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THE EFFECTS OF AUGMENTED VERBAL INFORMATION FEEDBACK IN THE MOTOR SKILL LEARNING OF TOTALLY BLIND SUBJECTS SEVEN TO TWENTY-ONE YEARS OF AGE

The Ohio State University

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SEVEN TO TWENTY-ONE YEARS OF AGE

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
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...*

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"The Relationship between Posture and Selected Measures of Static and Dynamic Balance of Hearing Impaired Children."
CHAPTER I

INTRODUCTION

The role of feedback and Knowledge of Results (KR) as it relates to learning is strongly supported by research (Schmidt, 1980). Studies of information feedback (IF) or Knowledge of Results (KR) show it to be the strongest, most important variable controlling performance and learning (Izion, 1966; Bilodeau & Bilodeau, 1961). It has repeatedly been shown that there is no improvement without KR, progressive improvement with IF, and deterioration of performance after its withdrawal (Bilodeau & Bilodeau, 1961).

According to Parteniuak (1976), "a well established fact is that if a learner is not told how well or poorly his movement matched the goal or desired outcome, learning will not occur" (p.180). Information feedback serves at least the three following empirical properties generalized from the issues of reward research. Feedback has been thought to strengthen responses; sustain performance; and to eliminate previously established responses (Eilodeau, 1961; Eilodeau & Bilodeau, 1961; Robb, 1966).
Knowledge of Results (KR) is viewed as a source of error information used by the subject in problem-solving. As such, "a key assumption is that the subject actively operates upon KR during motor learning and uses the information it provides to develop a plan and/or to evaluate the various hypotheses he generates relating to the nature of the correct response" (Schendel & Newell, 1976, p. 251).

Humans are seen as information processing systems. As such, KR is information that is actively processed to serve a directive function for subsequent responses (Adams, 1978). According to Thomas (1980), "the information load" (p. 162) hypothesis is a major factor in central processing speed. This hypothesis involves the interactive effects of the complexity of information feedback and available processing time (post-KR delay interval). This factor is critical if information feedback is truly error information used by the subject in problem-solving.

Thomas, et al. (1979) offers evidence that the "information load has a differential influence on performance of children that is clearly age related" (p. 697). Further, because information processing is limited, "variables such as task difficulty and preciseness of KR must be carefully integrated in appropriate ways for different ages of children" (Thomas, et al., 1979, p. 697). If information processing is overloaded by task complexity or IF precision,
"decrements in both learning and retention are likely to occur" (Thomas, et al., 1975, p.657).

Research relating to the precision of KB "has generally indicated that more precise KB results in increased performance for adults, but a generally accepted premise is that some optimal level will be reached beyond which performance increments will not occur" (Thomas, et al., 1980, p.163). Ammons (1956) further relates the "optimum specificity" (p.287) of information feedback to the performers stage of learning. Specificity of KB, therefore, is dependent upon the subject's ability to use the information at various stages of learning.

According to Magill (1977), the theoretical significance of the post-KB interval, or the time interval between the administration of KB and the next response, is that it is "primarily during this time that information processing occurs and the learner must decide how to use the KB" (p.113). As a result of his review, Adams (1971) presents two generalizations related to the post-KB delay interval. According to Adams (1971), "increasing the post-KB interval up to a point will improve performance level in acquisition" (p.135). This point was confirmed by Schendel and Newell (1976) whose review noted "reliable improvements in the subject's level as a result of increasing - to some optimal level - the duration of the post-KB interval"
This is interpreted to indicate that "KR-related activities increase as task complexity increases and, as a result, additional processing time is required" (Schendel & Newell, 1976, p.252).

The role of KE has also been examined with handicapped populations. Two studies examined the effect of KE in the learning of the pursuit rotary task with mentally retarded subjects (Eaumeister, Hawkins, & Holland, 1966; and Borgan, 1980). Borgan (1980) found auditory feedback associated with correct responses to be most effective for his mildly retarded subjects. Eaumeister, et al. (1966) found their mentally retarded and non-handicapped subjects to "benefit equally from supplementary knowledge of results" (p.42). Loovis and Ziegler (n.d.) examined the effects of verbal augmented Information Feedback in the form of KE, Knowledge of Performance (KP), and a combination of KE and KP in the learning of a shuffle board task by a congenitally blind adult female.

In an effort to provide a more critical analysis of the learning curve, Loovis and Ziegler (n.d.) examined performance at the initial, middle, and final stage of learning. Loovis and Ziegler (n.d.) noted that "all treatments were effective in promoting skill acquisition, but that each was differentially effective during the learning curve" (p.7). Loovis and Ziegler (n.d.) report that "the
blind can use information feedback, namely KP and KE during skill acquisition" (p. 10). A visually impaired subject "must rely on someone or something to provide KP during motor skill acquisition" (Locvis & Ziegler, n.d., p. 10). Further, "there is still the need in a closed skill for KE which helps shape appropriate skill topography and execution" (Locvis & Ziegler, n.d., p. 10). Despite methodological concerns, Locvis and Ziegler (n.d.) conclude that "verbally augmented statements should probably highlight, at least initially, information about the quality of the subject's performance and then only secondarily information pertaining to the results of the attempt" (p. 10).

In examining the need of the visually impaired, Euell (1982) noted that "the more loss of vision a student has, the more he must depend upon his other senses to gain information" (p. ix). As such, the role of supplemental information feedback is magnified. Although much research related to the role of IF has dealt with blind-folded tasks, other research relating to the influence of IF with the visually impaired was not found. The present study examined the effect of augmented verbal information feedback in the learning of a velcro dart-throwing task by totally blind subjects.
Statement of the Problem

Numerous studies have examined the effect of information feedback in motor skill learning, however, few of these studies have involved handicapped subjects. Further, only one study (Loovis & Ziegler, n.d.) examined the effect of verbal information feedback (in the form of KR and RF) in the motor skill learning of visually impaired subjects. Loovis and Ziegler (n.d.) found that a visually impaired subject "can use information feedback ... during skill acquisition" (p.10).

According to Euell (1982), a blind child "depends primarily upon his tactual and auditory senses to obtain information about himself and his environment" (p.54). Further, the teacher of the visually impaired "should give detailed auditory instructions which are in concrete terms within the individual's realm of experience and not based on visual cues" (Euell, 1982, p.54).

In light of the limited research on the role of information feedback in the motor skill acquisition of handicapped subjects, and the visually impaired in particular, this study was developed. The intent of this study was to examine the effects of augmented verbal information feedback in the learning of a novel motor task by totally blind subjects.
This investigation further sought to answer the following questions:

1. What form of verbal information feedback (Kf, Kf, or combinations of Kf and Kf) is most effective in the motor skill learning of totally blind subjects?

2. Does the form of verbal information feedback have a differential effect related to the stage of learning by totally blind subjects?

3. Does the subjects' cause of blindness, sex, residence, or age affect the learning of gross motor skills by totally blind subjects?

Hypotheses

Three null hypotheses were examined:

1. The verbal information feedback treatment condition will not effect the motor skill performance and retention of totally blind subjects.

2. The verbal information feedback treatment conditions will not differentially effect the motor performance of totally blind subjects across learning sessions.

3. The subjects' age, sex, residence, and cause of blindness will not effect the motor skill performance of totally blind subjects.
Limitations of the Study

The following limitations may influence the results of this investigation:

1. The results of this study may have limited generalization to the overall population due to the limited number of the totally blind subjects selected.

2. The ages of the subjects chosen to participate in this study vary widely, and as such, their information processing ability varies. The subjects' information processing ability may affect their ability to use information feedback.

3. The gross motor ability of the subjects chosen to participate in this study was not screened. The perceptual/motor and motor ability of the participating totally blind subjects was not controlled and may have affected their ability to perform the assigned motor task.

4. Visually impaired subjects typically have deficits in body awareness and spatial awareness. This factor was not controlled during the investigation and may have limited the subjects' ability to perform the assigned motor task.

5. Motor ability of visually impaired subjects typically varies in relation to the age of onset of their impairment. The subject's age at the onset of
blindness may affect his/her ability to perform the
assigned motor task.
6. The results of this study are limited to the effects
of verbal information feedback in the learning of
one motor task (dart throwing).

Assumptions
The following assumptions are considered to be true
and relevant for this study:
1. Subjects selected for inclusion in this study are
representative of the overall population of totally
blind subjects.
2. The subjects' performance is not affected by other
factors associated with the treatment procedures.
3. The task assigned in this investigation is representa­tive of motor skill acquisition by totally blind
subjects.

Rationale
Research relating to the role of information feedback
in the motor skill learning of visually impaired subjects
is limited. Depauw (1981) found only six articles that de­scribed empirical evidence to document the need of the
blind for vigorous exercise and programmed activities. The
bulk of the articles found "concerned practical topics such
as what kinds of activities are suitable for blind or visually impaired individuals and how activities for sighted can be modified for blind and visually impaired students in public school" (DePauw, 1961, p. 162).

The present study was important and justifiable because it sought to offer empirical support regarding the use of verbal information feedback in motor skill learning of the totally blind. This study further has implications relating to the instructional programming of the totally blind as well as adding to the body of knowledge relating to the role of augmented verbal information feedback in motor skill acquisition.

Definitions

**Augmented Information Feedback.** Supplementary, augmented or extra information feedback refers to any information not being a direct and necessary consequence of the task or information added to a standard task (Stallings, 1982; Bilodeau, 1966).

**Information Feedback.** Feedback is a general, all-inclusive term referring to the information signal the performer receives regarding the correctness, accuracy or adequacy of his response (Bourne, 1966; Martiuk, 1976).
**Inter-response Interval.** The time interval between two consecutive responses.

**Knowledge of Performance (KP).** Information feedback received following the performance which provides information about the movement itself (Sage, 1977).

**Knowledge of Results (KR).** Information feedback received following the performance which provides information about the outcome produced by the movement (Sage, 1977).

**KR-delay.** The time interval between the response and the receipt of KR.

**Post-KR delay.** The time interval between the receipt of KR and the performance of the next response.

**Session.** A series of 30 trials performed in a particular data collection period.

**Trial.** The motor performance of the learning task in a data collection session. Each trial consists of one execution of the task.

**Totally Blind.** Subjects identified by their school to have insufficient vision to read print or to use their vision for learning (National Society for the Prevention of Blindness, 1966). Participants of this study were also screened to ensure that they were unable to receive visual
feedback from the target relating to the results of their task performance.
Studies of Information Feedback (IF) or Knowledge of Results (KR) show it to be the strongest, most important variable controlling performance and learning (Irion, 1966; Bilodeau & Bilodeau, 1961). Knowledge of Results (KR) is viewed as a source of error information used by the subject in problem-solving. As such, "a key assumption is that the subject actively operates on KR during motor learning and uses the information it provides to develop a plan and/or to evaluate the various hypotheses he generates relating to the nature of the correct response" (Schendel & Newell, 1976, p. 251). "Although most researchers and learning theorists would agree to the necessary existence of knowledge of results during practice for the occurrence of learning, such agreement cannot be found when the temporal role of KR during practice is considered" (Magill, 1977, p. 113). Researchers relating to the role of KR must be aware of three intervals in the KR trial cycle. These intervals include the KR delay (the time interval between the
response and the receipt of FB); post-KB delay (the time interval between the receipt of KB and the performance of the next response); and inter-response interval (the time interval between the two responses). Adams (1971) notes that the inter-response interval cannot be defined independently of the KB delay and the post-KB delay intervals.

Much of the research relating to the role of FB in motor learning is examined in light of current theory. The authors, therefore, relate their findings in terms of these theories.

This chapter will review current literature relevant to this study in five sections. The first section examines research related to the use of IF in academic learning. The current trends in motor learning will be examined in the second section. The third section examines the role and function of KB and KP in motor learning. The next section will review research related to the stages of skill acquisition. The final section will review research related to KB and KP with handicapped and non-handicapped subjects.
Information Feedback in Academic Learning

Research related to the use of IF in academic learning has appeared to focus on the delay of IF, the number of correct alternatives identified in multiple choice testing, and the use of computers to provide IF. Bloom and Bourdon (1980) examined the grading of a sixteen item simple-addition-facts student paper by 183 elementary teachers. Of the seven mutually exclusive types of feedback, "non-corrective feedback was used three times as frequently as corrective feedback" (Bloom & Bourdon, 1980, p.13). Further, "among types of non-corrective feedback the least useful type was used two-thirds of the time" (Bloom & Bourdon, 1980, p.13). According to Bloom and Bourdon (1980), "teachers demonstrated limited use of the feedback strategy positively associated with student achievement" (p.13).

"The results of this study make it clear that no general model of feedback has a wide use, and that teacher feedback does not reflect what research indicates about the effectiveness of various types of feedback" (Bloom & Bourdon, 1980, p.14).

Sturges (1972) examined retention as a function of three forms of IF, three immediate tests, presence or absence of initial presentation of items and two seven day retention tests. Sturges (1972) found that "with a cue, retention was optimal with no immediate test" (p.99). Further, "following immediate tests, instructions to study all
alternatives improved recall but not recognition" (Sturges, 1972, p.59). As a result of these findings, Sturges (1972) concluded that "the information retained varies with the subject's reaction to feedback and the kind of immediate practice" (p.59).

In a related study, Sturges (1969) examined the effect of two levels of IF delay, and two forms of IF upon the retention of factual multiple choice test items. The IF provided consisted of the stem of the item with either all four multiple choice alternatives with the correct answer underlined, or the correct choice only. IF was either available immediately or after a 24 hour delay. Retention was tested immediately following IF and after a seven day interval. Sturges (1969) found that "neither delay nor the form of IF had an effect on immediate retention" (p.11), however, "seven-day retention was superior with delay when IF included both correct and incorrect alternatives" (p.11). Delay of IF had no effect when provided with the correct alternative only (Sturges, 1969).

Phye and Baller (1970) examined the effects of three conditions of IF and delay of IF in the retention of course-related material. IF was either immediate or delayed 48 hours and contained three, seven, or no multiple choice answer alternatives. Retention was measured either immediately or after 7 days. Phye and Baller (1970) found
"insufficient support . . . for the assertion that increase in knowledge of alternatives within the delayed informative feedback condition results in better retention performance over time" (p.380). Further, Fhye and Haller (1970) agree with others finding "no effect of delayed informative feedback upon immediate retention" (p.380).

Suter and Anderson (1975) also examined the effect of delayed feedback on the retention of a "meaningful passage" (p.170) in a 20-item multiple choice test. Feedback was available immediately, or after 24 hours. As a control, two treatment groups received no feedback. Retention was tested on Day 7. Suter and Anderson (1975) found that the "presence or absence of feedback did not affect the probability of being right on a 1-week retention test" (p.170), however, "feedback proved significantly better than no feedback, and delayed feedback proved superior to immediate feedback" (p.170).

In an extension of the concept of delayed IF, Joseph and Maquire (1982) examined the interaction between the time of feedback and the academic self-concept of fourth grade students. As a result of their examination of regression lines, Joseph and Maquire (1982) found that "delayed feedback appeared to benefit students of low perceived ability" (p.360).
Fisher, Williams, and Roth (1981) assessed some effects of the Computer Assisted Self-Evaluation (CASE) system of frequent multiple choice testing with immediate computer feedback. Two equivalent groups of undergraduate students were formed. One group received 24 CASE quizzes with immediate feedback while the second group received two CASE-generated midterms with delayed feedback. Fisher, et al. (1981) note that "quiz students significantly outperform midterm students on the Posttest" (p. 449). Further, "on a retention test given two years later, the Quiz Group scored eight percentage points higher than the Midterm Group" (p.449). The authors also note that Quiz students "had a more positive attitude toward and were more involved in the course" (p.445). These findings are interpreted in support of the CASE system to provide a "simple, cost-effective means of individualized testing in large lecture classes" (Fisher, et al., 1981, p.449).

According to Clark and Manning (1981-82), "computers may have the greatest educational impact on adult professional learners rather than as delivery devices for Computer Assisted Instruction in undergraduate settings" (p.377). Further, with the application of computers to medical education, computers can provide practicing physicians with memory support, profiles of practice for needs assessment, and diagnostic/management algorithms. Clark
HcH een and Thc rman (1981) note that "the interactive use of the computer in tutorial dialogue with students offers the most promise in providing immediate knowledge of results in a testing situation" (p.140). "Immediate knowledge of results has become one of the ends of the educational process" (p.141) something that the teacher should strive toward.

Theories of Motor Learning

"Without a doubt, one of the most heated and persistent controversies throughout this century in the field of motor behavior has concerned the competing ideas about the locus of movement control" (Schmidt, 1980, p.122). Theories of learning have historically been dichotomized into two broad schools of psychology 1) behaviorist theory and 2) cognitive theory (Kleiman, 1983; Stallings, 1982). This dichotomy has been unfortunate in that it has led to accepting either one or the other as the basis for instructional practice rather than profiting from the contributions of both" (Stallings, 1982, p.23). Further, at their
polar extremes their views are "absolutely incompati-
able" (Schmidt, 1980, p. 122).

Behaviorists view the environment as the primary source for explaining, predicting, and controlling behavior and therefore learning (Stallings, 1982). To the behaviorist, learning entails either the bond or association of a stimulus and a response, or the reinforcement of a response (Kleinman, 1963; Stallings, 1982). One's perception, is seen by the behaviorist as a hypothetical factor within the individual which is unobservable and therefore not available for manipulation in the control of behavior (Stallings, 1982). Learning, therefore, is a function of repetition of the stimulus-response pairings.

In contrast to the behaviorist theory, the cognitive theorist is concerned with the individual's perception of the total learning situation. Here one's perceptions are seen to be affected by an indefinite number of stimuli including both present and past experiences (Stallings, 1982). Further, the individual's interpretation of his environment is seen as a critical factor (Stallings, 1982). To the cognitive theorist, learning is a product of the individual's efforts to analyze the situation, and perception rather than repetition is stressed (Stallings, 1982).

In addition to those controversies that separate the behavior theorist and the cognitive theorist, there are
many issues upon which the behaviorist and cognitive theorists divide themselves. Due to the focus of this work, let it suffice to note that the behaviorists are separated in one respect. Operant theorists argue that the critical element in learning pertains to the consequences of the response itself rather than to the association of that response with a given stimulus as promoted by the classical conditioning theorists (Kleinman, 1983).

Although the principles of operant and classical conditioning appear applicable to many aspects of human behavior, "critics of these theories agree that neither the mere association between a stimulus and a response nor the reinforcement of a response itself is adequate to explain the intricacies of complex behavior acts" (Kleinman, 1983, p.48). There is a growing belief that behaviorist theories are too simplistic to account for the processes which underlie the learning and performance of complex motor skills (Kleinman, 1983). According to Kleinman (1983), human learning requires continuous intrinsic regulation and control in which the learner becomes a control system between the stimulus and the response.

This lack of adequate theory for guiding research in motor behavior caused motor behaviorists to reach out in other directions for explanations of motor learning (Schmidt, 1975). In an attempt to reconcile the objectivi-
ty of behaviorism with the flexibility of the cognitive theory, motor learning researchers are turning toward information-processing models of behavior (Kleinman, 1983).

Schmidt (1975) hails the information processing idea as an important event in a number of fields leading to the closed-loop theory of learning. Key elements of the closed-loop system are feedback, error detection, and error correction. Closed-loop theorists contend that movement is controlled through the combination of feedback from the responding limb, and the vestibular, visual, or auditory system.

Unlike the closed-loop system, the open-loop system has no feedback or mechanism for error regulation. Conventional reinforcement and conditioning theories describe learning as being determined by extrinsic open-loop contingencies of reward and punishment or temporal association (Smith, 1966). "If the stimuli are adequate, and the motivation and habit or perceptual states of the organism are sufficient, the response will occur, otherwise not" (Adams, 1971, p. 117). Control, therefore, results from centrally stored movement commands or programs. These programs are structured in advance, and then run-off without the involvement of feedback. Open-loop operations, then, are limited to those in which reactions are direct functions of external stimulation or information conditions uninfluenced by feedback regulation (Smith, 1966).
Many closed-loop theories exist dating back to 1934 (Schmidt, 1975). Adams (1971) developed a theory based on an existing body of carefully controlled research on the instrumental learning of simple, self-paced, graded movements. According to Schmidt (1975), "clearly, the production of a theory that was so easily testable by researchers was appealing, and the Adams theory became a most important article in the field of motor learning in a very short time" (p. 226).

The Adams (1971) closed-loop theory proposes that there are two states of memory, termed the memory trace and perceptual trace. The perceptual trace is the "construct which fundamentally determines the extent of movement, and it is what S uses as the reference to adjust his next movement on the basis of the KI he has received" (Adams, 1971, p. 123). The perceptual trace is responsible for guiding the limb to its correct location in performance of a task. "The strength of the trace grows as a positive function of experiencing the feedback stimuli on each trial" (Adams, 1971, p. 123). In Adams' closed-loop theory, information about error in the form of KR is foremost in leading to a correct response.

Adams' closed-loop theory relies heavily on the perceptual trace for the moment-to-moment guidance of behavior. The theory rejected the "simplistic approach" (Adams,
of the single controlling mechanism of the perceptual trace in favor of the second main construct. The role of the memory trace is to select and initiate the response preceding the use of the perceptual trace (Adams, 1971). After being cued to action, strength of the memory trace grows as a function of practice. According to Adams (1971), "the memory trace is an open-loop program" (p. 126) whose "strength is a function of stimulus-response contiguity" (p. 125).

According to Schmidt (1975), "Adams' theory has a number of characteristics that are generally considered desirable attributes" (p. 227). Among these are his concern for learning; a reduced scope; empirical support; and simplicity. Despite its basis in the learning of linear positioning tasks, Adams' theory is directed toward the learning of novel motor tasks with "a reasonable probability of empirical reality" (Schmidt, 1975, p. 227).

With the growth in research and thinking that has developed since Adams' theory was published, some shortcomings in the theory have been identified (Schmidt, 1975). These criticisms include the limitations to positioning task learning; the error detection mechanism; the subject's inability to learn without KR; generalization to rapid responses; perceptual trace development; storage problems; and novelty problems (Schmidt, 1975). Some of these criti-
cisms result from logical difficulties with Adams' theory, others result from data that failed to support his predictions (Schmidt, 1975).

In light of these identified shortcomings, Schmidt (1975) presents a theory that extends Adams' closed-loop theory. Schmidt's schema theory deals with rapid ballistic tasks with short movement times, open as well as closed skills, accuracy tasks, and tasks that have maximum speed and height as goals (Schmidt, 1975). Schmidt's theory contains three main components: the motor program; states or memory; and error detection.

The original form of closed-loop motor programs implies that every movement has a separate set of stored motor commands. This premise brings with it problems of the storage of the many programs. Schmidt's (1975) schema theory proposes the existence of motor programs generalized for a given class of movement. According to Schmidt (1975), "these generalized motor programs are assumed to be able to present the prestructured commands for a number of movements if specific response specifications are provided" (p. 232). The performer must, therefore, determine the parameters of the response needed to modify the existing stored motor programs. Due to the lag of processing proprioceptive feedback, schema control is an open-loop system (Schmidt, 1975). According to Schmidt (1975), stimuli from
the periphery cannot initiate a new program until the present schema has run its course.

When a performer makes a movement that attempts to satisfy some goal, he stores four bits of information: the initial environmental conditions; the response specifications for the motor program; the sensory consequences of the produced response; and the outcome of the movement (Schmidt, 1975). These sources of information are stored together after the movement is produced. When a number of such movements have been performed the relationship among these sources of information is abstracted. The strength of this relationship increases with each successive movement of the same general type and with increased accuracy of the response feedback. According to Schmidt (1975), "this relationship is the schema for the movement type under consideration and is more important to the subject than is any one of the stored instances" (p. 235).

Schmidt (1975) notes the schema to be the most important portion of the present theory. The memory also serves a vital role. Recall memory is the state that produces the movement. Recognition memory is the state that determines whether the subject can recognize if the movement was correct (Schmidt, 1975).

Two memory states are postulated by Schmidt (1975). However, they should not be seen as totally independent
states for they develop using some of the same variables. According to Schmidt (1975), "the recognition schema develops using the initial conditions, the sensory consequences, and actual outcome integrated into the existing recognition schema" (p. 242). "The recall schema depends on the actual outcome (NB or subjective reinforcement), the initial conditions, and the response specifications" (Schmidt, 1975, p. 242). Further, the recall schema is updated after each performance by the integration of this information into the existing schema (Schmidt, 1975). While both memory states are clearly dependent on the actual outcome, and the initial conditions, both schema develop according to the experience the performer has with these variables (Schmidt, 1975).

The interaction of the memory schema with the response variables also serves a role in error detection. Given his store of past sensory feedback, the subject can generate two types of sensory consequences modified by the initial conditions at hand. The schema generates both the expected proprioceptive feedback, and the anticipated exteroceptive feedback prior to attempting to meet the performance goal. Further, an error signal is generated by the comparison of the actual and expected sensory consequences (Schmidt, 1975). "The error labelling system is proposed to be another schema, in this case a schema for labelling sensory
signals" (Schmidt, 1975, p.239). When this schema is well developed, the performer will be able to attach a label to the error signals "according to the KB-sensory-signal relationship" (Schmidt, 1975, p.239).

Schmidt (1975) termed the labelled error signal "subjective reinforcement" (p.239). This signal serves as a substitute for KB providing outcome information to update the recall schema. However, "subjective reinforcement is less accurate than is the perfect KB, and so the subject will probably use KB to update the recall schema when KB is present, but when KB is not present, the subject can resort to the less accurate subjective reinforcement for his outcome information" (Schmidt, 1975, p.239).

Knowledge of results, therefore, is considered to be the "essential ingredient" (Schmidt, 1975, p.239) without which the performer cannot develop the schema for labelling errors. In addition to being fed back to the schema for update, KB is fed to the error labelling system to improve the accuracy of future error labelling based on deviations of actual and expected sensory feedback. Further, this information provides revised estimates of the expected sensory consequences and response specifications for the next trial (Schmidt, 1975). According to Schmidt (1975), when essential error information is fed back to the schemata, "learning is possible" (p.240).
According to Pew and Baron (1978), Adams' closed-loop theory and Schmidt's schema theory "provides verbal-analytic statements of the functional specifications of a system that could learn to produce movements of a particular type" (p.71). These theories "leave so many degrees of freedom unconstrained that one is at a loss to know whether they could be translated into representations of motor performance in a natural setting" (Pew & Baron, 1978, p.72). Pew and Baron (1976) note that, in general, these popular theories "do not provide sufficient detail" (p.71) to make it possible to produce a model that would predict the behavior of real subjects.

The robust role of KR in learning further emphasizes the controversies between open-loop and closed-loop control of movement behavior. Schmidt (1980) reports that "as the number of motor-behavior researchers and the amount of research output grew during this century, so too grew the intensity of the debate" (p.122). Both groups of theorists have gathered support for their position and against that of the opposing group (Schmidt, 1980).

In the examination of the role of KR in learning, confusion develops over the question of how opposing views can receive empirical support of their position at the same time. In explanation of this question, Schmidt (1980) notes that "scientists who have dealt with these issues
have chosen paradigms or tasks that are particularly suited to providing evidence that 'their' theory appears to be correct" (p.123).

Studies gaining evidence in support of the use of feedback have either used very "slow discrete tasks where there is ample time for feedback corrections, or they have used tracking tasks where the processing of feedback from the display is a critical aspect of performing" (Schmidt, 1980, p.123). Support for the open-loop position has been gained by scientists who have used very rapid, discrete actions where feedback has been found not to be important for movement control (Schmidt, 1980). Schmidt (1980) suggests that in tasks of very short duration, "exteroceptive or proprioceptive information indicating that a new pattern of action should be produced requires approximately 200 msec. before an associated change in movement can be seen" (p.124). Similarly, as the movement time becomes longer, there is more time for these feedback processes to take place, and so "the accuracy in the movement becomes increasingly dependent on feedback processes" (Schmidt, 1980, p.125).

Schmidt (1980) takes the position that both the open-loop and closed-loop positions are "reasonable" (p.123). However, "each of the views are correct only for certain times within a response" (Schmidt, 1980, p.123).
A reconciliation between these opposing groups of theorists, however, appears to be taking place (Schmidt, 1980). Efforts to resolve the issue appear to lie in "changing the question for one of feedback or programs to a series of questions asking when, under what conditions, and for which tasks is feedback or program control used in movement (Schmidt, 1980, p.123).

The Role and Function of KB and KR

Studies of Information Feedback (IF) or Knowledge of Results (KR) show it to be the strongest, most important variable controlling performance and learning (Irion, 1966; Bilodeau & Bilodeau, 1961). It has repeatedly been shown that there is no improvement without KB, progressive improvement with KB, and deterioration of performance after its withdrawal (Bilodeau & Bilodeau, 1961). According to Marteniuk (1976), "a well established fact is that if a learner is not told how well or poorly his movement matched the goal or desired outcome, learning will not occur" (p.180).

Bilodeau (1966) notes that a variety of different terms have been used for much the same experimental procedures. Such terms include Knowledge of Performance; Knowledge of Results; Feedback; Achievement Information Feedback; Information Feedback; Reinforcing Feedback;
Psychological Feedback; Reinforcement; and Reward. Rohl (1966, 1972) notes that many textbooks use the terms feedback, reward, reinforcement, and knowledge of results interchangeably. Further, the terms feedback and information feedback are being used in skill learning research to refer to all kinds of feedback rather than just knowledge of results (Rohl, 1972). "Different terms may be used very similarly by different investigators, and the same term may have different meanings to its different users" (Eilodeau, 1966, p.255). Eilodeau and Eilodeau (1961) noted that their major conclusion regarding the role of feedback is "obvious": "to control behavior; regulate functions of errors" (p.259).

Feedback is a general, all-inclusive term referring to the information signal the performer receives regarding the correctness, accuracy or adequacy of his response (Bourne, 1966; Marteniuk, 1976). This information may be received while he is performing the skill, or after the skill has been completed, and be received through any one, or a combination of sensory systems. As such, feedback may be intrinsic; internal; external; concurrent; terminal; augmented or extra. Supplementary, augmented or extra information feedback refers to any information not being a direct and necessary consequence of the task or information added to a standard task (Stallings, 1962; Bilodeau, 1966). Information-
tion feedback may also be terminal in nature, referring to a summary score or if that occurs following a performance, or concurrent, referring to if occurring during performance (Bobb, 1966, 1972; Stallings, 1982). Concurrent if has also been referred to as "on-going" information providing moment-to-moment regulation of behavior (Bott, 1966).

Bott (1972) notes confusion to have arisen between the terms intrinsic and internal feedback. "Intrinsic feedback is information 'looped' to the task" (Bott, 1972, p.100). Internal feedback refers to those receptor organs that register or provide information regarding the action of the body itself (Bott, 1972). The term internal feedback is often used interchangeably with proprioceptive feedback (Stallings, 1982). Further, however task specific feedback may be, if feedback is not available through one sensory source, man quickly adapts to make use of information from another available source (Folt, 1972; Ammons, 1956).

Information feedback serves at least the three following empirical properties generalized from the issues of reward research. Feedback has been thought to strengthen responses; sustain performance; and to eliminate previously established responses (Eilodeau, 1961; Eilodeau & Eilodeau, 1961; Bott, 1966). "Like primary reward, KR might serve to reinforce (strengthen) habits, evoke already established habits (cue properties), and provide the motivation (incen-
tive) for learning or performing" (Bilodeau & Bilodeau, 1961, p. 253).

KR can be reinforcing in that information rewarding an acceptable performance increases the probability of repeating a similar performance (Bobb, 1972). Adams (1978) regards learning as a problem-solving process in which KR is error information that tells how well he is succeeding in his problem-solving task. Further, as error information, KR provides the motivational charge to eliminate itself (Adams, 1978).

Although much evidence regarding the role of motivation has been collected informally or has been inferred, increased motivation is considered the most common effect of IF (Ammons, 1956). Annet and Kay (1957), however, note that "it does not appear to be necessary to assume an intrinsic motivating factor in knowledge of results but that states of 'motivation' or 'frustration' may be manipulated by presenting goal achievement to the subject via some kind of knowledge of results" (p. 76). Further, Ecurne (1966) notes that "the reinforcing function of typical information feedback is at best minimal and even may have consequences opposite to those usually supposed" (p. 300). Further, KE's information content appears crucial to learning, but whose motivational function appears important only in extreme circumstances which contribute to a low level of "natural"
arousal (Bourne, 1956). Ainsworth (1956) notes that "it is very important to keep in mind what the subject is motivated to do when knowledge of performance increases his motivation" (p. 286). Often, the performer is motivated to score higher, rather than to learn the task at hand (Ammons, 1956). Bobb (1972) notes that the role of IF as a motivator is extremely complex "because there is nothing intrinsically motivating about feedback" (p. 95). The role of IF as a motivator is further complicated by the individual's information processing system. Feedback that motivates one person may inhibit another.

Man is seen as an information processing system. Information processing is an on-going activity. Information as to the state of the environment is constantly being fed into the central processing system. These data are either stored in memory for future decision making or used to direct patterns of behavior (Bobb, 1972). As such, KR is information that is actively processed to serve a directive function for subsequent responses (Adams, 1978). "In all attempts to utilize feedback effectively, the performer must have an accurate reference pattern to which he can compare his response" (Bobb, 1972, p. 106). Through this interaction, learning takes place.

The role of feedback and KR is strongly supported by research (Schmidt, 1980). In summary, it must be noted
that "feedback appears to play a variety of roles, depend­ing on what kind of task is studied and when in the re­
response the analysis is made" (Schmidt, 1980, p.128). Fur­
ther, for feedback to be used "requires attention"
(Schmidt, 1980, p.125) on the part of the subject to initi­
ate error correction.

**Stages of Skill Acquisition**

"As one progresses from an inexperienced to a skilled
state, dramatic changes seem to occur in motor performance"
(Stelmach & Larish, 1980, p.141). According to Stelmach
and Larish (1980), this change is "most evident in the
transition of movement control from a conscious mode to an
automatic mode" (p.141). This section will examine this
transition of movement control with reference to Informa­
tion Feedback.

As a general orientation to the nature of skill acqui­
sition, Fowler and Turvey (1976) parallel skill acquisition
to the evolution of a species. In drawing this parallel,
Fowler and Turvey (1976) describe a species as a "special
purpose device" (p.3) whose "salient properties distinguish
the given species from other species" (p.3). These salient
properties "make the state of adaptation of the species the
special and relatively invariant properties of it's envi­
ronment" (Fowler & Turvey, 1976, p.3). "In the course of
time the species maintains its special attunement by coupling its evolution to that of its changing environment" (Fowler & Turvey, 1978, p.3).

Fowler and Turvey (1978) further note that the species' "adaptation to an environment is synonymous with the evolution of special biological and behavioral features that are compatible with special features of the environment" (p.3). "Insofar, as an environment has structure that provides the criteria for adaptations, so we may expect . . . a task to have structure that provides a source of constraint on skilled solutions" (Fowler & Turvey, 1978, p.3).

In this regards, "skill acquisition is attunement" (Fowler & Turvey, 1978, p.5). and man, with his ability to perceive and deliberate, is the "actor" (p.4). As an actor, man can become "any one of a variety of special purpose devices whose complexity is compatible with the complexity of the task it must perform" (Fowler & Turvey, 1978, p.5). As such, "learning a skill involves discovering an optimal self-organization" (Fowler & Turvey, 1978, p.6).

Further in the course of acquiring skill, the actor must gather "skill specific variables of stimulation that . . . guide and regulate the current approximations and prescribe the next approximation to the desired performance (attunement)" (Fowler & Turvey, 1978, p.6). According to
Fowler and Turvey (1978), "skills have structure, and discovering an optimal self-organization is in reference to those variables of stimulation corresponding to environmental and biokinematic relations that specify the essential features of the skill the actor is to perform" (p.6).

Fowler and Turvey (1976) present the acquisition of skilled performance as a "superordinate system, one that encompasses the actor, his actions, and the environmental supports for his actions" (p.7). From this perspective, "coordination is a relation defined over the actor and the environment, and control is the exclusive prerogative of neither" (Fowler & Turvey, 1976, p.7). According to Fowler and Turvey (1978), "to achieve some aim, . . . an actor must engage in a systematic relationship with the environment" (p.8).

In attempting to describe skill acquisition, Gentile (1972) identifies two stages of learning. Bobb (1972) describes three phases of learning. Gentile (1972) and Bobb (1972), however, share some common descriptors of their levels of skill acquisition.

Gentile's (1972) stages are labelled "Getting the Idea of the Movement" (p.5) and "Fixation/Diversification" (p.11). In Gentile's (1972) Stage I, the individual "organizes a motor pattern" (p.5) to accomplish a particular goal. According to Gentile (1972), "the means-end rela-
tionship or the plan of action which will accomplish the particular goal constitutes what is to be learned" (p.5). Further, "the motor pattern which will be effective in producing a particular outcome is determined, is restricted, is controlled by the environmental characteristics inherently related to the goal" (p.5). In his initial attempts at goal-attainment, "the learner must identify and selectively attend to the regulatory subset of the stimulus population" (Gentile, 1972, p.6). According to Gentile (1972), "only after he can identify and attend to these regulatory conditions is he able to formulate a motor plan that is effective" (p.6).

In Gentile's (1972) initial stage of acquisition, preceding execution, "an image of the movement or general plan of action seems to occur" (p.7). "Barring neurological impairment or marked distractions, the short-term memory of the goal and of the plan will still be available to the performer after executing the movement" (Gentile, 1972, p.8). Such a comparison provides the basis for the next response. "Has the goal accomplished?" (Gentile, 1972, p.8). "Has the movement executed as planned?" (Gentile, 1972, p.8). Following one or more responses of "Yes, I have the idea of the movement now... the problem has been solved" (Gentile, 1972, p.9) the performer enters into Gentile's (1972) stage II.
Gentile (1972) describes stage II as where "having acquired a general concept of the motor pattern that seems to be effective, the learner progresses into a stage in which he attempts to increase the consistency or to refine some characteristics of goal-attainment" (p.11). At this stage, the learner seeks to "reach a particular level of skill (Gentile, 1972, p.11). In attempting to reach this goal, the motor pattern acquired during the initial stage may be refined and retained, or markedly altered, "depending on the nature of environmental control" (Gentile, 1972, p.11). Then, "as the movement becomes more 'habitual' . . . the performer becomes less dependent upon monitoring the external environment" (Gentile, 1972, p.11).

In comparison to Gentile (1972), Robb (1972) describes skill acquisition in three phases. Phase I is a stage of "Plan Formation" (Robb, 1972, p.52). According to Robb (1972), at this stage the learner must understand "the nature of the task and its objectives or purposes" (p.52) in an effort to "formulate an executive plan" (p.52). In addition, during phase I, the learner must also understand the "sequence of the components of the movements" (Robb, 1975, p.52).

After the learner has "received and understood the executive plan, he must practice (Phase II) in order to fix the performance sequence in the human system" (Robb, 1972,
At this phase, the "learner must engage in meaningful practice with emphasis on the temporal patterning of subroutines" (p.60) "to reduce the range of errors between the movement plan desired and the movement pattern produced" (p.65).

In Bobb's (1972) third stage (Automatic Execution) "a skill is characterized by an increase in the ease in which a task or skill is accomplished, and decrease in the stress and anxiety of the performer" (p.66). "The performer has achieved the sequence of the movement through meaningful practice, has reduced his range of errors, has perfected his temporal patterning, and now performs the total movement pattern automatically with fairly consistent results" (Bobb, 1972, p.67).

In his attempts to meet the desired goal, the learner must interact with his environment. According to Bobb (1972), "attention is the descriptive term used to explain which stimulus subsets are processed from a total stimulus field" (p.57). "In the early stages of learning, the student is not able to discriminate between relevant and irrelevant information" (p.58). Later in learning, motor control is relegated to lower brain centers freeing the central processing system "to deal with other components of the task" (Bobb, 1972, p.67). This transition allows the performer to "concentrate on other factors involved in the
According to Gentile (1972), during the learning process, the teacher "takes various roles and assumes different responsibilities" (p. 14). "For both open and closed skills the teacher can provide the student with information regarding either his movement or his goal-attainment" (Gentile, 1972, p. 14). In the initial phase of skill acquisition, "the student must be confronted with the environmental conditions that control his movement" (Gentile, 1972, p. 16). Here the "teacher's task is to help the student identify and attend to the regulatory stimulus subset" (Gentile, 1972, p. 17). At this stage of acquisition, "the need for additional information beyond that which normally occurs as a consequence of the movement is not entirely clear" (Gentile, 1972, p. 19). However, "if the student is unable to make goal/outcome or plan/movement comparisons, then the teacher could provide augmented feedback" (Gentile, 1972, p. 19).

"If the teacher gives too much information on how to perform a certain skill, some of the information will be processed and some will be filtered out" (Gentile, 1972, p. 20). During this early phase of learning, "demonstrations may serve a major purpose ... by showing the sequential ordering of the subroutines, as well as giving information about the executive program, the total purpose or objective being sought" (Gentile, 1972, p. 59).
"Once the student has the idea of the movement, the two most important areas requiring continued teacher involvement would seem to be 1) structuring conditions of practice, and 2) providing feedback and assisting in decision processes" (Gentile, 1972, p. 19). According to Retk (1972), "feedback is probably the single most important factor during the practice session" (p. 66). At this stage of learning, "it is more meaningful for the student to be told when or why the error occurred, i.e. what caused the error, and be given a clue for correcting the performance than be told that the objective was not accomplished (Bobb, 1972, p. 65).

Del Ray (1972) differentiates the form of feedback beneficial in the open and closed skill environment. According to Del Ray (1972), "since the spatial aspects of the environment are static in a closed skill, the student is required to become consistent in his movement pattern so that he will produce the same response each time the skill is performed" (p. 43). On the other hand, "since the spatial aspects in an open environment are always changing . . . appropriate augmented information feedback for open skills would seem to be knowledge of results" (Del Ray, 1972, p. 43). This form of feedback would include "feedback about the environmental changes produced by the movement or feedback about the environmental conditions"
that were operative at the time the student selected a motor pattern" (Del Ely, 1972, p. 43). Fowler and Turvey (1978), however, note that Adams' notion that learning is based on the receipt of KE, "is a gratuitous claim" (p. 21). Fowler and Turvey (1978) note that "information about the nearness to a desired outcome will be insufficient informational support for arriving at a solution to a coordination problem (p. 21)."

"The efforts of a novice to perform an act may be viewed in part as discovery or search tactics aimed at revealing the organizational structure of the task" (Fowler & Turvey, 1978, p. 24). "At present, our knowledge about how motor skills are automated is surprisingly scant and certainly incomplete" (Stelmach & Larish, 1980, p. 154). In attempting to understand this transformation of motor control, "we should no longer focus on just the motor act itself, but rather emphasis should be placed on the contiguity between context (environmental cues) and action" (Stelmach & Larish, 1980, p. 142)."
Review of Research Related to KB and KE with Handicapped and Non-handicapped Subjects

This section reviews current research related to KB and KE in motor learning. As such, six segments have been identified in examining the various effects of KB and KE in research. In this section, research relating to the Mode and Frequency of KB and KE; The KE-delay Interval; The Post-KE Interval; Specificity of KB; Comparison of KB/KE and Behavior Management Procedures; and the use of KB and KE with Handicapped Populations will be discussed.

Much of the research related to the role of KB in motor learning is examined in light of current theory. The authors, therefore, often relate their findings in terms of these theories.

Mode and Frequency of KB and KE

Research has examined both the form of feedback (KB) as well as its role in learning. Adams, Gootz, and Marshall (1972) and Stelmach (1973) provided visual, and auditory feedback in the learning of linear positioning tasks. The learning of the same task was used by Berti (1966), and Faust-Adams (1975) in examining the roles of vision and proprioceptive feedback. In an extension of these feedback modes, more complex tasks of index-finger writing (Laszlo, Eairstow, & Baker, 1975) and the golf skill of putting (Ak-samit & Husak, 1983) were studied.
Stelmach (1973) provided vision, heightened proprioceptive and auditory feedback in the learning of a linear positioning task. After twenty trials with available feedback, KR was removed for an additional twenty trials. Stelmach (1973) concluded that "feedback appears to be an important variable in studying STM" (Short-term Motor Memory) (p.336). Augmented feedback was found to markedly reduce errors at recall (Stelmach, 1973). Further, "the results were interpreted to be in support of the view that a memory trace is imprinted with feedback from all modalities and that the amount of such feedback determines memory trace strength" (Stelmach, 1973, p.333).

The extent of practice in acquisition (15 or 150 trials), as well as the availability of feedback was studied by Adams, Goetz, and Marshall (1972). Augmented or minimal auditory and (heightened) proprioceptive feedback were manipulated in the learning of a linear positioning task in a total of eight treatment groups. Adams, et al. (1972) noted that the groups receiving minimal feedback did not perform significantly different from each other. Further, augmented feedback produced better performance than minimal feedback (Adams, et al., 1972a). Adams, et al. (1972) found that performance in acquisition was positively related to the amount of feedback, and to the amount of practice. These findings were seen to support the assumption
that the perceptual trace is strengthened as experience with feedback stimuli increases (Adams, et al., 1972a). Further, Adams, et al. (1972) noted that performance will deteriorate on feedback withdrawal trials when feedback is minimal (absent). This deterioration in performance "defines a weak perceptual trace that is susceptible to forgetting" (Adams, et al., 1972a, p.357).

In the learning of the golf putt, Aksamit and Husak (1983) found no marked difference between visual and kinesthetic feedback conditions. However, in a task depending on accuracy, Laszlo, et al. (1979) found "practice increases the reliance on kinesthetic feedback" (p.1225). Further, "as the extent of practice increases, so does the reliance on kinesthetic error information" (Laszlo, et al., 1979, p.1225).

In a study of the role of concurrent visual and concurrent proprioceptive feedback, Holt (1968) concluded that "concurrent visual feedback was the most important variable" (p.183) for the learning of a linear positioning task.

Faust-Adams (1975) attempted to separate the effects of concurrent and terminal visual feedback in the learning of a linear positioning task. Although the presence of visual information resulted in better performance, Faust-Adams (1975) concluded that "concurrent visual feedback
does not contribute to performance in short-term memory situations" (p.279). "The presence of additional visual information concerning the terminal position to which the hand was about to move did, however, result in better performance" (Faust-Adams, 1975, p.279). According to Faust-Adams (1975), these results "were taken as providing evidence against the Adams closed-loop theory of motor learning" (p.275).

In the further examination of the mode of sensory feedback, Bamella (1982) examined the effect of terminal visual and verbal FE. According to Bamella (1982), "while the terminal results yielded little difference, the learning curves for visual and verbal post-response information varied" (p.1223). According to Bamella (1982), the subjects experienced "an advantage early in learning when information on errors was supplied verbally" (p.1234).

In the examination of the effect of KE two procedures have been used. KE has been presented on variable frequencies and withdrawn following a varying number of trials.

Ho and Shea (1978), McGuigan (1959), and Bilodeau, Bilodeau, and Schumsky (1959) examined the effect of the relative frequency of KE on the learning of simple motor tasks. In each of these studies, performance was seen to improve with exposure to KE.
McGuigan (1959) provided KR on 10%, 55%, and 100% of performance trials in the learning of a line drawing task. McGuigan (1959) found that "the greater the percentage of trials on which KR was given, the better the performance" (p. 83).

Bilodeau, et al. (1959) provided KR on specific trials and on the last five of a 24 trial acquisition period of a linear positioning task. Bilodeau, et al. (1959) noted no improvement without KR, progressive improvement with KR, and deterioration of response proficiency after the withdrawal of KR. The deterioration of performance upon withdrawal of KR may result from insufficient exposure to KR in acquisition (24 trials) to establish a perceptual trace (Bilodeau, et al., 1959). This study "reasserts the powerful relationship between response and the presence or absence of KR" (Bilodeau, et al., 1959, p. 144). Further, Bilodeau, et al. (1959) noted that "the positive effect of a single KR trial is probably much greater (and more lasting) than the negative effect of a non-KR trial" (p. 144).

Ho and Shea (1978) examined the effects of KR on the retention of a linear positioning task. Each subject received KR on ten trials, however, on a varying frequency and performed a varying number of trials. Ho and Shea (1978) found that "the different amounts of knowledge of results did not produce different retention levels"
These findings are noted to be contrary to Adams' prediction that retention is a function of how many times the feedback stimuli is associated with the correct response (Ho & Shea, 1978). A tentative explanation of these findings is that subjects "no longer use knowledge of results to modify their responses after performance has reached some criteria" (Ho & Shea, 1978, p. 865). "Additional knowledge of results provided after this criterion performance is attained would be redundant" (Ho & Shea, 1978, p. 865). According to Ho and Shea (1978), these results provide evidence contrary to Adams' closed-loop theory and only partially support Schmidt's schema theory.

Schmidt and White (1972) studied Adams' closed-loop theory that the perceptual trace, developed over practice, forms the basis of an error detection mechanism. According to the theory, in the absence of KR, the error detection mechanism can be used to guide performance. To test this notion subjects performed 170 trials of a rapid linear positioning task. FF was available in all trials except on trials 11-20 and 141-170. Schmidt and White (1972) noted an increasing correspondence between the actual errors and the subjects' estimation of these errors. These findings are "indicative of a developing error detection mechanism" (Schmidt & White, 1972, p. 143). Further, during KR withdrawal periods, the subjects "continued to learn slightly,
suggesting that the error detection mechanism acted as a substitute for KB" (Schmidt & White, 1972, p.143).

Newell (1974) conducted a study that "extended Adams' closed-loop theory of motor learning to short, fast-timing movements where the use of peripheral feedback for movement control was precluded" (p.235). Subjects performed a linear positioning task in 150 msec. Seven groups of subjects were exposed to KB for different numbers of trials. Newell's (1974) study revealed no significant differences between groups for any of the KB withdrawal points. In this study, when KB was withdrawn early in practice and the perceptual trace had not developed, a decrement in performance occurred. According to Newell (1974), "the amount and the rate of this decrement tended to vary as a direct inverse function of the number of prior KB trials" (p.243). As the perceptual trace became stronger with exposure to KB, KB became "redundant in providing any information for S could associate with response outcome" (Newell, 1974, p.243).

"This study, which forced the recognition mechanism to operate on completion of the response, and subsequently to provide information for selection of the following response, shows that performance in the absence of KB can only be maintained when the recognition mechanism is strong" (Newell, 1974, p.243). Newell (1974) concluded that "the primary role of KB is in providing information
for the reduction of movement error and the development of the appropriate reference for evaluation of response produced feedback" (p.243).

In a test of Adams' postulation that "there are separate recall and recognition mechanisms responsible for movement control" (Newell & Chew, 1974, p.245), auditory and visual KR were made available in the learning of a rapid linear timing movement. After 70 acquisition trials with KR, KR was withdrawn for an additional 40 trials. In this study, Newell and Chew (1974) found that "feedback withdrawal produced a decrement in response recognition, but not recall during the initial phase of KR withdrawal" (p.245). "Thereafter, the recognition and recall processes tended to operate in unison" (Newell & Chew, 1974, p.245).

Zecker (1982) examined the role of KR and mental practice in the learning of a bean-bag toss task. A twenty trial pre-test phase with KR was followed by a twenty trial treatment phase. In the treatment phase, subjects practiced the toss with KR, practiced without KR, or engaged in mental practice. In the mental practice treatment, subjects "imagined the entire toss...without actually making any body movements" (Zecker, 1982, p.57). As a control condition, subjects tossed a frisbee through a hoop.

Zecker (1982) found that the performance of the practice groups (with and without KR) was "essentially identi-
cal" (p.60) in the pre-test. The group practicing with KR was the only group showing a performance decrement between pre-test and post-test. The group practicing without benefit of KR showed performance improvement. Zecker (1982) notes the large number of repetitive trials with only brief rest periods to have resulted in a "negative drive" (p.59) that interfered with performance on the post-test. According to Zecker (1982), "the fact that the mental practice condition showed the largest pre-test to post-test improvement cannot be explained by either an open-loop or closed-loop theory" (p.59). Further, this "seems to indicate that in the absence of KR, the act of physically going through the entire sequence of movements is not critical to ongoing or subsequent performance" (Zecker, 1982, p.59). According to Zecker (1982), "this would tend to support the idea that mentally practicing the task in some sense strengthens or maintains the perceptual trace in a way similar to physically practicing the task" (p.59).

According to Ammons' (1956) Generalization 3, "knowledge of performance affects rate of learning and level reached by learning" (p.283). Further, Ammons (1956) notes that "where knowledge of their performance is given to one group and knowledge is withheld or reduced in the case of another group, the former group learns more rapidly, and reaches a higher level of proficiency" (p.283).
According to Ammons' (1956) Generalization 8, "when knowledge of performance is decreased, performance drops" (p. 290). Adams' (1971) closed-loop theory maintains that when the perceptual trace is well established, the subject should be able to continue to learn without KB. Adams (1971), therefore, presents two generalizations that are more specific as to the extent of exposure to KB before its withdrawal. According to Adams (1971), "withdrawal of KB produces deterioration of performance when the level of training is low or moderate" (p. 136). However, "after a relatively large amount of training, learning can continue when KB is withdrawn" (Adams, 1971, p. 140). Adams (1971) refers to this as the "subjective reinforcement effect" (p. 140) which is learning "on the basis of internal information" (p. 140). This position is consistent with Ammons' (1956) Generalization 10: "where subjects are not being given supplementary knowledge of performance by the experimenter any longer, the ones who maintain their performance level have developed some substitute knowledge of performance" (p. 292). Schmidt (1975), however, notes that "there is no evidence that individuals can continue to learn positioning tasks after KB withdrawal" (p. 228). "Theoretically, after the recognition schema is developed, withdrawal of the KB provides a basis for continuing to respond with the former level of accuracy, but any improvement, except by accident, is not possible" (Schmidt, 1975, p. 250).
Knowledge of Results Delay Interval

McGuigan's (1959) study of line drawing (reviewed earlier) also involved KR delay intervals of 0, 15, and 30 seconds. These delay results indicate that variations of delay "did not lead to significant differences in performance" (McGuigan, 1959, p.60).

According to Ammons' (1956) Generalization 6: "longer the delay in giving knowledge of performance, the less effect the given information has" (p.287). However, Adams (1971) promotes the principle that "delay of KR has little or no effect on acquisition" (p.132). This disparity of views may be resolved by Bilodeau and Bilodeau (1961). According to Bilodeau and Bilodeau (1961), "it is clear that to delay or to give immediate KR can be quite immaterial for learning to make relatively simple E's" (p.254). Further, the effect of delays of KR presentation "depends upon what happens between E and KR" (Bilodeau & Bilodeau, 1961, p.255).

Ammons (1956) notes that "it is probable that there is an optimum delay for every task and every stage of learning" (p.289). Further, "the learner may not be able to use information given more than 15-20 seconds after the response so he uses what is immediately available in the way of information and this may be irrelevant or even misleading" (Ammons, 1956, p.289). Information coming too soon
after the response similarly may not be used (Ammons, 1956).

**Post-KR Interval**

Knowledge of Results serves as a primary source of information to the problem-solving subject. Further, "most researchers and learning theorists would agree to the necessary existence of knowledge of results during practice for the occurrence of learning" (Magill, 1977, p. 113). However, "such agreement cannot be found when the temporal role of KR during practice is considered" (Magill, 1977, p. 113).

In the examination of the role of KR, "a key assumption is that the subject actively operates upon KR during motor learning" (Schaeidel & Newell, 1976, p. 251). According to Magill (1977), the theoretical significance of the post-KR interval, or the time interval between the administration of KR and the next response, is that it is "primarily during this time that information processing occurs and the learner must decide how to use the KR" (p. 113). In this regard, both the duration of the post-KR interval and the role of activity during the post-KR interval has been examined in studying the role of KR in information processing.
Adams, Marshall, and Goetz (1972b) examined the hypothesis that forgetting could result in the absence of interference during the post-KB interval. The subject performed ten trials of a linear positioning task under five feedback conditions. The trial was repeated immediately (5 second post-KB delay) or after a 90 second post-KB interval.

Adams, et al. (1972b) report feedback to be a determinant of KB forgetting. The results indicate that short-term forgetting was found "in the absence of interference when the conditions of feedback are sufficiently impoverished" (Adams, et al., 1972b, p.95). Further, "there was little forgetting with all primary channels intact" (Adams, et al., 1972b). Similarly, deleting two of the three feedback channels "had little effect on retention" (Adams, et al., 1972b, p.95). However, the minimal feedback condition, attenuating all feedback channels, resulted in significant forgetting of feedback. Further, this feedback condition "produced a weaker perceptual trace that failed to maintain full strength over the retention interval" (Adams, et al., 1972b, p.95).

In summary, the 90 second post-KB delay interval resulted in loss of retention. The greatest loss was found to occur under conditions of the least feedback (Adams, et al., 1972b).
In two experiments, Barclay and Newell (1980) examined the use of a self-paced post-KF delay interval to assess children's use of response outcome information (KR) in learning motor skills of varying difficulty. The subjects were to perform a linear positioning task in 150 msec. The subjects "could begin the next movement as soon as they were ready after the experimenter had provided KR" (Barclay & Newell, 1980, p.101). KR was presented after a 5 second delay.

According to Barclay and Newell (1980), "the general findings of both experiments was that as the subject became more familiar with the task and began isolating an appropriate response, less time was needed to process KR" (p.105). During the initial stages of learning, more time was required to evaluate KR, however, as performance improved, KR was processed more rapidly. This effect was demonstrated by lower and more stable post-KR intervals (Barclay & Newell, 1980). Further, according to Barclay and Newell (1980), "the relationship between performance and information processing time described here suggests that children develop the ability to evaluate KR, decide on a new response plan or revise the old one, and effectively modify their behaviors to meet different task requirements" (p.107).
The results of these experiments support the assumption that information (KR) processing is systematically related to motor learning (Barclay & Newell, 1980). Barclay and Newell (1980) note that "younger children either process KR in a qualitatively different way than adults or these younger children are less efficient in processing the information feedback" (p. 106). In conclusion, "the results confirm children's differential use of KR, and suggest that any description of motor skill acquisition must account for the complex interaction between the subjects' developmental level and the difficulty of the task at hand" (Barclay & Newell, 1980, p. 96).

Magill (1973) examined the effect of a filled or unfilled post-KR interval during the acquisition phase of a blind positioning task. The post-KR interval of 2 or 30 seconds was either filled or unfilled with a motor or verbal interpolated task.

Magill (1973) reports that "there was no effect on performance of either length of the post-KR interval nor activity during the interval" (p. 49). Further, "neither length of the interval nor the interpolated activity during the interval affected retention as it is involved in the acquisition phase of learning" (Magill, 1973, p. 54).

Shea and Upton (1976) examined the effect of an interpolated motor short-term memory task during the KR delay
interpolated responses during KR delay interval, which interfere with the stored feedback presentation of the previous response in a sequence of learning trials, will interfere with skill acquisition" (Shea & Ogden, 1976, p. 281).

Hardy (1983) examined the effects of interpolated activity on the cognitive information operations occurring during the post-KR interval. Four post-KR activity groups participated in the use of the McCloy block test of multiple responses with a 25-second post-KR delay interval. The dependent measure was the number of trials taken to negotiate the block test in less than 35 seconds on three consecutive trials without an error.

According to Hardy (1983), "the results indicate that interpolated activity did impair the acquisition of a actor skill significantly more than the controlled activity (rest), although there were no differences among the various types of interpolated activities" (p. 147). Further, Hardy (1983) reports the "interpolated activity effects the acquisition rate by interfering and/or restricting cognitive information processing" (p. 146).

Magill (1977) designed a study to examine the effect of the length and type of activity during the post-KR interval on the acquisition of a serial positioning task. Three levels of interpolated activity (none, verbal, and
tracking) were combined with two levels of post-KR interval length (12 and 60 second) in 20 trials.

Magill (1977) found that "neither interval length, nor interference affected performance" (p. 115). Further, "the interval length x interference interaction similarly failed to indicate performance effects" (Magill, 1977, p. 115). These results are reported by Magill (1977) to be in line with the majority of other research concerning post-KR interval effects and the acquisition of motor skills. "They are not in line, however, with theoretical views expressed concerning the relation of this interval with the acquisition process, especially early in learning" (Magill, 1977, p. 117). According to Magill (1977), the theoretical proposal concerning the role of post-KR interval in the acquisition of a motor skill would have predicted that an interval length longer than a certain length should hinder the acquisition of a motor skill. However, "results of this experiment indicated that neither varying the length of the post-KR interval nor introducing interfering activity during that interval affected the rate of acquisition of a serial positioning task" (Magill, 1977, p. 117).

According to Magill (1977), the effects of various post-KR delay intervals and interference activity during this interval are "predictable from current theory concerning information processing and memory" (p. 113). However,
empirical evidence relating specifically to interval length and interference effects has not such a (predicted) relationship" (Magill, 1977, p.113).

As a result of his review, Adams (1971) presents two generalizations related to the post-KB delay interval. According to Adams (1971), "increasing the post-KB interval up to a point will improve performance level in acquisition" (p.135). This point was confirmed by Schendel and Newell (1976) who's review noted "reliable improvements in the subject's level as a result of increasing - to some optimal level - the duration of the post-KB interval" (p.252). This is interpreted to indicate that "KB-related activities increase as task complexity increases and, as a result, additional processing time is required" (Schendel & Newell, 1976, p.252). Adams' (1971) second generalization notes that the type of activity in the post-KB delay interval does not influence acquisition.

"Evidence concerning the effect of activity by the learner during the post-KB interval has been somewhat conflicting" (Magill, 1977, p.114). Studies examining the effect of different interpolated activities upon the processing of KB "have not yielded such consistent support for cognitive theories' view of KB" (Schendel & Newell, 1976, p.252). Studies requiring the subjects to engage in kinesthetic activities during the post-KB interval have been
shown to have no effect on the subject's learning rate (Schendel & Newell, 1976).

The finding that interpolated activities had no effect on performance in acquisition "is disconcerting for the theory which holds that the perceptual trace is operating in the interval" (Adams, 1971, p.135). Adams (1971) reports that the interpolation of similar motor movements "would be expected to degrade acquisition, but it did not" (p.135). In explanation of this finding, Adams (1971) suggests that a weakened or distorted perceptual trace is sufficient for movement correction. However, at some point, the trace is expected to become poor enough to impair performance (Adams, 1971). "It would seem that a capacity-demanding task, possibly in the form of a to-be-remembered movement, is required for any interference to occur in the cognitive information-processing activities" (Schendel & Newell, 1976, p.252).

According to Adams (1971), with the theoretical assumption that the post-KR interval is a period of verbal-cognitive behavior, it is not surprising that motor activities fail to interfere" (p.136). Adams (1971) further notes that "a proper choice of verbal-cognitive responses should be able to show an effect" (p.136) on performance. Under the supposition that the human's capacity for processing information is limited, "any sufficiently demanding
secondary task can severely restrict the amount of processing capacity the subject has available for KR processing activities and this, presumably, would be revealed in a retarded learning rate" (Schendel & Newell, 1976, p.252).

Schendel and Newell (1976) report that despite inconsistencies in the motor-learning research related to information processing during the post-KR period, "there is no compelling evidence against the notion that the subject actively processes the KR he receives" (p.254). Further, this interpretation is favored by a balance of the evidence (Schendel & Newell, 1976). "The conflicting results appear to be due solely to the unsuccessful manipulation of interpolated kinesthetic and verbal activity and/or the presence of certain confounding influences" (Schendel & Newell, 1976, p.254).

**Specificity of Knowledge of Results**

According to Thomas (1980), one variable overlooked when attributing the improvement of motor behavior in children is their ability to process information. Further, "substantial evidence indicates that a change in information processing accounts for a significant proportion of the variance in improved performance associated with development" (Thomas, 1980, p.158).
As children mature, "strategies and control processes for handling information become more effective" (Thomas, 1980, p. 158). Further, the same information load can be processed in less time, or conversely, a greater information load can be processed in the same time (Thomas, 1980). According to Thomas (1980), "the information load" (p. 162) hypotheses is a major factor in central processing speed. This hypothesis involves the interactive effects of the complexity of information (Kb) and available processing time (post-Kb delay interval). This factor is critical if Kb is truly error information used by the subject in problem-solving.

Reeve and Magill (1981) examined the "usefulness of the components of a Kb statement for organizing response correction" (p. 60) in a linear positioning task. Undergraduate subjects were randomly assigned to one of four experimental treatment groups defined by the components of the Kb statement. Subjects received Kb in the form of magnitude and direction; direction only; magnitude only; or direction with the magnitude information being ten times the distance of error. According to Reeve and Magill (1981), "the two magnitudes of distance error were included to determine if subjects were using this component of Kb to adjust their responses" (p. 82).
Reeve and Magill (1981) found performance of the direction only group and the distance and direction group were not significantly different from each other. Both these groups, however, were "significantly more accurate than the distance times ten and direction group" (Reeve & Magill, 1981, p.63). Further, Reeve and Magill (1981) noted that "the three groups receiving directional information had significantly less error than the distance only group" (p.83). According to Reeve and Magill (1981), direction of error information was most useful to the learner initially. Further, the difference between the distance and direction group indicates that the subjects were responding to the magnitude information in correcting the errors (Reeve & Magill, 1981).

"When the distance information lacks meaning, as it does during the initial trials, it may adversely affect attempts to correct errors" (Reeve & Magill, 1981, p.84). Further, subjects receiving distance only KR developed "internal labelling systems" (Reeve & Magill, 1981, p.84) to determine directional errors. In conclusion, Reeve and Magill (1981) note that before KR can serve as the external standard that permits the labelling of errors, "the learner must first develop an understanding of the information contained in the KR statement" (p.84).
Irowbridge and Cason (1932) examined the effect of various specificity of KR in the learning of a line drawing task. Undergraduate subjects were assigned to one of four procedure groups in the drawing of a three inch line. Subjects received No KR; Nonsense KR; Right-Wrong KR (line within 1/8 inch); or KR as Correct. The Nonsense procedure was "designed to check the influence of distraction, or possibly an increase in the S's attention on the line-drawing function" (Trowbridge & Cason, 1932, p.246). In the Correct treatment group, the subject was told his line-drawing error in 1/8 inch units above (plus) or below (minus) the three inch target.

On initial trials, Trowbridge and Cason (1932) note the subjects to have drawn lines much shorter than three inches. Further, subjects in the Nonsense, No KR, and Right-Wrong KR groups "did not know what they were doing a large portion of the time" (Trowbridge & Cason, 1932, p.258). "The principle difference between these three procedures and the 'Correct' procedure was that in the 'Correct' procedure the S's were told the length of the line they had just drawn, and they were therefore in a position to make the appropriate changes and adjustments on later trials" (Trowbridge & Cason, 1932, p.258).

As a result of the procedures, Trowbridge and Cason (1932) noted that "the superiority of the 'Correct' proce-
dure over all others was quite marked" (p. 257). "In the 'Nonsense' procedure, many of the subjects were distracted by E's speaking a nonsense syllable after each line, and the results obtained with this procedure showed that saying almost anything may have a measurable effect on the efficiency of a line-drawing function" (Trowbridge & Cason, 1932, p. 257).

Shapiro (1977) assessed the role of qualitative KR in the linear positioning learning of four year old subjects. Three levels of KR were presented. The least precise KR group received KR indicating "more" or "less". Condition two consisted of KR indicating "a little more" (one to five inches below the target), "a lot more" (five to ten inches below the target), "a little less" (one to five inches beyond the target), or "a lot less" (five to ten inches beyond the target). Group three received the most specific form of KR. These subjects were given KR indicating "a little more" (one to three inches below the target), "more" (three to six inches below the target), "a lot more" (six to ten inches below the target), "a little less" (one to three inches beyond the target), "less" (three to six inches beyond the target), or "a lot less" (six to ten inches beyond the target).

Shapiro (1977) reported the subjects in all three groups to have significantly decreased their variability as
a result of practice and exposure to KB. Further, performance of subjects receiving the maximal KB specificity demonstrated a "tendency ... to continually show higher levels of performance" (Shapiro, 1977, p. 157). However, "no significant differences were found among the three KB groups" (Shapiro, 1977, p. 157). "Although not conclusive, the trends in the data indicate that the subjects' performance may be facilitated with increasing levels of qualitative KB" (Shapiro, 1977, p. 158).

Gill (1975) examined the effect of varying KB precision levels on the acquisition and later performance of a linear positioning task. The experiment was divided into three phases. Phase 1 consisted of 21 trials with two precision levels of KB. In the 21 trials of Phase 2, half of the subjects changed KB precision level and half continued using the same treatment. Phase 3 consisted of 21 trials without KB.

Gill's (1975) results indicated that "extremely precise KB (millimeters) did not have the predicted deleterious effect on actual performance, but neither did KB in millimeters have any more beneficial effects than KB in centimeters" (p. 157). Introduction of a new precision level in Phase 2 "created immediate problems in estimating or labeling" (p. 157) errors, however, these effects gradually disappeared.
Gill (1975) concluded that "increasing the amount or precision of KR is not necessarily desirable" (p.197). KR in millimeters was effectively used to correct actual performance, however, "the maximum possible KR precision is not necessarily optimal" (Gill, 1975, p.197). According to Gill (1975), "moderately precise KR (centimeters) provided sufficient information . . . KR precision beyond a level that is sufficiently precise to evaluate sensory feedback should be avoided during motor skill acquisition" (p.197).

Smoll (1972) examined the effect of precision of KR on the ability to deliver a duckpin bowling ball at 70% of the subject's maximum velocity. Subjects performed 60 trials with three experimental conditions. Subjects received a) quantitative KR accurate to hundredths-of-a-second; b) quantitative KR accurate to tenths-of-a-second; or c) qualitative KR (too fast, too slow, or correct). Smoll (1972) found that the more precise KR resulted in a significantly higher level of performance than the less precise qualitative KR. This finding is believed to result from the subject receiving information about the magnitude of error as well as the direction of error in his performance (Smoll, 1972). Further, "subjects receiving quantitative IF (Information Feedback) accurate to hundredths-of-a-second did not achieve a significantly different level of performance from those receiving IF accurate to tenths-of-a-second" (Smoll, 1972, p.492).
Smoll's (1972) results indicate "the importance of considering precision of KE not only in terms of what is meaningful to performers, but in terms of what the human mechanism is capable of utilizing" (p. 492). Smoll (1972) further concludes that there is an "optimum precision" (p. 492) of KE that is meaningful to the performer. Practice involving KE beyond this level does not enhance motor skill acquisition (Smoll, 1972).

Salmoni (1980) examined the effect of precision of KE in the performance of a line drawing task by third grade and adult subjects. Three levels of specificity were provided in 20 trials. The first group was told whether their response was "right" (plus or minus 1 centimeter) or "wrong". The second group was given KE as units (centimeter) too long or too short of the target. The third group similarly received KE in millimeter units.

The results arranged from least precise to most precise KE find the children completed 45%, 68%, and 74% of the trials correctly. Adults performed 62%, 81%, and 86% of trials correctly. Salmoni (1980) reports a similar trend when the average number of trials is examined before a correct response is made. The averages for the children were 7.9, 4.3, and 3.1 trials respectively for the three levels of precision. For the adults, the trial averages were 7.6, 3.8, and 3.2 trials respectively. According to
Salmoni (1980), "the KR precision effects were identical for adults and children" (p.574). Further, "these results do not support the optimal level hypothesis or the contention that this level should be different for children than for adults" (Salmoni, 1980, p.574).

"The main conclusion of the present experiment is that performance with qualitative KR is not as good as performance with quantitative KR" (Salmoni, 1980, p.574). There was no difference found between centimeter and millimeter KR precision groups. An explanation for this finding was that the line drawing task was too easy to require the precision offered by the millimeter KR (Salmoni, 1980).

Newell and Kennedy (1978) conducted two experiments examining "the hypothesis that the optimum precision level of knowledge of results for motor learning varies as a direct function of age" (p.531). First, third, fifth, and ninth grade subjects performed 20 trials of a linear positioning task under a variety of KR precision levels.

Newell and Kennedy (1978) found significant main effects of grade and KR precision in each experiment. Taking the two experiments together, "the data indicate that the optimum level of KR for motor learning covaries with age" (Newell & Kennedy, 1978, p.535). This finding is viewed as support of the general assumption that "young children are less proficient processors of information than youths or adults" (Newell & Kennedy, 1978, p.535).
The authors, however, report that "the results of the present study leave us uncertain as to whether the effects of KR precision are the result of the children's differing ability to evaluate the sensory information or their inability to attach a number of varying precision to the sensory stimuli" (Newell & Kennedy, 1978, p.535).

Newell and Kennedy (1978) summarize the findings in support that the "optimum precision level of KR for motor learning varies with age" (p.536). "The absolute relationship between these factors, however, is likely to vary with the nature of the task employed" (Newell & Kennedy, 1978, p.536).

Thomas, Mitchell, and Solmon (1979) conducted two experiments examining the effect of the preciseness of KR, task difficulty, and KR withdrawal in children's learning of a repositioning movement task. Three levels of KR were provided including; No KR; General KR (direction above or below the target); or Specific KR (units and direction above or below the target).

According to Thomas, et al. (1979), "both experiments offer evidence that information load has a differential influence on performance of children that is clearly age related" (p.697). Further, because information processing is limited, "variables such as task difficulty and preciseness of KR must be carefully integrated in appropriate ways for
different ages of children" (Thomas, et al., 1979, p.697). If information processing is overloaded by task complexity or KB precision, "decrements in both learning and retention are likely to occur" (Thomas, et al., 1979, p.697).

In summarizing the two experiments, Thomas, et al. (1979) note that "when processing time is limited (post-KB interval), increasing the precision of KB (and thus the processing time needed to handle it) results in decrements for both performance and retention in younger children" (p.698). "However, since older children can process information more rapidly and more effectively, both their performance and retention are increased by more precise KB" (Thomas, et al., 1979, p.698).

Rogers (1974) conducted three experiments to examine the role of KB precision and post-KB interval duration in the learning of a simple positioning task by undergraduate subjects. In the first experiment, subjects received KB after a 43 second interval (KB-delay), performing a subsequent response after a 7 second (post-KB) interval. Ten trials were performed receiving KB at four levels of precision. As a result of this study, Rogers (1974) found that a "feedback precision optimum" (p.606) may exist. Further, Rogers (1974) found that "as S's information load increased, more time is required for his selection of a response modification" (p.605). In this regard, the seven-
second post-KR interval "may have been inadequate for the 4-digit (most precise KR) condition" (Rogers, 1974, p.605).

To examine this notion, Experiment II was a replication of the first study with the post-KR interval extended to 14 seconds. The KR delay interval was shortened to 36 seconds. Rogers (1974) found that increasing the post-KR interval removed that "feedback precision optimum" (p.606). Further, Experiment II "supported the suggested dependency between precision of feedback and post-feedback interval length" (Rogers, 1974, p.606).

Experiment III was an extension of Experiment II using a timing task. Rogers (1974) noted that the "deleterious acquisition effect of excessively precise feedback in the third study was less severe than in the first" (p.607). These findings "lend limited generality to the feedback optimality phenomenon" (Rogers, 1974, p.607). Further, "the combined results of the three studies were interpreted as supportive of an information-processing approach to the study of post-feedback interval" (Rogers, 1974, p.604).

According to Ammons' (1956) Generalization 5: "the more specific the knowledge of performance, the more rapid the improvement and the higher the level of performance" (p.287). This position is in agreement with Adams' generalization that "the rate of improvement depends upon the precision of knowledge of results" (Adams, 1971, p.130).
Research relating to the precision of KB "has generally indicated that more precise KB results in increased performance for adults, but a generally accepted premise is that some optimal level will be reached beyond which performance increments will not occur" (Thomas, et al., 1980, p.163). Ammons (1956) further relates the "optimum specificity" (p.287) of KB to the performer's stage of learning. "At the start of learning a new task, the subject can use little information. As learning proceeds, he is able to use more and more" (Ammons, 1956, p.287). Specificity of KB, therefore, is dependent upon the subject's ability to use the information at various stages of learning.

Giving older children more precise information about their performance results in better retention (Thomas, 1980). "The younger children retain information as well as the older ones if that information is not complex" (Thomas, 1980, p.163). According to Thomas (1980), "the combination of greater complexity of KB and slower processing speed resulted in the younger children being unable to use all the information to improve the strength of the memory trace during the learning phase" (p. 163).
Comparison of KB/KF and Behavioral Management Procedures

Research has examined the comparison of KB and KF with behavioral management techniques. The role of KB has been compared to social reinforcement (Levy, 1974; Wallace & Hacker, 1979), reward, and punishment (Donohue & Ratliff, 1976).

Donohue and Ratliff (1976) compared the role of reward (presentation of a candy); punishment (removal of a candy); knowledge of correct results; and knowledge of incorrect results in learning. In the 60 trial acquisition phase, all groups showed some evidence of learning with the exception of the reward group. Further, the knowledge of correct results group was superior to that of the knowledge of incorrect results group, while both were superior to the reward and punishment groups. Performance of the reward and punishment groups did not differ significantly. In the extinction phase, performance of the knowledge of incorrect results group was "resistant to extinction" (Donohue & Ratliff, 1976, p.101). However, the performance of the reward and knowledge of correct response groups "deteriorated quite rapidly" (Donohue & Ratliff, 1976, p.101) in extinction. In conclusion, Donohue and Ratliff (1976) noted that the knowledge of results "was more effective in promoting learning than was the concrete reinforcement of candy" (p.101).
The role of KR and social reinforcement affecting the learning of 80 mentally retarded subjects was examined by Levy (1974). KR provided the number of seconds (per 20 second trial) the subject was able to track the rotary pursuit task. Praise, reproof, and tangible (candies) reinforcement was presented contingent upon improved performances (Levy, 1974). Levy (1974) noted that "social reinforcement definitely affects behavior on an accuracy task to a far greater degree when combined with KR over time" (p. 757). Further, Levy (1974) noted that "when knowledge of results is absent the social reinforcement conditions shows greater relative variability than when knowledge of results is present" (p. 757).

Wallace and Hagler (1979) examined the role of feedback in the learning of the basketball foul shot with the non-dominant hand. Following a 5C trial acquisition phase, subjects performed a 25 trial performance phase. "While both groups received KR by visually observing the results of each shot, one group received KE (Knowledge of Performance) while the other group received social reinforcement" (Wallace & Hagler, 1979, p. 267).

The group receiving knowledge of performance was found to show superior performance. According to Wallace and Hagler (1979), "this is because the learner has not yet developed an internal standard or perceptual trace of the de-
siired movement to be learned" (p. 269). "Consequently, it is important for the learner to obtain KP (Knowledge of Performance) from an outside source such as the teacher or coach so that the internal standard can be developed" (Wallace & Hagler, 1979, p. 269). The authors note that "since KR did not provide information regarding proper mechanics of the set shot, subjects in the KR + SR (Social Reinforcement) condition apparently did not develop the proper mechanics of the shot as well as subjects who received KP (Knowledge of Performance)" (Wallace & Hagler, 1979, p. 270). "The present study indicates that learning is possible in the absence of KP when KR is present, but a higher level of performance is achieved when both types of information are present" (Wallace & Hagler, 1979, p. 271).

In summary, behavior management techniques were effective in establishing behavior change, however, to a lesser extent than KR. Social reinforcement is more effective in improving performance on an accuracy task when paired with KR. However, this combination of social reinforcement and KR was not as effective as Knowledge of Performance in the learning of the basketball foul shot.
**KE and KP with Handicapped Populations**

The role of KE has also been examined with handicapped populations learning of pursuit rotary tasks and a shuffle board task. After 20 learning trials with KE, and ten trials without KE, Baumeister, Hawkins, and Holland (1966) noted that 48 mentally retarded boys and non-handicapped boys "benefitted equally from supplementary knowledge of results" (p. 42).

As reviewed earlier, Levy (1974) compared the effects of behavior management procedures with KE with Educable Mentally Retarded subjects. Morgan (1980) examined the role of supplementary visual, tactile, or auditory feedback (KB) in the learning of a pursuit rotary task by mildly retarded children. Seven study groups designated as visual/on target; visual/off target; auditory/on target; auditory/off target; tactile/on target; tactile/off target; and control were administered in fifteen 20 second trials. Comparisons indicated that the auditory/on target condition improved significantly more than the performance improvement of all other treatment groups (Morgan, 1980). Further, "auditory feedback associated with correct response behavior of the mildly retarded was most effective for acquisition of a pursuit rotary task" (Morgan, 1980, p. 1228).

Loovis and Ziegler (n.d.) examined the effects of verbal augmented information feedback on the closed motor
skill acquisition of a congenitally blind adult female. Feedback in the form of KB, Knowledge of Performance (KP), and a combination of KB and KP was provided in the learning of a shuffle board task in a Multielement single-subject design.

Loovis and Ziegler (n.d.) noted that "all treatments were effective in promoting skill acquisition, but that each was differentially effective during the learning curve" (p. 7). Examining performance at the initial, middle, and final stage of learning provided a more critical analysis of the learning curve. KP was found to produce a "slow steady rate of improvement" (Loovis & Ziegler, n.d., p. 7). Performance under KB (Hit or Miss) was shown to be low in the initial and middle stage "followed by a definite increase in performance" (Loovis & Ziegler, n.d., p. 7) in the final stage of learning. As a result of the KB + KE treatment, performance was found to be low in the initial stage "followed by a meaningful increase in performance during stage two" with a "small increase in performance" (Loovis & Ziegler, n.d., p. 7) in the final stage of learning.

During the initial stage, KP was found to be most effective producing the highest mean performance (Loovis & Ziegler, n.d.). Similarly, KB was more effective during the final stage. The KE + KE treatment produced the high-
est mean performance showing it to be "more beneficial during the middle trials" (Loovis & Ziegler, n.d., p.7). According to Loovis and Ziegler (n.d.), the KR + KP combination was "successful in mediating the shift from what is almost exclusively vision oriented learning in the earliest stage to what is predominantly proprioceptive control in the latter stage" (p.8).

During the final learning stage, Loovis and Ziegler (n.d.) report that "a significant increase in the ability to use KR was noted" (p.8), representing a "shift from externally or augmented information to a more subjective reliance upon internal or proprioceptive feedback" (p.8).

Loovis and Ziegler (n.d.) report that "the blind can use information feedback, namely KR and KE during skill acquisition" (p.10). A visually impaired subject "must rely on someone or something to provide KR during motor skill acquisition" (Loovis & Ziegler, n.d., p.10). Further, "there is still the need in a closed skill for KE which helps shape appropriate skill topography and execution" (Loovis & Ziegler, n.d., p.10). Despite methodological concerns, Loovis and Ziegler (n.d.) conclude that "verbally augmented statements should probably highlight, at least initially, information about the quality of the subject's performance and then only secondarily information pertaining to the results of the attempt" (p.10).
In examining the need of the visually impaired, Buell (1982) noted that "the more loss of vision a student has, the more he must depend upon his other senses to gain information" (p.ix). As such, the role of supplemental information feedback is magnified. Although much research related to the role of KE has dealt with blind-folded tasks, other research relating to the influence of KE with the visually impaired was not found.
CHAPTER III

METHODS AND PROCEDURES

The present study examines the effect of augmented verbal information feedback in the learning of a novel velcro dart-throwing task by totally blind subjects. This chapter describes the methods and procedures utilized in this investigation. The procedures are presented in the following sections: 1) Subject Selection; 2) Experimental Design; 3) Description of the Setting; 4) Trial Administration and Procedures; 5) Orientation Format; 6) Description of the Target and Dart; 7) Scoring and Reliability; and 8) Data Analysis Procedures.

Subject Selection

Totally blind subjects were selected to participate in the investigation. To eliminate deficits that may interfere with the subject's ability to successfully perform the required task, participants of the study were identified by school personnel to be totally blind students free from mental or physical handicaps. The parent/guardian of each
subject was sent a letter explaining the study and a Research Consent to be completed for their approval of the subject's participation in the investigation. Fifty totally blind students from the Ohio State School for the Blind (Columbus n=19), Kentucky School for the Blind (Louisville n=7), and the Indiana School for the Blind (Indianapolis n=24) met the requirements for participation in the investigation. Subjects from each school grade were randomly assigned to one of three verbal IF treatment groups. Eighteen subjects received the KE treatment. Sixteen subjects received the KP treatment. Sixteen subjects received the combination of KE + KP during learning sessions. General background information was also collected on each subject. This information included the subject's state of residence, sex, chronological age, as well as the cause and his/her age at the onset of blindness. This information is shown in Appendix A. A summary of this information is shown in Table 1.
### TABLE 1

**Summary of Subject Information**

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>KR</th>
<th>KE</th>
<th>KR + KP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subjects</strong></td>
<td>1=50</td>
<td>18</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td><strong>Males</strong></td>
<td>22</td>
<td>8</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td><strong>Females</strong></td>
<td>28</td>
<td>10</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td><strong>CA</strong></td>
<td>15.45</td>
<td>14.92</td>
<td>15.47</td>
<td>16.03</td>
</tr>
<tr>
<td><strong>Residence:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH</td>
<td>19</td>
<td>6</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>KY</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>IN</td>
<td>24</td>
<td>10</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td><strong>Cause of Blindness</strong></td>
<td>21</td>
<td>9</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>F.I.F.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Optic Nerve Degeneration</strong></td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Glaucoma</strong></td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Tepetoretinal Degeneration</strong></td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Microphthalmia</strong></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Macular Dys trophy</strong></td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Others 11 each</strong></td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

**Experimental Design**

The intent of this study was to examine the effect of verbal information feedback on the performance and retention of a velcro dart-throwing task by totally blind subjects. Subjects from each school grade were assigned randomly to one of three treatment groups. The subject groups received Knowledge of Results (KR), Knowledge of Performance (KP), or a combination of KR and KP during the treatment phase. Each treatment group received an information feedback treatment in three 30 trial sessions separated by
a two minute rest period. A retention session was conducted 24 hours later. During the retention session, subjects in all treatment groups performed the velcro-dart throwing task without the benefit of verbal information feedback. The resulting target scores were examined to determine the effect of verbal information feedback on skill acquisition and retention.

Description of the Setting

All activities related to this investigation took place on the school grounds. At each data collection site, space was made available within the recreation area. At the Ohio State School for the Blind, the Recreation Area T.V. Boom was used for data collection. The Wrestling Room was used at the Indiana School for the Blind. Data collection was conducted in a multi-purpose room at the Kentucky School for the Blind. Each data collection site had ample space and was free of distractions from outside sources. The target was suspended from the ceiling at the wall in an open area with its center located 60" above the floor.
**Trial Administration and Procedures**

The task was to throw a velcro dart from a stationary position to a target set 7' 9 1/4" (2.37 meters) away. The distance of 7' 9 1/4" (2.37 meters) is the official distance for competitive dart throwing. One practice trial was allowed at the start of each session. The score of this trial was not used for analysis because it was executed without benefit of a prior information feedback statement.

Each subject's participation required two days. On their initial visit to the data collection site, the subjects participated in an Orientation Format. A similar orientation format was also followed prior to the retention session trials.

The procedure for administration of each trial was identical. Subjects stood behind a foul line located 7' 9 1/4" (2.37 meters) directly in front of the target in preparation for completion of the task. The dart was offered to the subject with the instruction to throw when ready. An auditory cuing device was positioned behind the target center to provide a directional stimulus. Verbal information feedback was offered immediately (within 5 seconds) after execution, with a subsequent trial performed after a self-paced post-KR interval.
Each session began with the experimenter explaining the type of verbal information feedback to be provided. Verbal information feedback was provided in three treatment conditions:

**Treatment A: Knowledge of Results (KR).** Following each trial, the subjects were told: a. your toss missed the target to the right; b. your toss missed the target to the left; c. your toss missed the target high; d. your toss missed the target low; e. your toss missed the target high, right; f. your toss missed the target high, left; g. your toss missed the target low, right; h. your toss missed the target low, left; i. your toss hit the target to the right of the center; j. your toss hit the target to the left of the center; k. your toss hit the target above the center; l. your toss hit the target below the center; m. your toss hit the target above and right of the center; n. your toss hit the target above and left of the center; o. your toss hit the target below and right of the center; p. your toss hit the target below and left of the center; or, q. your toss hit the target center.

**Treatment B: Knowledge of Performance (KP).** Following each trial, the subject was provided with verbal information feedback relating to his/her motor performance. KP information feedback focused on a single (most detrimental) aspect of the task performance.
According to Jensen and Schultz (1970), accuracy results when "superfluous (noncontributing) movements are reduced to a minimum" (p. 355). This may be accomplished "by identifying noncontributing motions and purposely eliminating them" (Jensen & Schultz, 1970, p. 356). In this regard, RF focused primarily on the position and movement of the throwing arm. Other verbal RF IF focused on the position and movement of the shoulders, trunk, feet, and body. Examples of the RF treatment condition include: a. you released the ball too soon; b. you released the ball too late; c. you released the ball off to the (right/left) side, you need to point your hand to the sound; d. you are moving your (body part) too much, this motion does not help your toss, try to move as little as possible; or e. perfect toss.

**Treatment C:** RF + General RF. Following each trial, the subject received verbal IF as described in both Treatment A and Treatment B above.

During each of the three treatment conditions, subjects received social reinforcement as needed while data collection sessions were in progress. Social reinforcement included verbal praise of on-task behavior, and attention to the IF treatment conditions. This reinforcement sought to develop and/or maintain interest and enthusiasm in the subject's participation rather than focus on his/her per-
formance. The score of each trial was recorded by the experimenter following presentation of the information feedback treatment.

**Orientation Format**

1. **Welcome.**

2. **General instructions.** You are involved in a dart throwing task. Your task is to throw the dart to hit the target to score as many points as possible.

3. **Orientation to the target.** This is your target (standing at the target). Notice that the sound is coming from behind the target center (touching the target center). Notice that the target is quite large (touching the outer scoring edge of the target and the target center). This is to the right, left, above, and below the target center (moving the subject's hand on the target surface as each is described). All subjects were able to independently identify right, left, above, and below directions.

4. **Orientation to the throwing area.** This is where you are to throw from. The target is 7' 9 1/4" in front of you (facing the target). Listen to the sound. Remember the sound is coming from behind the target center. You must stay behind this foul line (touching the foul line). This spot on the foul line is
directly in line with the target center (touching the raised center spot on the foul line).

5. Orientation to the velcro dart. (Standing in the throwing area) This is the dart that you are to throw (the dart is handed to the subject). It is a velcro dart, there are no sharp points (touching the velcro dart). This dart will stick to the target when you hit it.

6. Directions to the subject. Your task is to throw the dart to hit the target as best you can. You may throw the dart in any way that you wish as long as you stay behind the foul line. However, I would recommend that you throw the dart in the same way each time. A sound cue is located behind the target center to help with your aiming. Try to hit as close to the target center as possible.

7. After each toss, you will be given information about that toss.

8. After receiving the dart you may throw when you are ready.

9. Do you understand what you will do? Do you have any questions?
Description of the Target and Dart

The target for the velcro dart throwing task was set on a cloth background. The cloth was selected for use due to its fabric nature and response to velcro fasteners. The cloth was a 40" x 40" crocket material separated into six concentric rings. The scoring regions were separated by raised lines. The regions were valued as 10 (4" diameter); 9 (8" diameter); 7 (16" diameter); 5 (24" diameter); 3 (32" diameter); and 1 point (40" diameter). The design of this target was consistent with targets of the Federation of International Target Archery (F.I.T.A.). The target is shown in Figure 1.

A velcro dart was tossed at the target in the course of the investigation. The dart was a 1.5 inch hollow plastic ball with five 1" x 1/4" velcro strips located around its circumference. The velcro dart is available commercially from Flaghouse Incorporated (#3083, Replacement Ball Darts, Set of 3, $2.50 per set), and Synergistics Research Corporation (650 Avenue of the Americas; New York, NY 10011; Set of 3, $2.50).
Figure 1: Illustration of Target
Scoring and Reliability

The dependent variable, recorded as indicative of motor skill learning, was the score received by throwing the dart at the target. Target scores ranged from ten to zero by concentric rings. No points (score of zero) were awarded for trials not hitting the scoring surface. Trials hitting the target line between two scoring regions were awarded the greater scoring value. Trials hitting the target but bouncing off were scored where they hit the scoring surface.

Trials on which the subject stepped in front of the foul line were handled as a standard task performance. The appropriate information feedback was provided, however, the score was not recorded. The subject was directed to stand behind the foul line and the trial repeated. Each trial score was recorded on a score sheet following the presentation of verbal information feedback and prior to the initiation of the subsequent trial.

Interrater reliability was determined between two doctoral students in physical education and the examiner. The reliability was determined by analysis of score agreement over agreement plus disagreement. The coefficient of agreement over twenty trials was 98.33 percent. One score disagreement was noted in sixty reliability comparisons when a trial toss landed on a line separating two scoring regions.
Data Analysis Procedures

The scores (from four sessions with 30 trials per session) for each subject were entered for data analysis. Statistical analysis was completed through use of the SAS (Statistical Analysis System) program on an Amdahl 470 V/8 computer at The Ohio State University. Analysis of Variance (ANOVA) procedures were completed with use of the SAS GLM (General Linear Models) program. GLM performs ANOVA procedures for unbalanced data.

Three null hypotheses were examined:

1. The verbal information feedback treatment condition will not effect the motor skill performance and retention of totally blind subjects.

2. The verbal information feedback treatment conditions will not differentially effect the motor performance of totally blind subjects across learning sessions.

3. The subjects' age, sex, residence, and cause of blindness will not effect the motor skill performance of totally blind subjects.
CHAPTER IV

RESULTS AND DISCUSSION

Fifty totally blind school age subjects tossed a velcro ball-dart at a target during the course of the investigation. Each trial received a point value of zero, one, three, five, seven, nine, or ten with the higher values awarded to tosses hitting closer to the target center. Following the performance of each trial, the resulting score was recorded.

Each subject completed three learning sessions and one retention session, each consisting of thirty trials. During learning sessions, subjects received one of the verbal IF treatments immediately upon completion of the trial. Each learning session was separated by a two minute rest period. The retention session was completed 24 hours later. Trials completed during the retention session were performed without the benefit of verbal IF.

Statistical analysis was completed through use of the SAS (Statistical Analysis System) program on an Amdahl 470 V/8 computer at The Ohio State University. ANOVA proce-
dures were completed with use of the SAS GLM (General linear Models) program. GLM performs ANOVA procedures for unbalanced data. The performance scores yielded a range from zero to ten and an overall mean of 4.31. The standard error of the mean across these scores was 0.0527.

**Analysis of Results by Treatments**

Three forms of verbal IF were provided during the learning sessions. Knowledge of Results (KR), Knowledge of Performance (KP), and a combination of KR + KP were examined as to their effect on learning and retention. The mean and standard error of the mean for each treatment are shown in Table 2. The combination of KR + KP yielded the highest treatment mean (4.65), followed by KP (4.37) and KR (3.96). The difference between these treatment means, however, was not significant (p = .4362). The ANOVA summary table may be found in Table 3.

**Analysis of Results of Treatments by Session**

As noted earlier, each subject participated in three (thirty trial) learning sessions and one (thirty trial) retention session. The mean and standard error of the mean for each session are shown in Table 2. The mean was highest in the third learning session (4.72), followed by the second learning session (4.51), and the first learning ses-
The mean of the retention session (3.73) was the lowest of the four sessions. Examinations of ANOVA procedures indicate that significant differences (p = .0001) existed between sessions.

Post hoc examinations of these four session means with use of Fisher's L.S.D. method (performed by SAS) identified significant differences to exist (p<.05). The performance mean of learning session III was found to be significantly greater than that of learning session I. Similarly, the mean performance of the retention session was significantly lower than the mean performance of each of the learning sessions. Although lower, the performance mean of learning session II was not significantly different from that of learning session III when observed in post hoc examination.

In observing the effects of IF treatments across learning sessions, an increase in performance was noted. ANOVA procedures, however, indicated that a treatment by session interaction did not exist (p = .9945), rather that a consistent pattern was present.

Across each of the four sessions, the combination of KB * KP treatment generated a higher performance mean. Similarly, KP and PB have lower performance means across each of the four sessions. The mean and standard error of the mean of each treatment by session are shown in Table 2.
TABLE 2

Means and Standard Error of Means of Treatments by Session

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>LEARNING SESSION I</th>
<th>LEARNING SESSION II</th>
<th>LEARNING SESSION III</th>
<th>RETENTION SESSION</th>
<th>OVERALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>KR</td>
<td>3.89</td>
<td>4.19</td>
<td>4.42</td>
<td>3.36</td>
<td>3.96</td>
</tr>
<tr>
<td>n=18</td>
<td>0.1768</td>
<td>0.1728</td>
<td>0.1675</td>
<td>0.1566</td>
<td>0.0864</td>
</tr>
<tr>
<td>KE</td>
<td>4.42</td>
<td>4.57</td>
<td>4.66</td>
<td>3.82</td>
<td>4.37</td>
</tr>
<tr>
<td>n=16</td>
<td>0.1732</td>
<td>0.1693</td>
<td>0.1706</td>
<td>0.1774</td>
<td>0.0871</td>
</tr>
<tr>
<td>KB + KP</td>
<td>4.59</td>
<td>4.82</td>
<td>5.12</td>
<td>4.06</td>
<td>4.65</td>
</tr>
<tr>
<td>n=16</td>
<td>0.1874</td>
<td>0.1964</td>
<td>0.1906</td>
<td>0.2041</td>
<td>0.0983</td>
</tr>
<tr>
<td>CVIBALI</td>
<td>4.29</td>
<td>4.51</td>
<td>4.72</td>
<td>3.73</td>
<td>4.31</td>
</tr>
<tr>
<td>n=50</td>
<td>0.2384</td>
<td>0.2447</td>
<td>0.2398</td>
<td>0.2469</td>
<td>0.0327</td>
</tr>
</tbody>
</table>

Across each treatment condition, a performance drop is
acted from learning session III to the retention measure
taken 24 hours later. Without the benefit of verbal IF,
the performance mean of the KB + KP treatment group dropped
1.0581 (20.6%), KP dropped 0.8350 (17.9%), and KB dropped
1.0561 (23.9%). Although statistically significant differences cannot be claimed, the KB + KP treatment generated a
greater performance increase as well as less loss of per-
formance without the benefit of verbal IF during the reten-
tion session taken 24 hours later.
Analysis of Results by Subject

In further examination of ANCOVA results, a significant difference was noted ($p = .0001$) among the fifty subjects. The ANCOVA summary table is shown in Table 3. In an effort to account for differences between subjects, an Analysis of Variance of performance scores by subject background information was developed. The summary of ANCOVA procedures by Background Information is shown in Table 4.

Table 3

ANOVA of Performance Score by Treatments, Subjects, and Sessions

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Ss</td>
<td>58</td>
<td>494.3784</td>
<td>8.5277</td>
<td>11.10</td>
<td>.0001</td>
</tr>
<tr>
<td>Treatment</td>
<td>2</td>
<td>16.1920</td>
<td>8.0960</td>
<td>0.84</td>
<td>.4362</td>
</tr>
<tr>
<td>Subjects w/in</td>
<td>47</td>
<td>450.5684</td>
<td>9.5866</td>
<td>12.46</td>
<td>.0001*</td>
</tr>
<tr>
<td>Treatments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Ss</td>
<td>3</td>
<td>27.0878</td>
<td>9.0293</td>
<td>11.76</td>
<td>.0001*</td>
</tr>
<tr>
<td>Sessions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment by Session</td>
<td>6</td>
<td>0.5301</td>
<td>0.0884</td>
<td>0.12</td>
<td>.5945</td>
</tr>
<tr>
<td>Error</td>
<td>141</td>
<td>106.2933</td>
<td>0.7680</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>159</td>
<td>602.6716</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant differences

Significant differences in performance score were noted when analyzed by cause of blindness, sex, residence, and age of the 50 totally blind subjects. The Means of per-
formance score by subject background information are shown in Table 5.

### Table 4

**Performance Score by Subject Background Information**

<table>
<thead>
<tr>
<th>Cause of Blindness</th>
<th>Ohio</th>
<th>Kentucky</th>
<th>Indiana</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.L.F.</td>
<td>3.80</td>
<td>3.11</td>
<td>3.84</td>
<td>3.60</td>
</tr>
<tr>
<td></td>
<td>n=4</td>
<td>n=3</td>
<td>n=14</td>
<td>n=21</td>
</tr>
<tr>
<td>Optic Nerve Degeneration</td>
<td>4.59</td>
<td>2.24</td>
<td></td>
<td>4.26</td>
</tr>
<tr>
<td></td>
<td>n=6</td>
<td>n=1</td>
<td>n=0</td>
<td>n=7</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>5.53</td>
<td>7.44</td>
<td>6.70</td>
<td>6.55</td>
</tr>
<tr>
<td></td>
<td>n=1</td>
<td>r=1</td>
<td>n=2</td>
<td>n=4</td>
</tr>
<tr>
<td>Retinitis Pigmentosa</td>
<td>n=0</td>
<td>n=0</td>
<td>4.52</td>
<td>4.52</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n=3</td>
<td>n=3</td>
</tr>
<tr>
<td>Microphthalmia</td>
<td>3.18</td>
<td>5.24</td>
<td>4.56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n=0</td>
<td>r=1</td>
<td>n=2</td>
<td>n=3</td>
</tr>
<tr>
<td>Macular Dystrophy</td>
<td>7.96</td>
<td>3.56</td>
<td></td>
<td>5.76</td>
</tr>
<tr>
<td></td>
<td>r=1</td>
<td>n=1</td>
<td>n=0</td>
<td>n=2</td>
</tr>
<tr>
<td>Other 4 1 each</td>
<td>3.70</td>
<td></td>
<td>4.99</td>
<td>4.09</td>
</tr>
<tr>
<td></td>
<td>n=7</td>
<td></td>
<td>n=3</td>
<td>n=10</td>
</tr>
<tr>
<td>Overall</td>
<td>4.40</td>
<td>3.68</td>
<td>4.42</td>
<td>4.31</td>
</tr>
<tr>
<td></td>
<td>n=15</td>
<td>r=7</td>
<td>n=24</td>
<td>n=50</td>
</tr>
</tbody>
</table>

**Analysis of Results by Cause of Blindness**

ANOVA procedures noted significant differences ($p = .0023$) to exist in performance when analyzed by the subjects' cause of blindness. Performance scores were highest
in subjects with blindness caused by Glaucoma (6.59, n=4). Subjects with blindness caused by B.L.F. (3.80, n=21) performed the lowest. Post hoc comparisons further indicated significant differences between the Causes of Blindness. Subjects with blindness caused by Glaucoma performed the velcro-dart throwing task significantly better than subjects with blindness resulting from Microphthalmia (4.56, n=3), Retinoblastoma (4.52, n=3), Retinal Degeneration (4.52, n=3), Optic Nerve Degeneration (4.26, n=7), "Other" (4.09, n=10) and B.L.F. (3.80, n=21). Similarly, subjects with blindness caused by Macular Dystrophy (4.56, n=3) performed significantly better than subjects whose blindness resulted from "Other" causes and B.L.F. No significant differences were noted between performance of subjects with blindness resulting from Glaucoma and Macular Dystrophy.

**Analysis of Results by Sex**

Significant differences (p = .0211) in performance score was noted when analyzed by sex of the subject. ANOVA procedures are summarized in Table 4. Post hoc comparisons of performance score by Sex indicated that males (n=22, 4.6727) performed significantly better than females (n=28, 4.0304).
Analysis of Results by Residence

ANOVA procedures indicated significant differences (p = .0377) to exist between the subjects' residence. Post hoc comparisons indicated that totally blind subjects (Ohio n=19, 4.40; Kentucky n=7, 3.68; Indiana n=24, 4.42) from the Ohio State School for the Blind and Indiana School for the Blind performed the velcro dart throwing task significantly better than participating subjects from the Kentucky School for the Blind.

Analysis of Results by Age

ANOVA procedures also indicated significant differences (p = .0044) to exist in performance score when analyzed by the subjects' age. Subjects between the age of 17-18 had the highest performance mean (n=11, 5.13). The mean performance of subjects under 11 years of age (n=2, 2.26) performed the lowest on the velcro-dart throwing task. Post hoc comparisons further indicated significant differences to exist between the age groups. Subjects between the age of 17-18 (n=11, 5.13) performed significantly better than subjects in the 11-13 years (n=14, 3.43) and less than 11 years (n=2, 2.26) age groups. Similarly, subjects in the 19+ (n=4, 4.64) age group performed significantly better than subjects 11-13 years and less than 11 years of age. Performance of subjects 17-18 years of age and 19+ years of age were not significantly different.
### Analysis of Significant Interactions

#### Table 5
ANOVA of Score by Subject Background Information

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<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P&gt;F</th>
</tr>
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<td>Between Ss</td>
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<td>2.7717</td>
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<td>0.0034*</td>
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<tr>
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<td>0.3954</td>
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<td></td>
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<td>116.8026</td>
<td></td>
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</tr>
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</table>

*significant differences
Analysis of the ANOVA summary chart (Table 4) also indicates that two significant first order interactions exist. A significant ($F = .021$) first order interaction was found to exist between the subjects' cause of blindness and the IF treatment condition the subjects received. This interaction indicates that subjects receiving the KB + KP information feedback treatment condition performed significantly better than subjects receiving KB and KP within the causes of blindness.

Another significant ($F = .0498$) first order interaction was also noted by ANOVA procedures. This interaction indicates that subjects within the three residences performed better when exposed to the KB + KP information feedback condition.

Two other first order interactions appear worthy of note. The treatment by age interaction ($F = .0780$) and cause of blindness by age interaction ($p = .9693$), although not statistically significant, help to account for differences between subjects. The treatment by age interaction ($F = .0780$) approached statistical significance and suggests that older subjects performed better within the three IF treatment conditions. Similarly, the cause of blindness by age interaction ($p = .9693$) suggests that a consistent pattern exist where older subjects within each cause of blindness performed better than younger subjects. These
interactions further identify age to be a key factor in the subjects' ability to use augmented verbal information feedback.

**Summary of Results**

Statistical analysis was completed through use of the SAS (Statistical Analysis System) program on an AMDahl 470 V/8 computer at The Ohio State University. ANOVA procedures were completed with use of the SAS GLM (General Linear Models) program. GLM performs ANOVA procedures for unbalanced data. These findings emerged:

1. No significant differences were found to exist between the effect of the three verbal information feedback treatments.

2. Significant differences were noted in the performance mean of the four learning/retention sessions. The performance mean of learning session III was significantly greater than that of learning session I. Similarly, the performance mean of the retention session was significantly lower than the performance mean of each of the learning sessions.

3. Significant differences were found to exist among the 50 totally blind subjects of the investigation.

4. Subjects with blindness caused by Glaucoma and Macular Dystrophy performed significantly better than subjects with other causes of blindness.
5. Totally blind male subjects performed significantly better than their female counterparts.

6. Totally blind subjects 14 years and older performed significantly better than younger subjects.

7. Totally blind subjects from the Ohio State School for the Blind and the Indiana School for the Blind performed the velcro dart throwing task significantly better than participating subjects for the Kentucky School for the Blind.

Discussion

A discussion of the results of this investigation takes place in four sections. In the first section, the results are analyzed by verbal information feedback treatment conditions. An analysis of the results by session and an analysis by subject follows. In the last section, results will be analyzed in relation to the null hypotheses.

Analysis of Results by Treatments

Significant differences were not found to exist between the effect of the three verbal information feedback treatments. In discussion of this finding, let us first review the findings of pertinent related literature.

Wallace and Hagler (1979) compared the effects of Social Reinforcement to Knowledge of Performance in the
learning of the basketball foul shot with the non-dominant hand. In this study, Wallace and Hagler (1979) provided both treatment groups with KE by allowing the subjects to visually observe the results of each shot. The group receiving KE was found to show superior performance.

Loovis and Ziegler (n.d.) examined the effects of augmented verbal IF in the learning of a shuffle tarot task by one congenitally blind adult female. IF in the form of KE, KE, and a combination of KE + KE was presented in a multielement single subject design. Loovis and Ziegler (n.d.) reported all IF treatments to be "effective in promoting skill acquisition, but that each was differentially effective during the learning curve" (p. 7).

Both Wallace and Hagler (1979) and Loovis and Ziegler (n.d.) noted the need for KE "at least initially" (Loovis & Ziegler, n.d., p. 10) to "develop proper mechanics" (Wallace & Hagler, 1979, p. 265) and "shape appropriate skill topography and execution" (Loovis & Ziegler, n.d., p. 10). These studies, however, differ in their use of KE. Wallace and Hagler (1979) allowed their subjects to gather their own KE visually. In contrast, the totally blind subject in Loovis and Ziegler's (n.d.) study made use of augmented verbal IF. In final comparison, we must focus on the learning processes of visually impaired and non-handicapped populations.
The visually impaired must develop great sensitivity to obtain information about their environment through their other senses. As such, their ability to use the auditory and kinesthetic sense is highly refined. We may speculate, therefore, that as a result of their refined sense, the totally blind subjects were able to effectively use KR, KP, and a combination of KR + KP to adapt their throwing pattern to improve their performance. In this respect, the IF treatment conditions may not be seen as separate and distinct to totally blind subjects.

On one hand, this finding may indicate a methodological problem where the IF treatments were not presented to be distinct and separate. On the other hand, this finding may indicate a difference in the way in which totally blind subjects use augmented verbal IF to learn.

**Analysis of Results by Session**

As noted earlier, IF has been found to be vital to the improvement of performance and learning. The increase of performance mean across the learning sessions support this position. In the presence of augmented verbal IF, totally blind school-aged subjects improved their performance of the velcro-dart throwing task. Similarly, in the absence of augmented verbal IF, the performance mean dropped significantly in the retention session taken 24 hours later.
This finding is consistent with research indicating that the performance of a discrete task drops progressively after twenty minutes (Reumann & Ammons, 1957). Performance during the retention session may also have been affected by a lesser motivation of the subject to perform well associated with the removal of IF.

Analysis of Results by Subjects

Examination of ANOVA procedures also indicates that significant differences existed between the performance of the 50 totally blind school-aged subjects. ANOVA procedures analyzing performance scores by background information indicated males, older subjects (14 years and older), and residents of Ohio and Indiana to perform significantly better on the velcro-dart throwing task. Similarly, subjects with blindness caused by Glaucoma and Macular Dystrophy performed significantly better. The finding that older subjects performed better is consistent with findings indicating older subjects to have more highly developed information processing abilities. Significant differences between subjects may further result from possible differences in their attention to or their ability to use verbal IF, or their general motivation to perform better.
Analysis of Null Hypotheses

During the course of this investigation three null hypotheses were examined:

1. The verbal information feedback treatment condition will not effect the motor skill performance and retention of totally blind subjects.

2. The verbal information feedback treatment conditions will not differentially effect the motor performance of totally blind subjects across learning sessions.

3. The subjects' age, sex, residence, and cause of blindness will not effect the motor skill performance of totally blind subjects.

The level of significance was set at .05. This analysis examined the effect of verbal information feedback on skill acquisition across learning trials. Based on the findings of this investigation, and within its limitations, we fail to reject hypotheses one and two. We reject hypotheses three in favor of findings that performance of totally blind subjects differed as a result of variations in sex, age, residence, and cause of blindness.
CHAPTER 1
Summary, Conclusions, and Recommendations

The present study examined the effect of augmented verbal information feedback (IF) in the learning of a simple gross motor task by totally blind subjects. IF, in the form of Knowledge of Results (KR), Knowledge of Performance (KP), or a combination of KR and KP, was presented to 50 totally blind school age subjects during three (30 trial) learning sessions. During a (30 trial) retention session taken on the next day, the velcro dart throwing task was performed without benefit of verbal IF.

Restatement of the Problem
The intent of this study was to examine the effects of augmented verbal information feedback in the learning of a simple motor task by totally blind subjects.

This investigation further sought to answer the following questions:

1. What form of verbal information feedback (KR, KP, or combinations of KR and KP) is most effective in the motor skill learning of totally blind subjects?
2. Does the form of verbal information feedback have a differential effect related to the stage of learning by totally blind subjects?

3. Does the subjects' cause of blindness, sex, residence, or age effect the learning of gross motor skills by totally blind subjects?

Summary of Pertinent Related Research

As a general orientation to the nature of skill acquisition, Fowler and Turvey (1976) parallel skill acquisition to the evolution of a species. Fowler and Turvey (1976) further note that the species' "adaptation to an environment is synonymous with the evolution of special biological and behavioral features that are compatible with special features of the environment" (p. 3). As such, "learning a skill involves discovering an optimal self-organization" (Fowler & Turvey, 1978, p. 6). Further in the course of acquiring skill, the actor must gather "skill specific variables of stimulation that . . . guide and regulate the current approximations and prescribe the next approximation to the desired performance (attunement)" (Fowler & Turvey, 1978, p. 6). Fowler and Turvey (1978) present the acquisition of skilled performance as a "superordinate system, one that encompasses the actor, his actions, and the environmental supports for his actions" (p. 7). From this perspec-
tive, "coordination is a relation defined over the actor and the environment, and control is the exclusive prerogative of neither" (Fowler & Turvey, 1978, p.7). According to Fowler and Turvey (1978), "to achieve some aim, ... an actor must engage in a systematic relationship with the environment" (p.8).

"As one progresses from an inexperienced to a skilled state, dramatic changes seem to occur in motor performance" (Stelmach & Larish, 1980, p.141). According to Stelmach and Larish (1980), this change is "most evident in the transition of movement control from a conscious mode to an automatic mode" (p.141).

Studies of Information Feedback (IF) or Knowledge of Results (KR) show it to be the strongest, most important variable controlling performance and learning (Irion, 1966; Bilodeau & Bilodeau, 1961). Knowledge of Results (KR) is viewed as a source of error information used by the subject in problem-solving.

Information feedback serves at least the three following empirical properties generalized from the issues of reward research. Feedback has been thought to strengthen responses, sustain performance, and to eliminate previously established responses (Bilodeau, 1961; Bilodeau & Bilodeau, 1961; Rott, 1966). "Like primary reward, KR might serve to reinforce (strengthen) habits, evoke already established
habitits (cue properties), and provide the motivation (incentive) for learning or performing" (Bilodeau & Bilodeau, 1961, p.253).

According to Ammons (1956) IF "effects rate of learning and level reached by learning" (p.283). Further, Ammons (1956) notes that "where knowledge of their performance is given to one group and knowledge is withheld or reduced in the case of another group, the former group learns more rapidly, and reaches a higher level of proficiency" (p.283).

Behavior management techniques were also found to be effective in establishing behavior change, however, to a lesser extent than KB. Similarly, social reinforcement was found to be more effective in improving performance on an accuracy task when paired with KB. However, this combination of social reinforcement and KB was not as effective as Knowledge of Performance in the learning of the basketball foul shot.

Wallace and Hagler (1979) examined the role of feedback in the learning of the basketball foul shot with the non-dominant hand. "While both groups received KB by visually observing the results of each shot, one group received KP (Knowledge of Performance) while the other group received social reinforcement" (Wallace & Hagler, 1979, p.267). The group receiving knowledge of performance was
found to show superior performance. "Consequently, it is important for the learner to obtain KP (Knowledge of Performance) from an outside source such as the teacher or coach so that the internal standard can be developed" (Wallace & Hagler, 1979, p.269). The authors note that "since KR did not provide information regarding proper mechanics of the set shot, subjects in the KB * SB (Social Reinforcement) condition apparently did not develop the proper mechanics of the shot as well as subjects who received KP (Knowledge of Performance)" (Wallace & Hagler, 1979, p.270). "The present study indicates that learning is possible in the absence of KP when KB is present, but a higher level of performance is achieved when both types of information are present" (Wallace & Hagler, 1979, p.271).

The role of KB has also been examined with handicapped populations learning of pursuit rotary tasks and a shuffle board task. Loovis and Ziegler (n.d.) examined the effects of verbal augmented information feedback on the closed rotor skill acquisition of a congenitally blind adult female. Feedback in the form of KB, Knowledge of Performance (KP), and a combination of KR and KP was provided in the learning of a shuffle board task in a Multielement single-subject design.

Loovis and Ziegler (n.d.) noted that "all treatments were effective in promoting skill acquisition, but that
each was differentially effective during the learning curve" (p.7). Loovis and Ziegler (n.d.) further report that "the blind can use information feedback, namely KR and KF during skill acquisition" (p.10). A visually impaired subject "must rely on someone or something to provide KR during motor skill acquisition" (Loovis & Ziegler, n.d., p.10). Further, "there is still the need in a closed skill for KF which helps shape appropriate skill topography and execution" (Loovis & Ziegler, n.d., p.10). Despite methodological concerns, Loovis and Ziegler (n.d.) conclude that "verbally augmented statements should probably highlight, at least initially, information about the quality of the subject's performance and then only secondarily information pertaining to the results of the attempt" (p.10).

In examining the need of the visually impaired, Euell (1982) noted that "the more loss of vision a student has, the more he must depend upon his other senses to gain information" (p.ix). As such, the role of supplemental information feedback is magnified. Although much research related to the role of KR has dealt with blind-folded tasks, other research relating to the influence of KR with the visually impaired was not found.
Conclusions

1. Totally blind subjects are able to use augmented verbal information feedback to improve the performance of their gross motor skills.

2. The difference between the effects of KR, KP, and the combination of KR + KP treatments in the gross motor skill learning of the totally blind is apparent but not statistically significant.

3. Older totally blind subjects are able to use augmented verbal information feedback more effectively than younger subjects to improve their gross motor skill performance.

Recommendations

1. Research should be conducted to compare the effects of augmented verbal IF in the motor skill learning of a full range of visually impaired and non-handicapped subjects. This research should compare the ways in which visually impaired and non-handicapped subjects process and use information feedback to learn.

2. Research should be conducted to compare the effects of different forms and specificities of KR and KE in the motor skill learning of visually impaired subjects.
3. Research should be conducted to compare the effects of different forms and specificities of KB and KE in the motor skill learning of non-handicapped subjects.

4. Research should be conducted to identify variables that may effect or predict motor skill performance of visually impaired subjects.

5. Research investigating the motor skill learning of visually impaired subjects should seek to control for differences between subjects. Specifically, efforts should be made to control for differences in body and spatial awareness and gross motor ability. Exclusive use of subjects 14 years of age and older will further control for differences between subjects due to information processing.

6. Research should be conducted relating to the comparison of information processing abilities of visually impaired and non-handicapped subjects. Variables such as KB-delay, post KB-delay, specificity of information feedback (KB and KE), and differing modes of information feedback should be investigated.

7. Research should be conducted to compare the effects of KB and KE on the learning of other motor tasks by visually impaired and non-handicapped subjects.
Research efforts should seek to investigate the effects of verbal IFF on a specific age of visually impaired subject.
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Appendix A

BACKGROUND INFORMATION OF SUBJECTS
TABLE 6
Background Information of Subjects

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(R.L.F.)

(GIANCCIA)

(GIANCCIA)

(GIANCCIA)

(RETINCELASTOMA)

(MACULAR AELASIA CETIC)

(ATROPHIA EULVAR)

(CENTRAL CEREBRITIS)

(CETIC ATROPHY)

(R.L.F.)

(GIBRAN MEASLES (OPTIC NERVE ACT FEASED))
Appendix E

CORRESPONDENCE
March 6, 1983

Vision Center of Central Ohio
1393 North High Street
Columbus, Ohio 43201

Dear Mrs. Muste;

Thank you for your assistance in the completion of the pilot stage of my doctoral dissertation, "The Effects of Augmented Verbal Information Feedback in the Motor Skill Learning of the Visually Impaired". The pilot study enabled me to make some necessary revisions of my methods and procedures.

The cooperation that I received from you and fellow staff of the Vision Center of Central Ohio was truly appreciated.

Thank you for the use of the facility and your arrangements which made this study come about.

Sincerely,

Daniel P. Joseph
March 21, 1984

To Whom It May Concern:

This is to verify that Mr. Dan Joseph's proposed dissertation topic, "The Effects of Augmented Verbal Information Feedback in the Motor Skill Learning of the Visually Impaired" has been approved by his Program Committee and he has been given permission to proceed with the investigation.

Sincerely,

[Signature]

Walter F. Erzing
Professor

WFE:Pls

College of Education
December 13, 1983

Mr. Chris Wanner
Principal
The Ohio State School for the Blind
5220 North High Street
Columbus, Ohio 43214

Dear Mr. Wanner,

I am a graduate student and degree candidate in Adapted Physical Education at The Ohio State University. This letter is to request the use of students of The Ohio State School for the Blind in a proposed research project. The proposed study would involve work in partial fulfillment of the requirements for the Doctor of Philosophy degree. The study entitled "The Effects of Augmented Verbal Information Feedback in the Motor Skill Learning of the Visually Impaired", as proposed would involve totally blind subjects.

The research project is designed to examine the effects of two levels of Knowledge of Results, Knowledge of Performance, and a control-in the motor skill acquisition of a velcro dart throwing task. The subjects would be involved in six 15 minute sessions during regular school hours. The findings of this study would be of benefit to motor programming of the visually impaired as well as adding to the body of knowledge relating to the use of Information Feedback with non-handicapped students. In addition, the participants of the study would learn an activity valuable in recreation and leisure time pursuits.

Anne Toole and Jim Peterfish indicated their support of this investigation and willingness to assist in the scheduling of subjects. The facility requirements for this study are minimal. A space approximately 10' x 10', free of distractions from outside sources may be used for the investigation.

I am very enthusiastic and look forward to doing this research and sincerely hope that The Ohio State School for the Blind can assist me in the completion of this very important study. My advisors and I extend our courteous thanks in advance for your time and consideration in this matter.

College of Education
If additional information is needed concerning this study please read the attached proposal. I will call you later this week to discuss this study and remain available at any time for this purpose.

Sincerely,

Daniel P. Joseph
Graduate Teaching Associate

Office: (614) 422-6226
Home: (614) 895-8794
January 9, 1984

To Whom It May Concern:

The Ohio State School for the Blind has given Daniel F. Joseph permission to use the facility in conducting his approved doctoral program with a selected group of enrolled visually handicapped students.

The title of the dissertation project is The Effect of Augmented Verbal Information Feedback in the Motor Skill Learning of the Visually Impaired.

If additional information is needed please contact me at the following telephone number, (614) 888-4616.

Sincerely,

Christopher F. Wanner
Principal

CPW//mar

cc: File
March 6, 1984

Kentucky School for the Blind
1867 Frankfort Avenue
P.O. Box 6005
Louisville, Kentucky 40206

Dear Mr. Marcia:

I am a graduate student and degree candidate in Adapted Physical Education at The Ohio State University. This letter is to request the use of students of the Kentucky School for the Blind in a research project. The study would involve work in partial fulfillment of the requirements of the Doctor of Philosophy degree. The study entitled "The Effects of Augmented Verbal Information Feedback in the Motor Skill Learning of the Visually Impaired", would involve totally blind students.

The research project is designed to examine the effects of Knowledge of Results, Knowledge of Performance, and a combination of Knowledge of Performance and Knowledge of Results in the motor skill acquisition of a velcro dart throwing task. The students would be involved in two sessions during regular school hours. The findings of this study would be of benefit to motor programming of the visually impaired as well as adding to the body of knowledge relating to the use of information feedback with non-handicapped students. In addition, the participants of the study would learn an activity valuable in recreation and leisure pursuits.

Mr. Chris Wanner, Principal of the Ohio State School for the Blind has indicated his support and has been very helpful in conducting this research. The facility requirements for this study are minimal. A space approximately 10' x 10', free of distractions from outside sources may be used for the investigation.

I am very enthusiastic and look forward to doing this research and sincerely hope that the Kentucky School for the Blind can assist me in the completion of this very important study. My advisor and I extend our courteous thanks in advance for your time and consideration in this matter.

College of Education
If additional information is needed concerning this study please read the attached proposal. I will call you later this week to discuss this study and remain available at any time for this purpose.

Sincerely,

Daniel P. Joseph
Graduate Teaching Associate

Office: (614) 422-6226
Home: (614) 885-8794
April 3, 1984

Mr. Daniel P. Joseph
School of Health, Physical Education, and Recreation
The Ohio State University
337 West 17th Avenue
Columbus, Ohio 43210-1284

Dear Mr. Joseph:

I have mailed out thirteen consent forms to parents.

We look forward to your coming to do your research project.
Let me know if you need further information.

Sincerely,

Richmond R. Marcy
Principal

Department of Education
March 6, 1984

Indiana School for the Blind
7725 North College Avenue
Indianapolis, Indiana 46220

Dear Mr. Haralson:

I am a graduate student and degree candidate in Adapted Physical Education at The Ohio State University. This letter is to request the use of students of the Indiana School for the Blind in a research project. The study would involve work in partial fulfillment of the requirements of the Doctor of Philosophy degree. The investigation entitled "The Effects of Augmented Verbal Information Feedback in the Motor Skill Learning of the Visually Impaired", would involve totally blind students.

The research project is designed to examine the effects of Knowledge of Results, Knowledge of Performance, and a combination of Knowledge of Results and Knowledge of Performance in the motor skill acquisition of a velcro dart throwing task. The students would be involved in two sessions during regular school hours. The findings of this study would be of benefit to motor programming of the visually impaired as well as adding to the body of knowledge relating to the use of information feedback with non-handicapped students. In addition, the participants of the study would learn an activity valuable in recreation and leisure pursuits.

Mr. Chris Wanner, Principal of the Ohio State School for the Blind has indicated his support and has been very helpful in conducting this research. The facility requirements for this study are minimal. A space approximately 10' x 10', free of distractions from outside sources may be used for the investigation.

I am very enthusiastic and look forward to doing this research and sincerely hope that the Indiana School for the Blind can assist me in the completion of this very important study. My advisor and I extend our courteous thanks in advance for your time and consideration in this matter.

College of Education
If additional information is needed concerning this study please read the attached proposal. I will call you later this week to discuss this study and remain available at any time for this purpose.

Sincerely,

Daniel P. Joseph
Graduate Teaching Associate

Office: (614) 422-6226
Home: (614) 895-8794
Appendix C

RESEARCH CONSENT
Parents;

We would like your son/daughter and several other students of the Columbus Public Schools to participate in a research project entitled "The Effects of Augmented Verbal Information Feedback in the Motor Skill Learning of the Visually Impaired". This study has been approved by Dr. Harold Merriman, Assistant Superintendent of the Columbus Public Schools. Your son/daughter will toss a velcro dart eight feet to a target in two sessions. The purpose of the study is to determine if verbal information statements affect the learning of a velcro dart throwing task. This task is non-vigorous and non-harmful.

The findings of this study would be of benefit to the motor programming of the visually impaired as well as to the non-handicapped. In addition, the participants of this study would learn an activity valuable in recreation and leisure time pursuits. All activities related to the study will take place on the grounds of your child's school building and under the supervision of The Ohio State University Department of Physical Education.

Your son's/daughter's consent for participation is also requested. A consent form has been enclosed to indicate your willingness to participate in this study. Please sign the consent form and return it in the stamped return address envelope provided. Whether or not your son/daughter participates in this study, his/her care or training will not be affected.

Your involvement in this research project will be greatly appreciated. Please feel free to contact us if you have any questions concerning this research project.

Sincerely,

[Signature]
Walter F. Erzing, Ph.D.
Project Supervisor

[Signature]
Daniel Joseph
Project Coordinator
(614) 422-6226

enclosures:
MOTOR LEARNING PROJECT

Consent Form

I consent to the participation of
as a subject in the research investigation entitled "The Effects
of Augmented Verbal Information Feedback in the Motor Skill
Learning of the Visually Impaired".

The nature and general purpose of the research project has
been explained to me in a cover letter. This research is to be
performed by or under the direction of Dr. Walter F. Eising
and Mr. Daniel P. Joseph, who are authorized to use the services
of others in the performance of this research.

I understand that the identity of my child will not be
revealed in any publication, document, recording, videotape,
photograph, or in any way which relates to this research. I
further understand that I may withdraw my consent and terminate
my child's participation at any time following the notification
of the Project Director.

Whether or not your son/daughter participates in this study,
is his care or training will not be affected.

Your involvement in this research project is greatly
appreciated.

_________________________   _________________________
Student's Signature       Parent's Signature

_________________________
Date

College of Education
Appendix D

SCCRESHEET
TREATMENT CONDITIONS

KR: HIT/MISS RIGHT/LEFT OF TARGET CENTER

KP: RELEASE TOO SOON/LATE
RELEASE OFF TO RIGHT/LEFT
MOVE (BODY PART) TOO MUCH

KR + KP
Appendix E

RAW PERFORMANCE SCORES BY SUBJECTS
### TABLE 7

**Raw Performance Scores by Subject**

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| III| 1 5 5 9 0 3 1 0 7 7 3 7 5 7 1 7 7 1 0 5 5 0 3 5 0 5 3 0 1 |
| B | 3 0 0 0 0 0 0 0 0 0 7 0 3 0 0 0 0 0 0 0 0 1 0 9 0 5 9 5 5 |
KNOWLEDGE OF PERFORMANCE TREATMENT GROUP

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III 3 1 5 3 1 3 9 7 0 3 5 5 3 5 5 0 1 5 1 5 0 9 1 0 1 5 7 7 8 7 1
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| III| 9 1 0 7 1 0 3 5 7 5 7 9 7 3 7 7 1 7 7 9 7 1 0 3 7 5 7 9 5 1 0 7 7 5 |
| R  | 7 5 3 5 5 3 7 5 1 9 7 3 1 0 3 5 7 1 9 5 5 7 0 0 5 9 7 8 8 8 |

### Subject 29.

| I  | 7 7 5 0 7 5 7 5 9 3 7 5 3 7 3 5 9 3 3 5 7 1 3 7 1 0 3 7 3 5 5 |
| II | 7 7 5 5 7 5 9 5 9 3 7 7 3 5 5 7 5 0 3 7 5 7 9 9 5 0 5 7 0 3 |
| III| 7 7 5 7 7 7 5 3 1 0 3 1 0 7 1 0 7 7 7 3 7 5 5 7 5 7 5 7 5 0 3 |
| R  | 7 0 1 3 0 3 0 3 1 3 1 1 7 0 0 0 5 9 7 3 5 9 7 9 5 7 5 5 1 |

### Subject 30.

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| II | 3 5 1 5 3 5 0 3 7 7 3 3 5 0 3 5 9 3 0 0 9 0 1 0 9 3 1 3 |
| III| 1 0 9 5 3 5 0 1 1 5 3 3 3 3 5 1 7 7 0 3 9 5 7 1 3 1 7 0 5 9 5 |
| R  | 0 9 7 5 7 5 7 0 7 1 1 3 7 1 1 1 0 5 1 9 1 0 3 3 1 0 9 5 7 7 5 |

### Subject 31.

| I  | 7 0 0 0 5 0 0 7 3 1 5 3 5 0 1 1 9 7 9 3 3 7 3 7 0 3 5 1 0 |
| II | 1 0 0 0 9 7 1 9 7 3 0 1 3 5 5 3 5 5 5 3 0 0 9 3 0 |
| III| 0 0 7 1 0 7 1 5 1 0 7 5 0 3 5 3 3 3 5 5 0 0 0 0 1 0 7 3 0 5 |
| R  | 3 0 0 0 5 1 5 1 3 6 5 0 0 7 3 0 0 3 5 0 5 0 1 3 3 1 0 0 7 5 5 |

### Subject 32.

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| III         | 0                | 5                | 0                | 5                |
| R           | 0                | 5                | 3                | 0                |

| Subject 37   |                  |                  |                  |                  |                  |
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| II          | 7                | 0                | 5                | 1                |
| III         | 7                | 0                | 5                | 0                |
| R           | 7                | 7                | 7                | 7                |

| Subject 38   |                  |                  |                  |                  |                  |
|-------------|------------------|------------------|------------------|------------------|
| I           | 1                | 3                | 9                | 3                |
| II          |                 | 7                | 5                | 3                |
| III         | 5                | 0                | 3                | 5                |
| R           | 5                | 3                | 5                | 0                |
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Subject 40.
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III 0 7 0 5 0 1 9 5 0 7 5 3 9 1 1 5 1 0 1 5 5 1 1 7 3 0 0 5 3 7 9
R 0 0 3 5 1 0 0 5 5 3 3 7 3 0 1 5 3 3 5 5 3 0 9 3 1 9 7 5 5

Subject 41.
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Subject 42.
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Subject 43.
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III 7710971075579555971079771071079959
R   757779910597797109979777107977977

Subject 50.
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II  107779710977757710510795551771059109
III 77155517103757975109959555101097759
R   01100000503115753313339005510