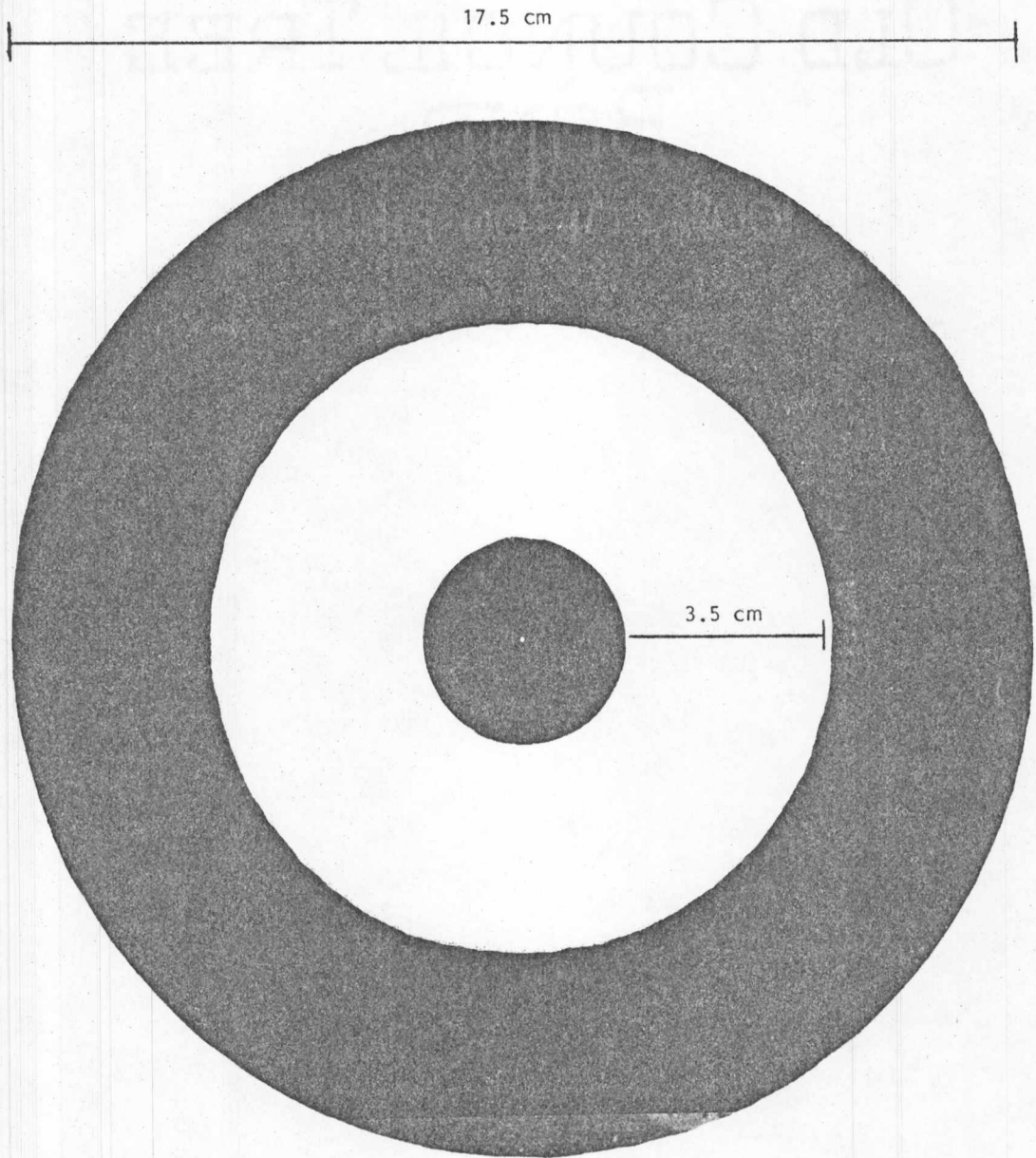


Figure C-1. Target.

APPENDIX D

INFORMED CONSENT

## INFORMED CONSENT

I understand that the purpose of this study is to investigate types of feedback on two similar but different tasks.

I understand that my participation is entirely voluntary. No coercion of any kind has been utilized to obtain my cooperation. I understand that I may withdraw my consent and terminate my participation without penalty at any time during the experiment.

As a participant in this study, I understand that I will be asked to throw a specified number of darts with my preferred hand at a target from a constant distance. I may have explained to me specific procedures to assist me in performing the task. I understand that I will be required to meet the investigator for one thirty minute session. All testing will be conducted in Room 144 of the Health, Physical Education, and Recreation Building.

I understand the above task requirements and any further questions I might have will be answered to my satisfaction by the investigator.

I understand that all of my performance will be videotaped and that all of my responses and tapes will remain completely confidential.

I wish to give my cooperation as a subject.

SIGNED \_\_\_\_\_

WITNESS \_\_\_\_\_

DATE \_\_\_\_\_

CAMPUS ADDRESS \_\_\_\_\_

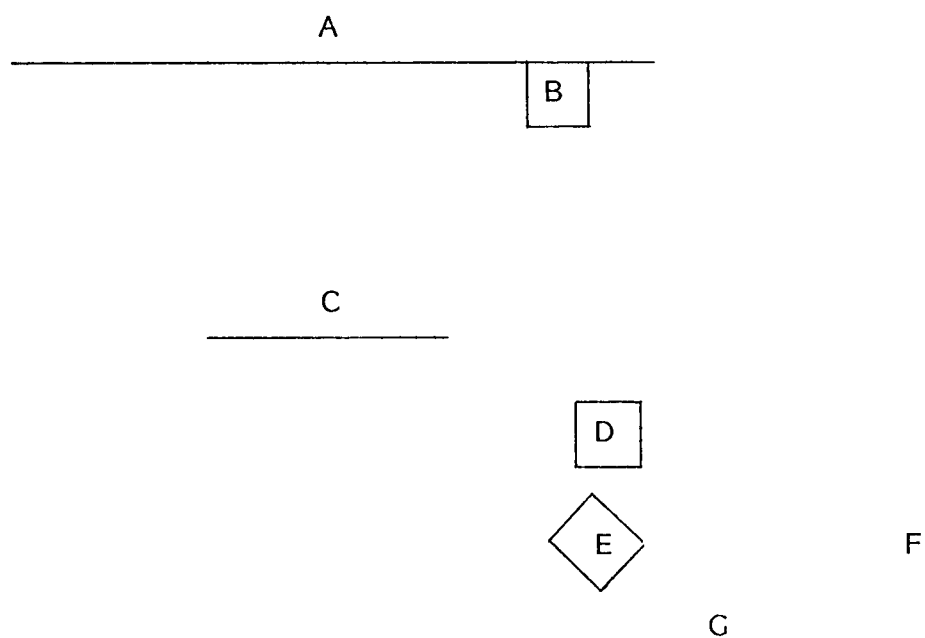
LOCAL PHONE \_\_\_\_\_

PREFERRED HAND            R            L

Michael Sanders  
Room 130 Stokely  
974-1225/1226

## APPENDIX E

### TESTING ROOM LAYOUT



- A. Target
- B. Block and Subject Identification Board
- C. Red Restraining Line
- D. Score and Dart Table
- E. Videotape Camera
- F. Assistant's Position
- G. Experimenter's Position

Figure E-1. Testing room layout.

## APPENDIX F

### PRELIMINARY AND GROUP INSTRUCTIONS

"Hi, I am Michael and this is (research assistant). The purpose of this study is to examine the effects of different types of feedback on dart throwing performance. Your task will be to throw a total of 50 darts (ten blocks of 5 darts). The first two blocks of five darts will be used to orient you to the task. These darts will not count for a score. When you have finished your first two blocks, you will throw 8 blocks of five more darts, each to be scored. During this practice all of your throws will be videotaped.

Other specific instructions will be given immediately following these first 10 throws.

#### Control

Same as above.

#### KR

You are one of several individuals in this study who must answer questions about their performance. Immediately after the last dart thrown, in the orientation phase and every subsequent trial return to the table provided and answer the five item questionnaire concerning your performance for the dart just thrown. The session will be complete when you have thrown the 50 darts and answered the items on your questionnaire.

#### KP

Same as KR.

KP/KR

You are one of several individuals in this study who must answer questions about their performance. Immediately after the last dart thrown, in the orientation phase and after every subsequent trial, return to the table provided and answer the two five item questionnaires concerning your performance for the dart just thrown. The session will be completed when you have thrown the 50 darts and answered the items on the questionnaire.

## VITA

The author was born October 24, 1951, in Helena, Montana. He attended Bishop Gilmore Elementary School, and graduated from Helena Central High School in June 1969. He attended Saint John's University, Collegeville, Minnesota, and graduated with a Bachelor of Science degree in social science in December 1973. He received a Master of Science degree in physical education from the University of Kentucky, Lexington, Kentucky, in August 1977. The author graduated from The University of Tennessee, Knoxville, Tennessee, with a Doctor of Education degree in August 1985.