AN ABSTRACT OF THE THESIS OF

Virginia Foster Atkins for the degree Doctor of Philosophy in Education presented on April 10, 1984.

Title: A Comparison of the Effect of Experimenter and Microcomputer Delivered Knowledge of Results on the Response Speed of Nonretarded and Mentally Retarded Students.

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Abstract approved: ______________________________
John M. Dunn

The purpose of the study was to analyze the effect of experimenter delivered and microcomputer delivered knowledge of results on the response speed of nonretarded and mentally retarded public school students. Response speed was measured for 63 nonretarded students and 63 mentally retarded students. Subjects were randomly assigned to conditions of no feedback, instructor feedback and computer feedback. The design of the project was a Pretest-Posttest Control Group Design (Campbell & Stanley, 1963). The data collected in this study were treated with Analysis of Covariance. The covariate was the pretest score and the dependent variable was the posttest score.

Within the limitations of this study, no significant results were obtained and the null hypotheses were

not rejected.

Baumeister and Ward (1967) and Hoover, Wade and Newell (1981) found that for retarded populations response speed (reaction time and movement time) were susceptible to training. A post-hoc paired t-test indicated that both retarded and nonretarded subjects significantly improved ($p<.001$) their performances of the response speed task. This change in performance may be attributed to other factors such as the effect of practice and the visual feedback that all subject's received by observing the position of the stick after each test trial.

A Comparison of the Effect of Experimenter and Microcomputer Delivered Knowledge of Results on the Response Speed of Nonretarded and Mentally Retarded Students

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Typed by Virginia Atkins

DEDICATION

To my husband, Thomas,

who sees all the colors in the rainbow.

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And the team of very special athletes, whose participation in competition has revised my model for living.

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CHAPTER I

INTRODUCTION TO THE STUDY

Introduction

Response speed in the mentally retarded has been found to be slower and more variable than in nonretarded individuals (Berkson & Baumeister, 1967; Baumeister & Kellas, 1968). Previous studies have demonstrated faster response speeds can be elicited from the mentally retarded through reinforcements and training techniques that provide in combination, physical assistance, nonverbal prompts, and verbal prompts, including praise, and knowledge of results (Holden, 1966; Baumeister & Ward, 1967; Hoover, Wade, & Newell, 1981). Magill (1980) observed that knowledge of results provides three instrumental factors in the learning of motor skills; information, motivation, and reinforcement. Further, knowledge of results is separated from other forms of feedback in that it is gained through an external source such as a teacher or measuring device.

Dunn, Morehouse, Anderson, Fredericks, Baldwin, Blair, and Moore (1980) indicate the learning process is slower for handicapped students, therefore the process takes longer. Moss, (1973) in a study of simple response speed in the mentally retarded, found that mentally retarded individuals performed patterns in a fashion similar to nonretarded individuals but progressed at a slower and more variable rate. Frequently thousands of trials were needed to reach an asymptote in the performance curve. With sufficient additional practice, mentally retarded subjects were capable of obtaining performance levels close to or equal to nonretarded individuals. (Berkson & Baumeister, 1967). Given the high number of trials needed to produce a change in performance of the mentally retarded, and the mandate of PL. 94-142 that instruction be designed to meet the unique needs of a handicapped child, the task for the teacher becomes a very labor intensive, time consuming effort. Dunn et.al. (1980) suggest individualized instruction, and in the case of the severely handicapped, one-to-one instruction. Obviously for the teacher with more than one student, the amount of time for student-teacher interaction is limited, even with the assistance of trained classroom aides and volunteers.

Purpose of the Study

The purpose of the study was to discover the effect of experimenter delivered and microcomputer delivered knowledge of results on the response speed of nonretarded and mentally retarded public school students.

Significance of the Study

The importance of this study relates to the use of feedback and its results on the response speed of children, particularly mentally retarded children. With practice, students may be able to respond to specific tasks more quickly than before.

It is important to establish the usefulness of microcomputers as instructional tools in special education and special physical education. The military has found that practice with video games can increase the gunnery skills of individuals (Knirk, 1983). Simulations might provide access to activities that have previously been inaccessible to individuals with disabilities, or may improve skills in certain motor tasks.

When addressing the problem of instructional time for special students, it has been established that for mentally retarded students more time is needed to master tasks. Atkinson (1967) states that in traditional teaching, less than 15% of time spent in school is used for instruction. One hour per day with a computer terminal provides for the student, a significant increase in instructional time. Holmes (1982) indicates that microcomputers are at least as effective as traditional instruction. Furthermore, according to Holmes, microcomputers increase student motivation, improve the rate of learning, and in some curricular areas, lead to increased student achievement. If computer assisted instruction is effective with nonretarded students, then computer assisted instruction might prove to be an effective instructional tool for the mentally retarded. Microcomputers would also relieve the teacher of the fatiguing task of delivering numerous trials in order to improve the performance of a mentally retarded student. A microcomputer could be used for assessment, and practice of repeated tasks, thereby freeing the teacher to work with other students. The microcomputer does not become tired or bored repeating the same drill hundreds of times as a person might (Magidson, 1977). As an added bonus, the computer is capable of quickly analyzing data, relieving the teacher of an additional time consuming task (Brudner, 1982). The rapid analysis of student data enables the teacher to make informed decisions about the course of an individual student's instruction.

This study examined experimenter delivered and microcomputer delivered knowledge of results as a factor affecting response speed in the mentally retarded.

The implications of the study were to make recommendations for improving response speed with mentally retarded students through experimenter delivered and microcomputer delivered knowledge of results and the usefulness of microcomputers as a teaching tool in special physical education.

Hypotheses

The following null hypotheses were tested to determine if they should be rejected or retained:

H1. There is no treatment effect for knowledge of results.

H2. There is no effect for retardation.

H3 There is no interaction effect between treatment and levels of retardation.

Assumptions

In conducting this study the following assumptions were made:

1. The microcomputer modification of the response speed subtest of the Bruininks-Oseretsky Test of Motor Proficiency did not affect the validity, reliability and objectivity of the measure.
2. The subjects were similarly motivated to participate.
3. The sample was representative of the nonretarded and the mentally retarded school age populations. The

subjects were randomly assigned to treatment groups.

4. Prior experience with microcomputers was controlled to the extent that this variable did not influence the results of the study.

Limitations of the Study

This study was subject to the following limitations:

1. The subjects in this study varied with respect to their prior experience with response speed tasks.
2. The information obtained for each subject on the written consent form was assumed to be correct.
3. The findings of this study were not generalized, but applied only to the group of subjects studied.

Delimitations of the Study

This study was delimited to 126 mild to moderately mentally retarded and nonretarded public school students. The mentally retarded students were qualified handicapped individuals falling in the categories of educable mentally handicapped and trainable mentally handicapped as determined by state and federal statutes. A modified form of the Bruininks-Oseretsky Test of Motor Proficiency Subtest 6: Response Speed, was used as a criterion measure. Response speed was measured to .001 using the hardware clock of a microcomputer.

Definitions and/or Explanation of Terms

The following definitions were established for use in this study:

Computer Assisted Instruction. Any of several forms of instruction facilitated by a computer or microcomputer, including drill and practice, tutorials, simulation, and problem solving.

Computer Managed Instruction. The use of a computer or microcomputer to test, evaluate, assess, and record performance data. Also the management of data for such uses as determining class rank, calculating grades, scheduling, identifying areas of expertise or deficiency.

Fitt's Index of Difficulty.

> Now referred to as Fitt's Law, is expressed as follows: MT= a + (b log 2A/W), where MT is the movement time, a and b are constants, A is the amplitude or distance from the starting position to the target center and W is the target diameter. By inserting various values of A and W, an index of difficulty (ID) for any movement may be expressed in bits...the relation ship between ID and MT is linear...(and) different movements which have the same ID value, ...take the same time to complete. (Fitts and Peterson, 1974, p. 108).

Individualized Education Program. (IEP) A prescriptive program designed for the individual student by teachers, parents, and other professionals as required by Public Law 94-142. The instructional design must include the child's present level of educational functioning, long term goals, short term objectives, a description of related services, the date the instruction began and the expected date of completion. Objective measures to determine if the goals and objectives were met must be designated as well.

Intelligence Quotient.(IQ). The result of dividing an individual's mental age by chronological age, then multiplying by 100.

Knowledge of Results. A specific form of feedback concerning one's performance of a task that is available only through an external source, such as a teacher, coach or video tape system (Magill, 1980)

Mental Age. Seaman and De Pauw (1982) refer to mental age as the cognitive or intellectual level at which the individual functions.

Mentally Retarded. According to American Association of Mental Deficiency:

> Mental retardation refers to significantly subaverage general intellectual functioning existing concurrently with deficits in adaptive behavior, and manifested during the developmental period. (Grossman, 1973, p 11)

Typically, this includes children whose IQ scores measure less than 70 on intelligence tests such as the Stanford-Binet or the Weschler Intelligence Scale for Children-Revised (Seaman & De Pauw, 1982). Mental

Retardation is determined by qualified personnel through the use of standardized tests and assessment procedures.

Response speed. A theoretical measure that is the summation of reaction time and movement time. As closely as can be measured it is the time from which a stimulus is perceived, until a response (movement) has been made. Figure 1 is a conceptual model of the response speed paradigm (after Baumeister & Kellas, 1968).

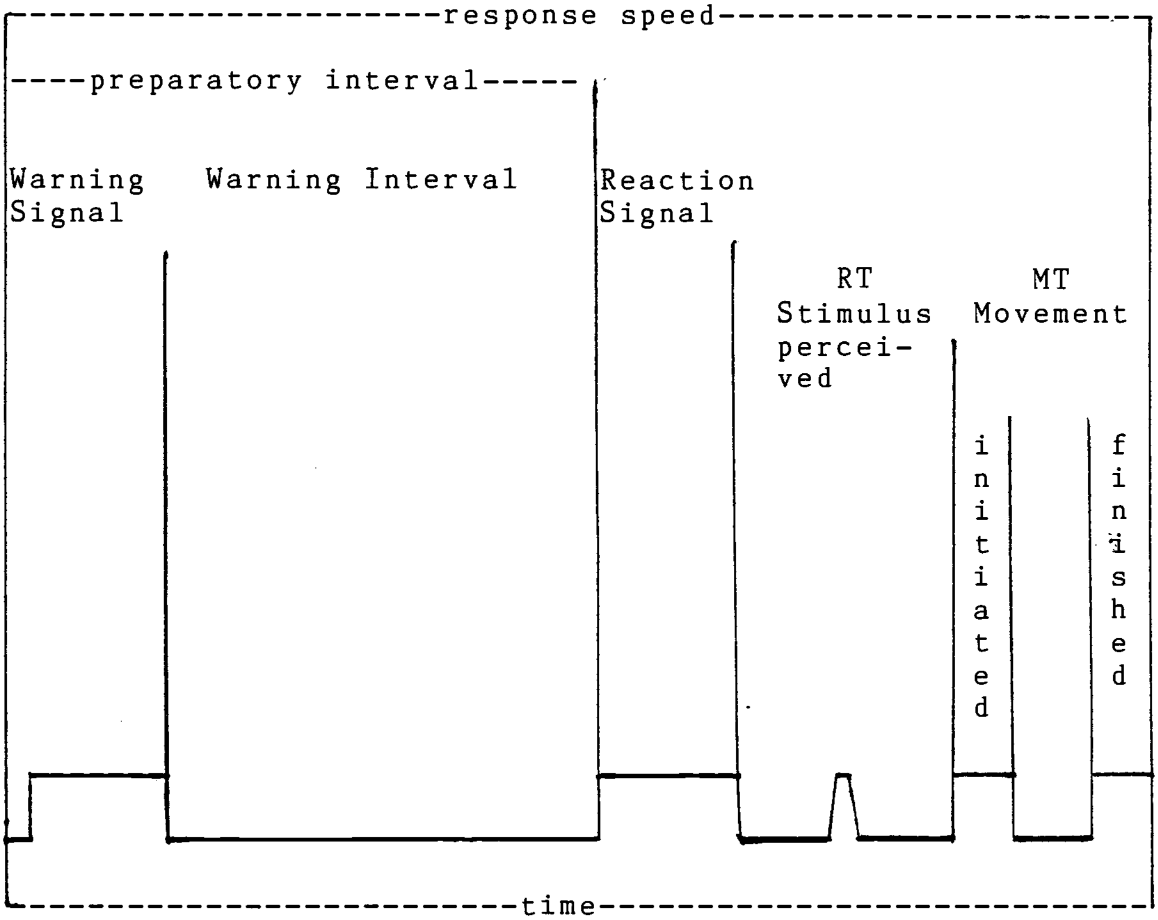

Figure 1. Response speed paradigm. This figure illustrates the conceptual model of response speed. First a warning signal alerts the subject that a response signal will be forthcoming, a warning interval follows, usually of random duration. These two factors comprise the preparatory interval. The reaction signal is presented, the subject perceives this stimulus, initiates a movement, and completes the response.

Response Speed Terms:

Intertrial interval. That period of time between the ending of a movement, and the beginning of the next warning signal.

Warning signal. A stimulus or stimuli presented to advise the subject that the response signal will be forthcoming.

Warning Interval. end of the warning signal and the onset of the response signal.

Preparatory Interval. The combined time of the warning signal and the warning interval.

Response signal. The stimulus or stimuli to which the subject is to immediately respond.

Reaction time. The amount of time from the onset of the response signal until the subject begins to move.

Movement time. The amount of time from the initiation to the completion of the movement.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter was to review the literature and to provide a rationale for the comparison of experimenter delivered and microcomputer delivered knowledge of results on a response speed task for mentally retarded and nonretarded students. The three research areas reviewed were; response speed, knowledge of results, and computer assisted instruction. While a considerable body of knowledge was available concerning the first two areas, the area of computer assisted instruction is not extensively published particularly with respect to special education and physical education.

Response Speed Development

The process of responding is not consistent from birth to death. Goodenough (1933) used a cross-sectional study to assess the changes in reaction time as individuals age. Testing 246 children between the ages of 2.5 to 11.5 years and 56 college age students, she found reaction time became faster with age. With regard to the differences between reaction time of males and females Goodenough reported:

> The slight sex difference in favor of the males which previous investigators have reported for adult subjects appears to hold good even in early childhood. The boys in our group tend to surpass the girls of the same age both in respect to average speed of reaction and in low variability from trial to trial. (p. 450)

The responses of preschool children were studied by Wallace, Newell and Wade (1978) in relation to difficulty of movement. Six preschool children, ages 4.0 to 5.0 years were given four consecutive days of practice on movements of varying difficulties, as determined by the Fitts' Index of Difficulty. Although not significant, there was a trend over the four days for a decrease in reaction time variability and a decrease in movement time. The researchers concluded that Fitts' Law, which indicated that movements with the same index of difficulty require the same time to complete, holds true for preschool children.

Studies of response speed with teenagers and young adults (Atwell & Elbel, 1948; Beise & Pealsey, 1941; Slater-Hammel, 1952) indicated response speed becomes faster through adolescent and young adult years. No correlation between reaction time and movement time existed for any group, nor could movement time be predicted from reaction time. Skilled athletes were found to have faster response times than physical education students.

In nonretarded populations, many variables associated with reaction time have been studied. Teichner (1954) reviewed 165 reaction time experiments. His findings were:

1. There is no evidence that reaction time is faster for one sensory system or another when the types of stimulation are compared on the same scale. There is a correlation between auditory and visual reaction time. Studies present conflicting conclusions for auditory, visual and tactual stimulation.
2. The combination of stimuli, (visual, auditory, tactual) produce faster reaction times provided they are presented simultaneously. Successive stimulation of sensory systems produce longer reaction times.
3. Reaction time is faster for persons with greater visual acuity and greater ability to distinguish visual figure from visual ground.
4. Up to the individual's own optimal limit, reaction time becomes faster as stimulus intensity increases.
5. Response-terminated stimuli is known to produce shorter reaction times than fixed duration stimuli.
6. Some studies report faster reaction time to onset of stimuli, while others report faster reaction time to cessation of stimuli.

7. Reaction time to both visual and auditory stimuli becomes faster until age 30. Ten year old boys have slower reaction times than 60 year old men.
8. On the average, a slight advantage for reaction time is found for males.
9. The use of a warning signal produces shorter reaction time than not using a preparatory signal. Optimum foreperiod between the warning signal and the reaction signal is between 1.0 and 4.0 seconds.
10. Reaction time initially increases after a change in body position. If the position is maintained, reaction time returns to its former value.
11. Complex, choice, or guided movements produce longer reaction times than movements made freely.
12. Temperature ranges between -50 and 117 degrees Farenheit have no effect on simple or complex reaction time.
13. Significant lengthening of reaction time is found when subjects are accelerated to forces of 1, 3, and 5 *g*.
14. During conditions of vigilance, reaction times are longer.

In summary, response speed, the combination of reaction time and movement time, is slow in the young child, becomes faster in adulthood until age 30, then begins to become slower again. Females are at a slight disadvantage, being somewhat slower to respond than males of the same age group. Movement time and reaction time seem to be independent of each other. Athletes are able to respond faster than nonathletes.

Repsonse Speed and the Mentally Retarded

Public Law 94-142 separates the construct fitness into physical fitness and motor fitness. (Federal Register, Aug. 1977). Physical fitness is usually concerned with health related items such as; strength, flexibility, lean body mass, power, and cardiovascular endurance. Motor fitness components include balance, eye-limb coordination, response speed and agility. Motor fitness contributes to the ability to throw, catch, strike and kick, the elements of most sports and games (Carre, Corbin & Lindsey, 1979). The physical fitness of retarded children is similar to nonretarded children of the same mental age (Stein & Pangle, 1966) and physical fitness will improve with this population, more rapidly than motor fitness.

Responding is part of daily life for all individuals. The ability to respond with accuracy and speed is very highly prized in our society. For mentally retarded individuals, response speed is usually slow and variable (Berkson & Baumeister, 1967; Baumeister & Kellas, 1968).

The obvious consequences of slow response are that everything takes longer, from self care skills such as dressing and grooming, to leisure pursuits including competitive sports and recreational games. The person who is slow to respond faces many difficulties in the school environment. The student may, for example, be passed over by the teacher in a question and answer situation, or invited to be the team manager because the level of play demands quick action.

The second and less obvious consequence of slow responding is its social legacy. Smith and Hurst (1961) found that motor ability as measured by the Lincoln-Oseretsky Motor Development Scale was a better predictor of peer acceptance than either chronological age or mental age for educable and trainable mentally retarded children. The experimenters measured verbal and nonverbal contacts initiated and contacts received. They concluded that the more motorically fit a child was the more social contacts were initiated and received.

Service providers should design and implement programs which assist mentally retarded individuals respond at a rate similar to that of their nonretarded peers. The justification for such instruction lies in the obvious everyday self care and recreational tasks as well as in the area of social acceptance.

Early investigators Peak and Boring (1926) reported a high positive correlation between speed of response and intelligence for nonretarded individuals. An analogous link between response speed and intelligence was found for mentally retarded individuals by Ellis and Sloan (1957). In their study of 79 Negro and Caucasion mentally defective males and females whose average chronological age was 14.5 years and whose mental age was 6.79, a positive correlation existed between the response speed and the mental age of the subjects. Therefore, a mentally retarded individual might be expected to have a response speed similar to a nonretarded individual of the same mental age.

Jones and Benton (1969) tested normal and educable mentally retarded children on simple auditory, simple visual, choice auditory and choice visual reaction time tests. When matched for chronological age, the 40 normal children were significantly superior in all tasks to the 53 retarded children. When the children were matched for mental age, the mean differences disappeared. These researchers reported a high correlation of simple and choice reaction times to mental and chronological ages within both intelligence groups.

Mental retardation may have a genetic or organic cause. Subjects were divided by etiology in a study by Bensberg and Cantor (1957) and tested for simple reaction times and also a two-choice reaction task. The 48 subjects were matched on the basis of chronological and mental age by genetic and post-traumatic causes of retardation. The individuals with genetic classifications were significantly ($p<.05$) faster on both the simple and discrimination tasks. The post-traumatic group did not demonstrate a significant relationship between mental age and the simple or discrimination reaction tasks.

Moss (1973) used simple and complex reaction time tests to examine motor specificity in the mentally retarded. Moss reported the following:

1. For individual's who are mentally retarded, simple reaction time is not dependent upon the movement that follows, as is the case for nonretarded children.
2. The mentally retarded may need thousands of trials to reach an asymptote in the performance curve.
3. The mentally retarded person learns through similar patterns as the normal person, but at a slower and more variable rate.
4. Many mentally retarded individuals are capable of performance levels close to normal performance levels if they are given enough additional practice. The attainment rate for a given level of performance is slower for the retarded individual. Mean reacton time for the mentally retarded decreases with practice.

5. Reaction time becomes slower as task complexity increases.
6. Reaction time and movement time are not highly correlated. Correlation between reaction time and movement time decreases with practice.

Destefano and Brunt (1982) found mildly mentally retarded children were able to respond with comparable speed to their nonretarded peers in closed skills, where the action required was predictable. For open skill tasks, where the demands of the task were unpredictable, mildly mentally retarded students were not able to perform as well as their nonretarded peers. The researchers suggested that mentally retarded children had not achieved a state of response constancy and were unable to simultaneously maintain the performance level and attend to changing situational and environmental demands.

Similarities exist for the normal population and the mentally retarded population in response speed. No connection has been established between reaction time and movement time for either intelligence group. Reaction time can be correlated to intelligence. This relationship holds true for the mentally retarded when mental age is controlled. Simple response tasks produce shorter reaction times than choice or complex tasks. The sex difference for response speed for the mentally retarded is negligible or in favor of the males but never in favor of the females. Motor proficiency is important to the mentally retarded person in two aspects: the ability to move efficiently and, in the total number of social contacts initiated and received. For mentally retarded students, it is important to control regulatory (cueing, distraction free environment, type of stimuli used) stimuli when learning the most basic skills.

For the retarded individual, both between subject variability and within-subject variability have been studied. One suggestion by Berkson and Baumeister (1967) is that the mentally retarded do not perform as close to the maximal limit as do the nonretarded. Reexamining the data from an earlier experiment, the authors noted that the heterogeneity of the variance between normal and retarded subjects that was previously ignored, was important when comparing subjects of different intelligence levels. When interpreting comparison studies, both central tendency measures and variability measures should be considered to determine if both groups are working close to their respective maximum efficiencies. Berkson and Baumeister (1967) recommended a correlation of individual medians with individual variabilities as a measure of efficiency.

> it suggests again that the average reaction time is a function of both a hypothetical upper limit of speed and the intraindividual

> variability of scores in a series of trials. Moreover, if one assumes that the limit of speed varies in a nonsystematic fashion from individual to individual, then a measure of the contribution of the within-individual variability to the group averages score might be the correlation of individual medians with individual variability. In the case in which the limit is approached, this correlation would be reduced, whereas it would tend to be maximum if reaction time were largely a function of variability within subjects. (p.267)

Baumeister and Kellas (1968) described the simple reaction time curve for six mentally retarded subjects as being platykurtic and more symmetrical than the curve for six nonretarded subjects. Nine hundred reaction times were taken for each of the 12 subjects. The 600 data points from responses from the second and third day of the experiment were used to construct frequency polygons. The distribution of the mentally retarded subjects' scores marked their slower reaction times and were widely distributed about the mode. In contrast, the scores for the normal subjects' reaction times were closely bunched around the mode and were positively skewed as is typical of normal subjects. Low levels of responding and high intraindividual variability are characteristic of reaction time measures in mentally retarded persons.

A coincidence timing task, attempting to react to the point when a moving object passes under a fixed object, was measured by McGowan, Dobbins and Rarick (1973). Performance of the task and the intraindividual variability were compared for 100 normal children and 100 educable mentally retarded children. When constant error and the intraindividual variability were calculated, no differences were found for the retarded and the normal children. This suggests that the inconsistency of retarded children does not contribute to their generally low performance level.

The retarded have been found to be more variable in performance of response speed tasks. The mentally retarded individual seems less efficient in maintaining performance near the upper limit of ability. Measures of dispersion as well as measures of central tendency should be reported when comparing response speed scored for retarded and nonretarded groups. The variability of performance of mentally retarded individuals may not be a contribution to their generally low performance level.

The preceding research supports the comparison of median scores for response speed as proposed in the Bruniniks-Oseretsky Test Manual.

Knowledge of Results and Response Speed

A lever pulling task was researched by Biloudeau, Biloudeau and Schumsky (1959) to determine the effects of introducing and withdrawing knowledge of results at different times in the learning process. One hundred and sixty college males were to displace a lever 33 degrees of an arc. The subjects were naive to the task. When the experimenter provided knowledge of results, the direction and magnitude of the error were given. The subjects were divided into four groups. Knowledge of results was delivered at different times during the 24 trials for each group.

> The experiment showed (a) no improvement without knowledge of results, (b) progressive improvement with knowledge of results, (c) response deterioration after withdrawal of knowledge of results. Further, an early series of trials without knowledge of results had no latent effect on the learning shown when knowledge of results was eventually introduced.(p. 144)

Gille & Payne (1980) reported that informative feedback about response speed enhanced the performance of poor readers on word recognition tasks. Reaction time was reduced by supplying informative feedback about the subject's response speed relative to a pre-established criterion. This reinforcement was found to a be powerful reinforcement and helped to maintain motivation.

A rotary pursuit task was studied with mentally retarded and nonretarded children to learn the effect of supplementary knowledge of results. A pretest of 20 trials was given to 48 retarded and 48 nonretarded boys. Half of the subjects in each group received additional knowledge of results in the form of a buzzing sound that indicated being on target. Rest was given for 0, 2, or 30 minutes before ten additional trials were made. On the first testing the normal subjects' scores were better than the retarded subjects' scores. The supplementary knowledge of results (the buzzing sound), facilitated performance about equally for both groups. The initial disparity between the scores of the normal children and the retarded children was found to decrease with practice. Baumeister, Hawkins and Holland (1966) concluded that the buzzer may have provided the wrong kind of knowledge of results to facilitate the learning of the pursuit rotor task by the mentally retarded.

Hoover, Wade and Newell (1981) found knowledge of results was one method employed by trainers to produce faster reaction times and faster movement times in moderately and severely retarded adults. Verbal knowledge of results took the form of comments such as "you hit the target" or "that was fast" were found to be effective as part of a learning strategy that included nonverbal prompting and physical assistance.

Videotape feedback, verbal feedback, and a combination of videotape and verbal feedback were used to inform mentally retarded individuals about the performance of an envelope stuffing task. Park (1973) found that verbal feedback was more effective than either of the other two forms of feedback for the subjects performing mailing task.

Porretta (1982) used Schmidt's schema to explain response in a theoretical construct. Schmidt suggested there are generalized motor programs for a given class of movements. These prestructured programs or plans allow the individual to respond a group of movements whose specifications are similar. Mentally retarded persons have been found to construct plans for simple movements but to have difficulty programming complex movements. Two kinds of schema are developed. The recognition schema is based on response specifications, and may include such components as speed, accuracy, force and trajectory. In addition, sensory consequences of the movement help form recognition schema. Recall schema results from information feedback or knowledge of results. This is updated as the person receives and stores information from movements in a similar class. Recall schema is facilitated through both variability of practice and knowledge of results. It would seem that variable foreperiod and knowledge of results would be supported in a response speed task for an individual to develop a recall schema.

Researchers studied feedback and knowledge of results in the learning of motor tasks and found them to be powerful mediators in the learning process. Knowledge of results was found to be effective when introduced early or late in learning, while performance decreased with the withdrawal of knowledge of results. Studies with the mentally retarded have used knowledge of results with tasks other than response speed or as part of a strategy designed to produce faster reaction times and faster movement times. Videotape of the subject's own performance was not found to be as effective as verbal feedback from the instructor for performance of a mailing task. Recall schema is devised by variability of practice and knowledge of results, and supports the individuals ability to learn tasks.

Magill (1980) divides knowledge of results from other forms of feedback. He observes that

> Knowledge of results is information about a response that is obtainable only by means of an external source, such as a teacher, coach, experimenter, or a video tape system.(p.215)

Knowledge of results can function in at least three important roles for the learner; providing information, providing motivation and providing reinforcement.

Knowledge of results, because of its external source, can be more easily manipulated by the teacher or coach than other forms of feedback. Two factors that influence the effectiveness of knowledge of results are: the time during learning that knowledge of results is delivered; and the specificity of the information given as knowledge of results. Beginners, according to Magill, need immediate knowledge of results to maintain behavior. Skilled individuals can maintain a high level of proficiency without knowledge of results. The magnitude of the error and the direction of the error, are two examples of specificity of knowledge of results. Beginners need enough specificity in feedback to give them information but not an overwhelming amount that confuses them (Magill, 1980). The more skilled performer needs detailed knowledge of results. The teacher or coach who can apply these principles to the delivery of knowledge of results will most likely have successful learners.

Reinforcement Effects and Response Speed

Knowledge of results is a specific form of feedback. It is important to consider the effects of other forms of feedback on the performance of response speed tasks.

In 1951, Henry reported a electroshock motivating technique used with treadle press or ball snatch tasks.

These were measures of simple reaction time. The dial of the experimental apparatus was set on the individual subject's own previous median score. Failure to respond as fast as the previous response maintains the circuit in the closed position and delivers an electroshock to the subject. Ten male college students received the shock condition while ten additional males were in the no shock control group. Reaction time for the control group did not change during the experiment, while the experimental group became significantly faster in reaction time.

Munro (1951) also used electroshock as a motivater in reaction time tasks. Sixty college males served as subjects in the experiment. Eight control subjects received no electroshock. Experimental groups were tested on the transferability of faster (motivated) reaction time on one task to another task and for retention of the faster (motivated) reaction time. The faster reaction times were found to transfer to other simple reaction time tasks. Follow-up tests at one, three, five ,seven, nine, and eleven weeks indicated that faster reaction time was retained until the seventh week before returning to the pre-electroshock level.

Mentally retarded individuals were tested for reaction time by Wolfensberger (1960) under five reinforcement conditions:

1. Concrete reward: The subject could choose from the

table of prizes an item to be gained by fast performance on the reaction time task.

2. Symbolic reward: The subjects were given chips during the testing which could be exchanged at the end of the session for prizes on the table

3. Concrete punishment: The subject chose five prizes from the table, the experiementer would take the prizes away for poor performance

4. Symbolic punishment: The experimenter would take away chips that could be later exchanged for prizes

5. Rest: The subject received a few seconds of rest.

All reinforcers were delivered after five trials (one block) of reaction times. Twenty-five trials, or five blocks were administered to all the subjects. All groups became slower to react as the trials were made. There were no significant differences between groups. Wolfensberger rejected all hypotheses about the reinforcing conditions in this study, concluding the subjects were bored with their tasks. Baumeister and Ward (1967) also commented on Wolfensberger's method of fixed ratio reinforcement, explaining that because reinforcement was not contingent upon faster performance, there was no motivation for the subjects to improve their performances.

Rest, reprimand and reward were the variables affecting simple reaction time as studied by Holden (1966). Thirty educable mentally retarded individuals were divided into three groups:

1. Rest, subjects were told their performance was satisfactory and received a two minute rest.
2. Reprimand, subjects were told their performance was too slow, and received other reprimands for the two minute period.
3. Reward, subjects were told they were performing satisfactorily and would receive money when the task was finished if they performed even faster.

Before the initial testing the subjects were shown a variety of items that could possibly be earned for satisfactory performance of the task. The subjects were tested on 42 sequences separated by the two minute treatment. At the end of the testing, all subjects were given their choice from the items shown to them at the beginning of the experiment. In the analyses of data, Holden also included reaction times to a trimodal stimulus and a nonrest condition from a previous study but he did not indicate if the subjects were the same for both studies.

> The analysis showed that both the Reprimand and Reward Groups improved significantly more than the Nonrest Group ($p < .01$) and that the Reward Group improved more than the Rest Group. All other comparisons were non-significant.(p. 431)

None of the experimental conditions was found to improve reaction time as much as the trimodal stimulation.

Improvement due to reward was not significantly different from improvement due to reprimand.

Two experiments were performed by Baumeister and Ward (1967) to determine the effects of reinforcement on the simple reaction time of the mentally retarded. Two blocks of trials were run with a three minute break between trials. The experimental conditions were a bell, the experimenter saying "good", or a bell and two pennies for each acceptable performance. A control group received no reinforcement during their two blocks of trials. All three conditions produced significant improvements in reaction time. The money-bell condition produced significantly faster reaction times than the bell alone but was not different from verbal praise. In a second experiment, with different subjects, 20 daily trials were given for nine consecutive days. Group two was reinforced for good performance with money and a bell on day 4, day 5, and day 6. Group two received a nickel reinforcement on day 7, day 8, and day 9 for fast performances. A one month rest was given followed by four additional days of testing. During the last four days of testing, Group one was reinforced for fast responses. Group two did not receive any reinforcement. The group receiving reinforcement continued to improve, while the group not receiving reinforcement did not improve. After the month of rest, the reversal of the response contingencies caused the previously unreinforced group to produce faster reaction times, while the previously reinforced group began to have slower reaction times.

Improvement of reaction time and movement time in moderately and severely retarded adults was the focus of a study conducted by Hoover, Wade and Newell (1981). Two experiments were reported with favorable results for both reaction time and movement time. Eleven mentally retarded adults were given baseline testing (50 trials) in moving a stylus from the starting disc to a target. Dependent measures were reaction time, movement time and error rate. Next a training phase was implemented. The trainer employed such methods as physical assistance, verbal encouragement and nonverbal prompts. There were eighty trials in each daily session. Data were taken for 13 consecutive days, and again under baseline conditions five months later. No effect was found for reaction time. Movement time, however, was significantly decreased. The favorable results were maintained after the five month interruption.

The second experiment, with eight moderately to severely retarded adults, used a standard telegraph key to measure reaction time. A chip delivery mechanism was located in the testing area. On day one, the subjects were given 80 trials. Chips were delivered to the experimental group of subjects on days 2 through 10 if their performances were at least 10% faster the the previous day's median score. Control subjects were paid $.35 per session, and experimental subjects could exchange the chips they earned for one cent each chip. A significant improvement in reaction time was shown through analysis of variance. The faster reaction times were also accompanied by a significant decrease in the variability of scores ($p<.01$), and a significant decrease in errors ($p<.01$). The authors concluded that:

> both the reaction time and movement time of severely and moderately mentally retarded young adults are susceptible to improvement through the employment of specific training procedures. (p. 394)

In summation, training and motivation can influence the response speed of normal and retarded individuals. Through these techniques, the retarded individual is able to perform closer to one's own optimal level and with less variability.

Computers In Education

The world has entered a new technological revolution with the widespread use of the microcomputer or personal computer. Time magazine's machine of the year for 1982 was the microcomputer (Rosenblatt,Friedrich, Jan 1983). Personal computing has been extended to the individual, a change no less radical than the advent of personal transportation. By gaining access to and command of data, an individual is better informed to make decisions, to experiment with or model real world situations.

Computers, as instructional tools, have been present in education nearly twenty years (Hickey, 1975). Their use was restricted to those who had access to a main frame computer or who had a time-sharing arrangement.
In the past educators could spend an entire career teaching and not encounter a computer more than once or twice. The job market now demands that nearly every working person interact with a computer. Grocery store clerks, gas station attendants, secretaries who word process, managers who must count inventory, all input and receive data with a computer. Hickey (1975) states

> Educational technology is the race horse straining at the gate, waiting for its rider to dash out of the locker room and leap into the saddle. Meanwhile it would not be surprising to

> see the horse bolt out of the gate and tear riderless around the track. (pg ii)

The role of computers in education is many faceted. Several authors have expounded the advantages of educational use of computers (Gerhard, 1967; Hickey, 1975; Kepner, 1982; Taber, 1981; Thomas, 1981; Van Matre, Pennypacker, Hartmann, Ward & Brett, 1981). These advantages include:

1. Drill and practice for increased proficiency and speed.

2. Problem solving and review to engage higher order thinking processes and logic.

3. Tutorials to master rule learning and provide task analyses.

4. Simulation and gaming to present material that models or represents actual situations.

5. Assessment, evaluation, diagnosis, prescription to determine starting points for instruction, objective pretest and posttest measures, or identify areas of mastery and weakness.

6. Provide immediate and long term feedback, and knowledge of results. Storing, tracking and in some instances, graphing performances. information.

7. Material is presented for individualized learning according to the individual's cognitive needs. Branching for remedial or advanced learning is possible. The learner sets the pace.

8. Provide instructional information for teachers identifying areas where students are experiencing difficulty, thereby increasing teaching efficiency.

9. Preferred modes of presentation and reinforcement can

be selected to suit different individuals.

10. Motivation for continued instruction through maintenance of attention, and shorter times to completion of instructional objectives.

11. Retention and recall are as good as or superior to conventional methods.

12. The student is removed from social judgements of teachers and peers and put in a nonthreatening learning situation.

13. Academically able handicapped students are able to function in the regular classroom through computer assistance, allowing students to be mainstreamed.

14. Administrative assistance for scheduling, parking, athletic statistics, basic competencies records, attendance, equipment inventory, grade distributions, library records, school calendar, rank in class, permanent record, textbook sales may all be kept and accessed by computer.

Computers are educational tools that can serve a multitude of purposes. They are instrumental to instruction and management of educational data. Computers will not replace teachers (Gleason, 1981; Thomas, 1981; Stein, 1983), but will assist in the teaching process. Decisions must be made by educational professionals, and parents in order to insure appropriate educational experiences for each student.

Technology and Learning

Many teachers are computer aware or computer literate, but few are computer proficient. The advent of the relatively inexpensive microcomputer has provided access to computing either at the school or at home. Educational programs or software, have been generated at the grass roots and commercial level. Some software is programmed with clever graphics or music but is not educationally sound. While other software is good for teaching but is unnecessarily dull. Attempts are now being made to systematically review and catalog the available computer programs so that students can be exposed to the best instructional programs.

Historically computer assisted instruction (CAI), was nothing more than electronic programmed learning. The author composed instructional programs preactively, and limited the interaction between the student and the computer (Hickey, 1975). As better instructional models were employed, instructional programs improved. Siegel and DiBello (1980) devised a corrective feedback paradigm for paired association tasks. If the error was not within the list of paired associates, the proper answer was provided. If the the error was on the list, the proper response was provided and additionally the incorrect response was matched with its associate word. Review was provided intermittently because it was shown to be better than review at the end of the list only. This review did not add significantly to instructional time.

Goldstein (1976) used a coaching approach to CAI for gaming and simulation. The computer played three roles:

1. coach - provide advice on strategy, and tutored the player in particular skills

2. psychologist - examined student behavior and made hypotheses about which skills were already possessed and which tutorial modes were most effective

3. tutor - used information from the coach and psychologist to personalize instruction to the players

Players were limited only by their failure to acquire the expert skills taught by the tutor.

Atkinson (1967) foresees a time when true dialogue will be possible between computer and learner, not just prestored answers to prestored questions. Further, he states that one hour per day with a computer can provide a student with more interaction, hence, personal attention than a regular day in the classroom. In general educational research, CAI has been found:(Holmes, 1982)

1. To be at least as effective as traditional education
2. To increase student achievement
3. To improve student's rate of learning
4. To increase student motivation

Computers and Special Education

The two most frequent computer applications in special education are the use of adaptive devices and Individual Education Program management. Some of the reported adaptive devices include (Hannaford & Sloane, 1981; Taber, 1981; Thorkildsen,1981):

1. Keyboard adaptations - large buttons arranged in alphabetical order.

2. Switches - activated by touch, light pens, optical scanners, voice, breathing in and out, eyebrow wrinkle and electromyographic impulses. These switches can be used to control the computer directly or to control peripherals such as self feeding devices, wheelchairs, telephones, thermostats, television sets, and other electrical appliances.

3. Modems that link a computer at the site of a homebound or hospital bound person to a computer in the classroom with the child's teacher and student peers.

4. Speech synthesizers - for persons who cannot speak or do not read.

5. LOGO a programming language for young children, where students use the computer as an object to think with while programming graphics, animation, text and music.

6. Reinforcements - through the use of color, music, voice, graphics, animation, and flashing words.

7. Interface with a videodisc that randomly accesses visual and spoken messages, that can question, demonstrate and reinforce non readers.

These adaptive devices make possible a myriad of tasks that were previously difficult or impossible for the handicapped individual to perform.

Brudner (1982) discusses computer managed instruction (CMI) with respect to the Individual Education Plan. The IEP which must be individually tailored for each special student includes the child's present level of educational performance, goals for the future, and from two to 25 short term objectives. For a teacher with even a small class, the paper work can be overwhelming. With computer assistance an IEP that may have taken one full day to write, may now be written in a little more than an hour. The advantage, Brudner highlights, is the potential to include more parental input which allows the IEP to become a daily exercise in joint decision making. The Allegheny Intermediate Unit Exceptional Children's Program (1980) found for reading and math skills, that the following major benefits were achieved through CAI:

1. Increased number of objectives developed per child
2. Increased number of objectives achieved per child
3. Teachers used the resource component to find additional instructional materials
4. Decreased teacher time to write and update IEP's
5. Skill mastery tests yielded formal documentation to support educational decisions
6. IEP's updated more frequently

Two similar programs, Project COMP, (Rosenkranz, 1974) Computerized Operational Material Prescription, and Project MASS (Mason, Smith, & Traub in Barrette, 1982) Microcomputer Assistance for Special Students found the systems to be beneficial to students and cost effective as well.

Individuals with handicapping conditions do not always use the same sensory or motor channels as do nonhandicapped persons. Handicaps result in deficits in input for the deaf child, output for the neurologically or motorically impaired child, and deficit in central processing for the mentally retarded child. Goldenberg (1979) states that if we are to understand how computers can help handicapped persons, we must understand the handicaps as well. Goldenberg also laments that existing technology is little used, and is not well reported in texts, professional conferences, or in educational literature such as ERIC and Exceptional Child databases. Few studies can be found in computer assisted instruction for special education and virtually none are available in special physical education.

Grimes (1981) mentions that handicapped student need formal, structured, teaching methods to ensure retention of academic skills. The model for the individualized education program (IEP) as mandated by Public Law 94-142 reinforces the idea of structure by assessment, and diagnosis. Each student has an educational program with specific goals and objectives. Goldenberg calls this model the hospital model and stresses its practicality for certain academic skill goals and for streamlining programmed learning. In this instance the child is not the agent. Goldenberg furthers four additional models for computer use with handicapped individuals:

1. Computer as entertainer - even programmers who work

all day play with computers during their leisure time. The computer provides stimulation and access to artistic creativity.

2. Computer as assistant - the computer allows one to do things in which competence has not been developed. An individual who does not perform on an instrument can compose music with the assistance of a computer. Likewise a person who is disabled to the point where it is impossible to hold a pen, may draw animated pictures with computer assistance.

3. Computer as eyeglasses - eyeglasses have no agenda for the wearer, but allow the wearer to do things that might otherwise be difficult or impossible. The computer allows one to manipulate the environment.

4. Computer as mirror - the computer reflects the inner self, and can provide a degree of autonomy never before experienced

Goldenberg's models, with availability of technological support, will be welcomed by most handicapped individuals. Project SEARCH conducted in Connecticut by Alan White, (Goldenberg, 1979) found through innovative testing that 12 per cent of the handicapped children studied were gifted. This is roughly three times the number of gifted children found in the general school population. The importance therefore, of providing handicapped individuals with appropriate technology cannot be overlooked.

Ball (1978) reported that computer games are valuable tools in decision making, following directions, number and word recognition, visual discrimination, spatial concepts and cooperation. All of these parameters would be helpful in learning physical education skills. Knirk (1983) supported the use of videogames in learning to visualize and mentally rotate objects, a skill found to be highly correlated with mathematical ability. He further reports:

> The Navy evaluated five computerized video games and found they are very effective as performance tests. It is possible to increase an individual's ability to shoot from a moving vehicle by having them practice on computer games. Further research dealing with video games in classroom settings is urgently required. (p.236 italics added)

With this preliminary report and encouragement, computer assisted instruction, including games, should be researched as a method to assist handicapped individuals learn or improve physical skills. Individuals with many different types of disabilities may benefit from computer assisted instruction of physical skills.

At present little documentation is available to support computer assisted instruction or computer managed instruction for special education or special physical education. Computer assisted instruction may be provided through traditional methods such as drill and practice or more student centered methods such as programming with LOGO. The advantages to computer assisted instruction are student interaction, immediate feedback, and the nonthreatening mode of presentation. Computer managed instruction has been shown to be beneficial in individual education program writing, increasing the number of objectives per student, increasing the number of objectives attained per student, and providing documentation. Games have been demonstrated as performance tests and have increased the gunnery skills of Navy personnel. Programs are needed to assist children in skill development, and to assist individuals in recovery from traumatic accidents or strokes. This study was intended to assist students to respond more quickly, and to serve as a basis for future projects to enhance motor skills with the aid of microcomputers.

CHAPTER III

METHODS AND PROCEDURES

The hypotheses tested in this study concern the effect of human delivered knowledge of results and microcomputer delivered knowledge of results or the witholding thereof, on the response speed of nonretarded and mentally retarded individuals. The study was conducted with students in public school in Arizona and Oregon.

In this chapter the methods and procedures used in this study are discussed in the following sections: (1) preliminary procedures; (2) selection of subjects; (3) selection of the instrument; (4) description of the apparatus and testing procedure; (5) collection and analysis of the data, sampling matrix, ancova table, and mathematical model. The data were summarized and a final report submitted to the thesis committee in partial fulfillment of the the requirements for the Doctor of Philosophy degree at Oregon State University.

Preliminary Procedures

The investigator reviewed the literature pertaining to response speed in retarded and nonretarded children, knowledge of results, and computer assisted instruction

(CAI). Permission was obtained from the thesis committee to conduct the research. Proper forms were filed with the Oregon State University Human Subjects Committee. The research committees of various public school districts were approached with the intent of engaging their students as subjects for research. Appropriate personnel at each school building were consulted concerning testing procedures and test scheduling. An informed consent form was furnished for the potential subjects in accordance with the Oregon State University's Human Subjects Committee's guidelines.

The subjects were randomly assigned to appropriate groups according to the research design. Data were entered into a computer file including the subject's identification code, date of birth, preferred hand and familiarity with video or computer games. Hand preference was determined by the Bruininks-Oseretsky preference test (Bruininks, 1978).

Selection of Subjects

The subjects for the study were 126 nonretarded and mentally retarded public school students from school districts in Arizona and Oregon. Chronological ages for the nonretarded subjects ranged from 85 months to 163 months with mean age 124 months. The range of ages for the mentally retarded subjects was 65 months to 182 months with the mean age 125 months. There were 34 nonretarded female and 29 nonretarded male subjects. The mentally retarded subjects consisted of 31 males and 32 females. Subjects were randomly assigned to each of the three experimental conditions using a table of random numbers. Subjects with identifiable physical handicaps that would impede the response speed task were not used. Mental retardation was determined by standardized tests given by qualified public school personnel. Participation in the study was voluntary, and depended upon obtaining permission from the subject's legal guardian. Testing sites were selected by the individual school districts.

Selection of the Instrument

The instrument was a modified response speed test from the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978). This test is mentioned in several special physical education texts as a possible screening device for motor ability (Fait and Dunn, 1984; Kalakian and Eichstaedt, 1982; Seaman and De Pauw, 1982). The norming population was 765 children in the United States and Canada. The test of response speed appears in both the long form and the short form of the test. The specific task requires the experimenter to drop a stick which the subject must stop with the thumb. Two practice trials and seven test attempts are administered. According to the test protocol, the experimenter provides the following directions to the subject:

> Watch the red line on the stick (point to red line). When the red line moves, stop the stick as fast as you can with your thumb (demonstrate by placing the subject's thumb against the stick). Just before I let the stick fall, I will say 'get set!'. Then, when you see the red line move, stop the stick with your thumb as fast as you can.

For each trial, the experimenter must wait a designated amount of time between the warning signal "get set!" and dropping the stick. The Bruininks-Oseretsky protocol is:

	Trial	Seconds
practice	1	1
practice	2	3
	1	2
	2	3
	3	1
	4	3
	5	2
	6	1
	7	1

This time interval is judged by the experimenter counting silently, "one thousand one, one thousand two, etc." for the appropriate foreperiod. Any subject judged to touch the stick before it is dropped or who failed to look at the stick when it was dropped will be administered another trial. The score for the subject is determined by reading the number (point score) from the spot that is at or just above the tape when the subject stops the stick.

For this experiment, the response speed test was modified in the following ways:

1. The test was simulated using a representation of a stick on the monitor of an Apple II Plus, micro-computer.

2. The subjects were given the following directions:

> "Watch the line on the stick, (point to the line on the monitor),when the line moves, stop the stick as fast as you can with your thumb (demonstrate by placing the subject's thumb against the button of the game controller device for the microcomputer). Just before the stick falls the words 'get set' will appear on the monitor, (point to the words on the monitor). Then, when you see the stick move, push the button, and stop the stick with your thumb as fast as you can.

3. The foreperiod and the response speed were timed by a Mountain Hardware Clock. The drop of the stick follows the Bruininks-Oseretsky test protocol for the Response Speed Subtest. This timing device rendered consistent foreperiods for each individual subject, and eliminated the need for nonverbal cues from the test administrator.

4. The scores for the student were actual time, and point scores. A matrix of point scores from the Bruininks-Oseretsky test was stored in the computer. The computer selected the point score according to the age and sex of the subject as suggested in the

test manual. The timing was done by a Mountain Hardware Clock, accurate to .001 seconds and calibrated according to the manufacturers directions.

5. Simultaneous with the drop of the stick, a tone sounded.

6. A subject who touched the response button before the stick began to move did not register a score. Instead the words "false press" appeared on the monitor to alert the experimenter. Trials with a false press or trials in which the subject failed to look at the monitor when the stick moved were not counted. An additional trial was administered.

Description of the Apparatus and Testing Procedure

Subjects were tested individually by the experimenter in a room separate from the regular classroom. The test apparatus consisted of an Apple II Plus microcomputer with a 64K memory. Additional hardware included a monitor (television set), an Epson MX-80 printer (with paper), a John Bell voice synthesizer, a Mountain Hardware clock, a TG Products game controller device, and two disc drives (Figure 2.). All of the peripherals were controlled by the microcomputer. The visible parts of the apparatus were the computer, the monitor, the two disc drives, the printer and the game controller device. The clock and voice synthesizer are contained in the body of the microcomputer. When the student participated in the study the individual looked at the monitor and pushed the button on the game controller. The microcomputer, disc drives, printer and paper were positioned in front of the test administrator, The student and the experimenter were seated side by side, with the student slightly closer to the table, so that the experimenter could look at the monitor as well. Subjects were approximately 30 centimeters from the monitor.

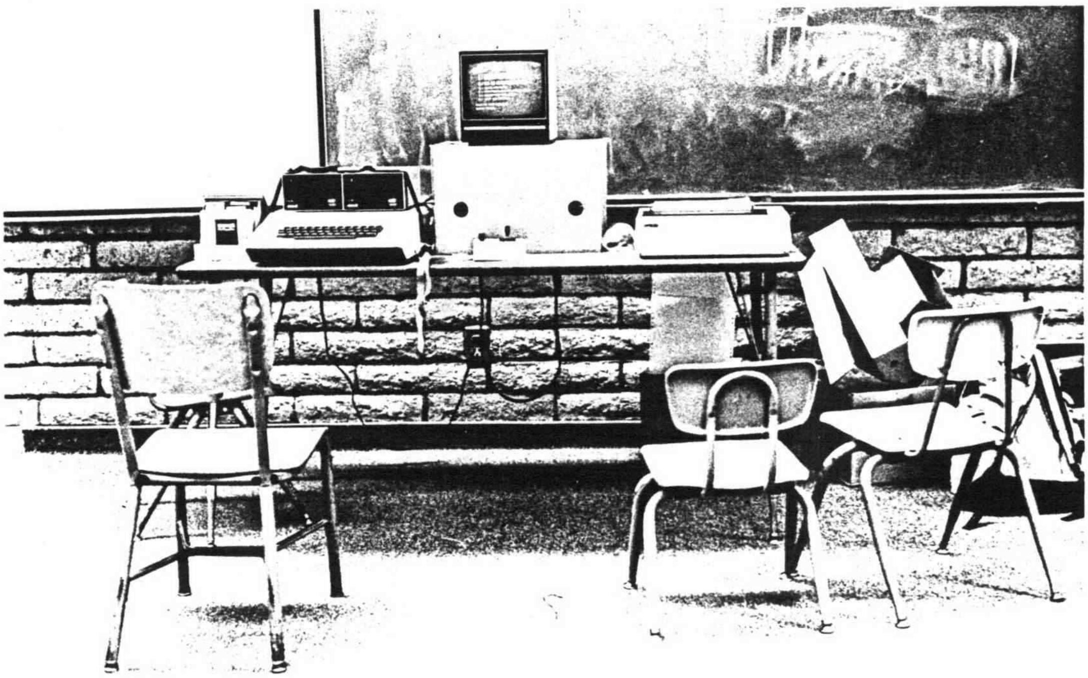

Figure 2. On site experimental equipment. Testing apparatus was a microcomputer with disc drives, monitor, printer, game controller, response software, and an assortment of boxes and chairs to adjust the monitor to the student's eye level.

The software was written in Pascal language. From the menu, the operator may decide to:

1. enter a subject
2. delete a subject
3. run the test
4. preprocess the pretest and posttest scores
5. graph the results
6. initialize a file disc

The entire response speed matrix for each age and sex was stored on file. Each time the student pressed the button, the actual time was recorded. The computer then searched the file according to the subject's age and sex and found the point score and norm score for each trial. The printer also made a hardcopy of each trial.

The game controller was fixed to the table top so it would not move away from the subject as the attempt was made to push the button. The experimenter controlled the computer from the keyboard.

The subject completed the pretest, series of practice trials and posttest within a two week period. Typically each subject completed the pretest and two practice sets in the first session, practice sets 3, 4, and 5 in the second session and in the final session practice sets 7, 8 and the posttest. Each set consisted of seven trials.

In this study, two treatment groups and a control group were studied. Mentally retarded and non-retarded subjects were included in the treatment and the control groups. The control groups for the nonretarded subjects and the mentally retarded subjects did not receive any feedback concerning their performance on the response speed task. For the subjects in the two levels of experimental treatment, auditory feedback was given. For one treatment group, the experimenter provided the feedback. For the second group, a voice synthesizer provided the feedback. The subject was informed whether the particular trial was faster than, slower than, or the same as the criterion measure. The criterion measure was the time of the median trial from the previous seven test trials. A total of 63 trials were given to the experimental and control group subjects. The first seven trials were the pretest and last seven trials constituted the posttest.

Collection and Analysis of Data

Data were collected at such times and locations that could be mutually arranged between the cooperating school districts and the investigator. All information was held in confidence. Files were kept for each student on a microcomputer floppy disc.

The design of the project was a Pretest-Posttest Control Group Design (Campbell and Stanley, 1963). The strength of this design is in its internal validity. Careful consideration was given to factors influencing external validity, such as, the interaction of testing and the experimental treatment. Other factors deserving note were the interaction of subject selection and the experimental treatment; and reactive arrangements. The data collected in this investigation were treated with Analysis of Covariance (ANCOVA). The covariate was the subject's pretest score. The dependent variable was the subject's posttest score. Data were processed by the Statistical Package for the Social Sciences (McGraw Hill, 1982) and Statistical Analysis System (SAS Institute, 1979) Figure 3 is a diagram of the experimental design.

Rn	0		0
Rmr	0		0
Rn	0	x1	0
Rmr	0	x1	0
Rn	0	x2	0
Rmr	0	x2	0

where R = random assignment

n = nonretarded students
mr = retarded students
o = pretest and posttest
x1 = experimenter feedback
x2 = microcomputer feedback

Figure 3. Experimental Design
Campbell and Stanley's Pretest-Posttest Control Group Design.

Figure 4. diagrams the distribution of the subjects. The sample size for each cell was determined by consulting Sample Size Tables developed by Cohen (Courtney, 1982). Twenty one subjects per cell was determined to be the minimum sample size. The effect size of .40 was chosen to accommodate the range of actual time scores. Convention was followed in using .80 as providing 80% probability that a false null hypothesis would be rejected. The .05 alpha level was chosen by convention as well (Courtney, 1982).

Treatment---Knowledge of results

	none	investigator	microcomputer
Subjects			
Nonretarded	n=21	n=21	n=21
Mentally Retarded	n=21	n=21	n=21

Figure 4. Sampling Matrix. The following parameters were established for the study:

effect size...... =.40
power............ =.80
confidence level. =.05
minimum cell size = 21 subjects

Table I is the Analysis of Covariance decision table.

Table I

Proposed Ancova Table
(Fixed Two-Way Design)

Source of Variation	---adjusted--- df	SS	MS	F-calc	F-tab	Decision
Treatment Knowledge	2	A	A/2	MSA/MSE	3.07	
Groups Ret/Nonret	1	B	B/1	MSB/MSE	3.94	
Interaction	2	AB	AB/2	MSC/MSE	3.07	
Error	119	E	E/119			
Total	124					

The mathematical model for ANCOVA is:

$$Yijk = M + Ai + Bj + ABij + B(xcij - \bar{x}c) + Eijk$$

where:

m is an unknown constant

Ai is a differential effect associated with treatment

Bj is a differential effect associated with retardation

ABij is a differential effect associated with interaction

$B(xcij-\bar{x}c)$ is the adjustment of the posttest

Eijk is the residual variable, that is independent and normally distributed. Where the mean = 0 and the variance = s2 (Courtney, 1983)

The following hypotheses were tested:

H1: There is no treatment effect for knowledge of results

H2: There is no effect for retardation

H3: There is no interaction effect between treatment and retardation

The hypotheses were tested and conclusions drawn in accordance with the above statistical procedure.

CHAPTER IV

PRESENTATION AND DISCUSSION OF THE FINDINGS

The purpose of the study was to analyze the effect of experimenter delivered and microcomputer delivered knowledge of results on the response speed of nonretarded and mentally retarded public school students. Response speed was measured for 63 nonretarded students and 63 mentally retarded students. Subjects were randomly assigned to one of three treatment groups: no feedback (control); instructor feedback; or computer feedback. Presented in this chapter is a description of the subjects, an analysis of the data, and a summary and discussion of the findings.

Description of Subjects

The subjects for the study were 63 nonretarded and 63 mentally retarded public school students in Arizona and Oregon. Chronological ages for the nonretarded subjects ranged from 85 months to 163 months with a mean age of 124 months. The range of ages for the mentally retarded subjects was 65 months to 182 months with a mean age of 125 months. There were 34 nonretarded female and 29 nonretarded male subjects. There were 31 males and 32 females in the mentally retarded group. Using a table of random numbers, subjects were randomly assigned to the control group or to either of the experimental conditions. Subjects with identifiable physical handicaps that would impede the response speed task were not used. Eleven subjects were tested in addition to the 126 that were reported in this study. Eight subject's scores were discarded because the children moved to a different school or their attendance was insufficient to complete the data gathering. The scores for three additional subjects were discarded because the student's possessed inadequate thumb strength to depress the game controller buttons.

Mental retardation was determined by standardized tests given by qualified public school personnel. Instruments used to determine mental retardation included but were not limited to: the Stanford-Binet; the Weschler Intelligence Scale for Children-Revised; the Vineland Social Maturity Scale; and the American Association for Mental Deficiency's Adaptive Behavior Scale. Participation in the study was voluntary, and was dependent upon obtaining permission from the subject's legal guardian. In Table II, descriptive data concerning the subjects' age and sex are presented.

Table II

Age and Sex of the Subjects

		Age in Months		
Group	N	range	mean	sex
Nonretarded	63	85-163	124	m=29 f=34
Mentally Retarded	63	65-182	125	m=31 f=32

Analysis of Data

Data were collected for each subject on the pretest, practice trials and the posttest scores. Scores for the pretest and posttest were treated with Analysis of Covariance to adjust for differences in the pretest scores. In the analysis of the raw data, the variance proved too great to meet the necessary assumption of homogeneity of variance. The F value $(.80814)^2/(.26868)^2$ equaled 9.05 which was significant at $p<.05$ for degrees of freedom 20 and 20. It was necessary, therefore, to transform the raw data using a natural logarithm in order to equalize the variance. After transforming the scores with the natural logarithm, the F value $(.19906)^2$ / $(.138575)^2$ equaled 2.06 which was less than the table value 2.12 for $p<.05$ for degrees of freedom 20 and 20. Therefore the assumption of homogeneity of variance was met.

The natural logarithmic transformation is useful when the dependent variable represents skewed data. This transformation reduces the importance of high values and increases the the importance of low values. The assumptions for analysis of variance and regression are met with the natural logarithmic transformation (Courtney, 1982). Analysis of covariance combines the techniques of analysis of variance and regression. In Table III, the adjusted cell means for the posttest response speed are reported.

Table III

Adjusted Cell Means for Posttest Response Speed

Group	Treatment	N	Mean
Retarded	Control no feedback	21	5.58080
	Instructor feedback	21	5.54612
	Computer feedback	21	5.54851
Non-retarded	Control no feedback	21	5.50480
	Instructor feedback	21	5.48769
	Computer feedback	21	5.49267

As reported in Table IV, results for treatment and groups were nonsignificant, as was the result for interaction. The first hypothesis, there is no treatment effect for knowledge of results, was not rejected. The calculated F value for treatment was .56 which was not equal to or greater than the table F value of 3.07 for degrees of freedom 2 and 125. For the second main effect, retardation, the calculated F value was 3.55, which was not equal to or greater than the table F value of 3.92 for degrees of freedom 1 and 125. Therefore, the second hypothesis, there is no effect for retardation, was not rejected. This measure approached significance, $p<.061$ and indicated a trend toward a difference in performance of the retarded and nonretarded subjects. In order for interaction to be present the table F value of 3.07 for degrees of freedom 2 and 125 had to be equaled or exceeded. The computed F value for interaction was .09. The third hypothesis, there is no interaction effect, was not rejected. (Table IV)

In summary, when these data were treated with analysis of covariance, allowing for initial differences in the pretest, no difference in performance of the response speed task was found as a result of no feedback, instructor feedback, or computer feedback. The nonretarded subjects and the mentally retarded subjects were not significantly different from each other in performance change. There was no interaction between the treatment and the groups for the response speed task.

Table IV

Ancova Results Table
(Fixed Two Way Design)

Source of Variation	---Adjusted--- df	SS	MS	F-calc	F-tab	Ho Decision
Treatment Knowledge	2	.01627	.00814	.56	3.07	not rejected
Groups Ret/Nonret	1	.05131	.05131	3.55	3.92	not rejected
Interaction	2	.00250	.00125	.09	3.07	not rejected
Error	119	1.70326	.01443			
Total	124					

To determine if there was a difference in the performance of the response speed task between the male and female subjects, an analysis of variance was made. In previous studies, (Goodenough,1933; Teichner,1954) the difference was reported in favor of the males or was not significant. One of the underlying assumptions of analysis of variance is that the variance between the two groups is equal or similar. In this study the initial variance for posttest scores between the nonretarded males and the retarded males was too great to meet the underlying assumption of equality of variance. This was also true of the nonretarded and retarded females. Several transformations were attempted to equalized the initial variance, but none were successful. It was therefore necessary to divide the subjects by groups to meet the assumption of equality of variance. Analysis of variance was conducted for the males and females in the nonretarded group and a second analysis of variance was conducted for the males and females in the mentally retarded group. Descriptive data, means and standard deviations for the males and females in the retarded group are presented in Table V. In Table VI the analysis of variance is reported.

Table V

Mean Posttest Scores and Standard Deviations for Retarded Males and Females

Sex	N	Mean in Milliseconds	Standard Deviation
Female	31	314.9677	44.0723
Male	32	290.6250	57.9654

Table VI

Analysis of Variance for Posttest Scores for Retarded Males and Females

Source of Variation	DF	SS	MS	F-calc	F-prob
Between groups	1	9330.6	9330.6	3.504	.0660
Within groups	61	162430.5	2662.8		
Total	62	171761.0			

To find a significant difference between the males and females in the mentally retarded group at the .05 level, the calculated F value must equal or exceed the table F value of 4.00 for degrees of freedom 1 and 60. The calculated F value was 3.504. The difference between the performances of the males and females of the mentally retarded group was nonsignificant.

Results were similar for the performances of the nonretarded males and females. The calculated F value of .541 did not equal or exceed the table F value of 4.00 for degrees of freedom 1 and 60. Therefore no significant differences between the performances of the nonretarded males and females was found. Tables VII and VIII report the descriptive data for the nonretarded males and females and the analysis of variance for the nonretarded males and females.

Table VII

Mean Posttest Scores and Standard Deviations for Nonretarded Males and Females

Sex	N	Means in Milliseconds	Standard Deviation
Female	34	216.7273	31.6260
Male	29	210.8621	30.9651

Table VIII

Analysis of Variance for Nonretarded Males and Females Posttest Score

Source of Variation	DF	SS	MS	F-calc	F-prob
Between Groups	1	530.99	530.99	.541	.4647
Within Groups	61	58853.99	980.89		
Total	62	59384.98			

Summary of Findings

The first null hypothesis, there is no treatment effect for knowledge of results, was not rejected on the basis of an obtained F value of .56. No difference was found in response speed under conditions of no feedback, instructor feedback, or computer feedback.

The second null hypothesis, there is no effect for retardation on response speed measures, was not rejected on the basis of an obtained F value of 3.55. No difference in response speed was found for posttest scores with retarded and nonretarded students when the pretest score was adjusted to remove the initial differences.

The third null hypothesis, there is no interaction effect between levels of treatment and nonretarded and mentally retarded students was not rejected on the basis of an obtained F value of .09.

No differences were found in the performances of the response speed task between the nonretarded males and females. Differences between the males and females of the mentally retarded group were likewise not found.

Discussion

The results of the ANCOVA test indicate that the null hypotheses were not rejected, as there were no significant F scores for any of the three hypotheses. Within the limitations of this study, no difference in performance of the response speed task can be attributable to the conditions of feedback.

Zsohar (1982) in a study of error correction in learning from written material found that feedback forms: rereading the text; the teacher stating the correct response; or other students stating the correct response; were equally appropriate types of feedback. No difference was found in the student's ability to master the material as a result of the different types of feedback. Zsohar reports that her findings are consistent with Goodson & Okey, (1978) and Sassenrath and Garverick, (1965) who found no difference attributable to types of feedback for instructional tasks that require students to produce written responses.

Holden (1966) used rest, reprimand, and reward as variables for a simple reaction time study with educable mentally retarded individuals. Holden found that reward and reprimand were superior to rest in improving the subjects performance on the reaction time task, but that the reprimand and reward conditions were not significantly different from each other. Holden's study suggests that the type of feedback may not be important in changing performance.

In contrast, the results of following studies are inconsistent with the findings of this investigation and the studies of Zsohar (1982) and Holden (1966).

Gille and Payne (1980) found that informative feedback about response speed enhanced the performance of poor readers on a word recognition task. The amount of practice time needed to bring the subject to a pre-established criterion response time was reduced by 35% when informative feedback about the subject's response time was provided. This was found to be a powerful reinforcement and helped to maintain motivation.

Bilodeau, Bilodeau, and Schumsky (1959) found knowledge of results to be essential for improvement of performance in a lever pulling task. None of the subjects improved in performance without knowledge of results. Withdrawal of knowledge of results caused the performance to decay. Progressive improvement was recorded when knowledge of results was supplied to the subject.

In the studies of Gille and Payne (1980) and Bilodeau, Bilodeau, and Schumsky, (1959) the tasks were not response speed tasks. Therefore the higher levels of performance attained with feedback may be attributed to the nature of the tasks and their inherent meaningfulness in contrast to the response speed task.

Baumeister and Ward (1967) using the conditions of a bell (sound), saying "good", or delivering 2 cents with the bell produced significantly faster reaction times in mentally retarded subjects than did the control condition of no reinforcement. Mentally retarded subjects showed a steady and substantial improvement in reaction time under conditions of reinforcement and a decay in performance when reinforcement was absent or withdrawn. Baumeister and Ward indicate that when reinforcement is available and contingent upon behavior, that rapid and substantial improvements in reaction time occur. In a 1968 study, Baumeister, Hawkins and Kellas state that reaction time performance can be influenced over a substantial period of time by rewards. Since reaction time improves with reinforcement, does not improve without reinforcement and decays when reinforcement is withdrawn, the authors suggest reaction time is governed by the same principles as other forms of instrumental behavior.

Baumeister, Hawkins and Kellas (1966) studied a rotary pursuit task with retarded and nonretarded boys. The researchers failed to find an interaction between knowledge of results supplied by the buzzer and intelligence group. They suggested that this result did not necessarily invalidate the hypothesis that supplementary knowledge of results would differentially benefit the performance of nonretarded and retarded subjects. Instead they offered the explanation that the supplemental knowledge of results supplied by the buzzer in the context of this particular task may have provided the wrong kind of knowledge of results.

Hoover, Wade and Newell (1981), found both reaction time and movement time susceptible to training using techniques including feedback, physical assistance, verbal encouragement and nonverbal prompts. After a five month rest from training, the researchers found the effects for reduced movement time remained in place. Hoover, Wade and Newell did not indicate what part of the improved performance could be attributed to feedback, physical assistance, or the verbal and nonverbal prompts.

Dunn et.al. (1980), recommend when a program for changing student behavior is not successful, the general rule is to increase the strength of the reinforcer. Individuals have unique reinforcement likes and needs. A reinforcer that is pleasant for one person may not interest another person, or may be aversive to a third individual. In this study, informational feedback whether delivered by the investigator or the voice synthesizer of a microcomputer was not a powerful enough reinforcer to produce performance changes in response speed that were different from the performance changes of the control group.

Further analysis of the data were conducted to determine if the subjects in the three groups did improve in performance. A post-hoc, paired t-test was conducted. For both the retarded and nonretarded students, the t-test showed significant (p< .001) improvement in the response speed task. (Table IX) One may conclude that some factor, such as practice, contributed to the subjects' change in performance of the response speed task.

Table IX

Paired t-tests for Pretest and Posttest Scores in Milliseconds

Group	Pretest Mean	SD	Posttest Mean	SD	Mean Diff	SD	t-Value	Prob
Ret	322.71	41.6	302.60	52.6	20.11	34.1	4.69*	.000
Non Ret	235.76	32.2	213.98	31.2	21.77	27.8	6.18*	.000

*table value for t at 60 degrees of freedom = 3.460 p<.001

The explanation for the difference found in this study and other studies examining response speed for mentally retarded and nonretarded individuals may be due to additional feedback gained by the subjects. The type of feedback examined in the study, the verbal feedback from the instructor and the voice synthesizer was intended to be the only source of information for the subjects. It must be taken into consideration however, that the image of the stick remained on the screen after the subject pressed the game controller button. The relative length of the stick remaining above the line could be compared to the initial position of the stick. Therefore all subjects, including control group subjects, could gain information about response task performance after each trial. It appears that the information from the stick position may have provided sufficient feedback for all subjects, including control group subjects, to improve their performance, thus neutralizing the effect of the experimental treatment.

This study pioneered the utilization of microcomputers as teaching tools in special physical education. The microcomputer, monitor, printer and peripherals proved to be highly reliable devices. These items were regularly transported from school to school, assembled and dissassembled, with no breakdown of hardware or software. The intrinsic filing system saved the researcher significant time finding norms for each individual's age and sex category, ranking and selecting median scores and preprocessing the data for entry into the mainframe statistical packages. If desired, each set of seven trials could be represented in a bar graph, or a histogram. The data could be descriptively presented with the median score for each trial set and the high and low range markers presented on a graph. This performance data could provide information that would allow parents and teachers to make informed decisions about a student's individual educational needs.

In summary, feedback, whether investigator or computer delivered, failed to produce changes in the subjects' response speed performances that were different from the performances of the control group. These results are consistent with the findings of Zsohar (1982), Goodson and Okey (1978), and Holden (1966) but are inconsistent with the findings of Gille and Payne (1980), Biloudeau, Biloudeau and Schumsky (1959), and Baumeister and Ward (1967). A post-hoc t-test revealed that all subjects' performances significantly improved. An explanation for this result is that all subjects, including control group subjects received visual feedback from the position of the stick after each trial was made. The verbal feedback received from the instructor and the voice synthesizer may not have been a factor in improving the subjects' performance. The change in performance was due to some other factor, probably practice or the incidental feedback from the position of the stick on the screen at the end of each trial.

CHAPTER V

SUMMARY, IMPLICATIONS, RECOMMENDATIONS

Summary

The purpose of the study was to analyze the effect of experimenter delivered and microcomputer delivered knowledge of results on the response speed of nonretarded and mentally retarded public school students. Response speed was measured for 63 nonretarded students and 63 mentally retarded students. Subjects were randomly assigned to conditions of no feedback, instructor feedback and computer feedback. The design of the project was a Pretest-Posttest Control Group Design (Campbell & Stanley, 1963). The data colleted in this study were treated with Analysis of Covariance. The covariate was the pretest score and the dependent variable was the posttest score.

Within the limitations of this study, no significant results were obtained and the null hypotheses were not rejected. Baumeister and Ward (1967) and Hoover, Wade and Newell (1981) found that for retarded populations response speed (reaction time and movement time) were susceptible to training. A post hoc, paired t-test indicated both retarded and nonretarded subjects significantly improved ($p<.001$) on their performances of the response speed task.

This change in performance may possibly be be explained through the effects of practice and the incidental feedback that all subjects received by noting the position of the stick after each test trial.

Implications

This investigation was not able to establish feedback as a factor improving the performance of students in a response speed task. However, apparently, there is some reason for the change in the subject's performance. Knirk (1983) found practice with computer games could increase the gunnery skills of military personnel. It is speculated that practice, in conjunction with the visual feedback, (the stick remaining on the screen), was sufficient to produce the change in response speed performance. Verbal feedback did not appear to be a factor in improving response speed.

The post-hoc results indicate an improvement in performance for the subjects participating in this study. Since no difference was found for the three feedback conditions, one might concur with Holmes (1982) that within the limitations of this study, computer assisted instruction was at least as effective as traditional instructor feedback.

From the point of view of the student and the teacher, computer assisted instruction may not produce any more dramatic changes in performance than traditional forms of instruction. However, certain indirect benefits may be realized. The numbers of attempts at certain tasks may be increased, and there may be additional instructional time for each student. Students may be assessed continuously and performances charted or tracked. Individual prescriptive lessons may be designed to meet the unique needs of the student based on the student's past performances. Students needing additional assistance may be quickly identified. Records and documents of student performance could be provided for teachers and parents.

Recommendations

As a result of this study, it is recommended that:

1. Research of this nature be demonstrated in a classroom setting, over extended periods of time to determine if the changes in performance are relatively permanent and if the performance changes are maintained over time.

2. A variety of motor skills and motor fitness tasks be examined with respect to traditional and computer assisted instruction. For example, a computer controlled mechanical device that drops the Response Speed Stick

from the Bruininks-Oseretsky Test of Motor Proficiency test kit could be used. The clock on the computer would precisely time the foreperiods and drop the stick according to the test protocol. The subject's point score and actual time could be read directly with an optical scanner, and the scores classified according to the subject's age and sex. These results could be compared with the results of the computer simulation of the same task.

3. A study be conducted to determine if the type of feedback offered by the teacher or chosen by the the student is a factor in improving performance of the response speed task. Feedback might include; voice synthesizer messages randomly chosen from a list of reinforcers, token delivery mechanisms, visual displays, perhaps a favorite cartoon character, or a graph of the student's progress, music, or combinations of reinforcement options. Students could indicate a preference for type of feedback. The teacher could develop a feedback file appropriate to the individual's needs.

4. A replication of this study be done in which the image of the stick disappears from the screen when the subject pushes the button to respond. This would effectively remove the visual feedback the student receives from the position of the stick upon completion of the task. The student would then be dependent upon the

feedback from the instructor or the voice synthesizer.

5. Future studies include asking the student's preference for traditional or computer assisted instruction. The researcher could examine the the results to determine whether one form of instruction was more effective with males or females, or if certain age groups of student's benefited differentially from computer assisted or traditional forms of instruction.

6. Individual differences be examined with respect to the response speed task. In a locus of control study, individuals who are externally motivated might benefit from a "pay value" for performing faster on the response speed task, e.g., being able to increase one's score on popular video games. Individual learners' states of being field dependent or field independent could be examined with respect to the response speed task.

7. Research be conducted to determine if time of day made a difference in an individual's ability to perform response speed tasks. Subjects could be tested during different time periods of the day. These data could be analyzed to determine if there is a pattern for persons in different circadian rhythms, i.e. nocturnal or diurnal patterns of best performance.

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APPENDICES

APPENDIX A

Human Subjects Form

OREGON STATE UNIVERSITY

Committee for Protection of Human Subjects

Chairman's Summary of Review

Title: A comparison of the effect of experimenter and microcomputer delivered knowledge of results on the response speed of non-retarded and mentally-retarded students

Program Director: John M. Dunn (grad. student Virginia Atkins), Physical Education

Recommendation:

X Approval*

____Provisional Approval

____Disapproval

____No Action

*The informed consent forms obtained from each subject need to be retained for the long term. Archives Division of the OSU Department of Budgets and Personnel Service is willing to receive and archive these on microfilm. At present at least, this can be done without charge to the research project. Please have the forms retained in Archives as well as in your files.

Remarks: ____________________

Date: August 10, 1983 Signature Redacted for Privacy

If the recommendation of the committee is for provisional approval or disapproval, the program director should resubmit the application with the necessary corrections within one month.

AUG 11 1983

APPENDIX B

Parental Permission Forms

GINNIE ATKINS
840 SW. GROVE ST. #4
CORVALLIS, OR.97333
753-0858

DEPARTMENT OF PHYSICAL EDUCATION
OREGON STATE UNIVERSITY
LANGTON HALL 132
754-3718 754-2644

Dear Parents,

Your son/daughter is invited to take part in an experiment that will help determine the usefulness of the microcomputer as as a teaching tool in physical education. I am currently a graduate student at Oregon State University and formerly an Adapted Physical Education Teacher at Arizona State University. I have eight year's teaching experience in elementary physical education and two year's experience in physical education for severely handicapped students. My interest is improving performance in physical education skills for both children special needs and for nonhandicapped students. With your permission, your son/daughter will be tested for and receive drill and practice for response speed, using a microcomputer. A line that represents a stick will appear on the television monitor. When the stick begins to fall a tone will sound. The student will be instructed to press a button when he/she sees the stick begin to fall and hears a tone. Your son/daughter will participate in one of the following groups:

PRETEST-PRACTICE-POSTTEST

Students in this group will be measured in an initial test, will receive practice, but will not be told how they are performing. They will be posttested after the practice.

PRETEST-PRACTICE WITH KNOWLEDGE OF RESULTS-POSTEST

Students in this group will be measured in an initial test. They will then receive practice that will tell them whether they are performing faster than, the same as or slower than before. Finally they will be posttested. Some of the students in this group will be given knowledge of results by the experimenter and some students will be given knowledge of results by a voice from the computer. This is the experimental condition.

Response speed is a measure with two components; reaction time and movement time. Reaction time has a physical limit and cannot be altered much with practice. Movement time has been shown in previous experiments to improve with practice. The purpose of this experiment will be to see if there is the same amount of improvement in response speed under the conditions of knowledge of results and without knowledge of results.

The possible benefits of the experiment are that the student, with practice, will be able to respond faster than he or she could before the practice was given. The students will work in a one on one situation with the investigator. This will require approximately ten minutes per day, for four or five days. The student will be seated comfortably, and will press the button approximately 25 times each session.

I would be happy to respond to your questions at any time during the course of the experiment. Please feel free to telephone me at any of the above numbers. Your permission for your child to participate in the experiment may be withdrawn at any time. Your child and your child's school will remain anonymous.

Thank you for your interest in allowing your child to participate in this experiment.

Sincerely,

Ginnie Atkins

PLEASE RETURN THIS PORTION TO YOUR CHILD'S TEACHER

STUDENT'S NAME---

STUDENT'S DATE OF BIRTH---

CIRCLE THE APPROPRIATE RESPONSE MALE FEMALE

RIGHT HANDED LEFT HANDED

PARENT'S NAME--

TELEPHONE NUMBER---

WE HAVE VIDEO/COMPUTER GAMES AT HOME YES----- NO-----

MY CHILD USES VIDEO/COMPUTER GAMES ------ HOURS PER WEEK.

I give my permission for my child to participate in the response speed experiment. I understand I may withdraw my permission for my child to participate at any time.

-----------------------------Parent's signature-------------date

----- No thank you, I do not wish to have a copy of the results of the experiment.

----- I would like to receive a copy of the results of the experiment. Please send the results to:

NAME--

STREET--

CITY----------------STATE---------------ZIP CODE-------

APPENDIX C

Individual Student Report Form

RESULTS FROM COMPUTER STUDY FOR

NAME--

WHO WAS IN THE GROUP WITH:

----NO FEEDBACK

----INSTRUCTOR FEEDBACK

----COMPUTER FEEDBACK

-----FASTEST RESPONSE IN ALL ATTEMPTS

----PRETEST MEDIAN SCORE

----POSTEST MEDIAN SCORE

THE PERFORMANCE OF THE RESPONSE SPEED TASK

----IMPROVED--BECAME FASTER

----STAYED THE SAME

----DECAYED--BECAME SLOWER

THANK YOU FOR ALLOWING YOUR CHILD TO PARTICIPATE IN THE STUDY IT WAS A VERY ENJOYABLE EXPERIENCE FOR ME TO WORK WITH ELEMENTARY SCHOOL STUDENTS AGAIN. NEARLY ALL OF THE STUDENTS IMPROVED IN RESPONSE SPEED AS A RESULT OF PRACTICE. YOUR COOPERATION AND YOUR CHILD'S COOPERATION IS GREATLY APPRECIATED. PLEASE FEEL FREE TO CONTACT ME IF YOU HAVE FURTHER QUESTIONS.

GINNIE ATKINS 754-3718 753-0858
C/O DR. JOHN M. DUNN, CHAIRMAN
DEPARTMENT OF PHYSICAL EDUCATION
OREGON STATE UNIVERSITY
CORVALLIS, OR. 97331

APPENDIX D

Sample Printout of Data Collection

DOE, JANE
SCREEN RESULTS
[1-2]

PRE-TEST

TRIAL	FP	TIME	POINTS	NORM
P 1	1	.173	9	16
P 2	3	.156	10	18
1	2	.154	10	18
2	3	.174	9	16
3	1	.162	10	18
4	3	.149	10	18
5	2	.175	9	16
6	1	.190	8	15
7	1	.186	8	15

------ RANKED SCORES ------

TRIAL NUMBER		SCORE
4		10
1		10
3		10
2	*MEDIAN*	9
5		9
7		8
6		8

TRIAL-SET 1

TRIAL	FP	TIME	POINTS	NORM
1	2	.178	9	16
2	3	.153	10	18
3	1	.161	10	18
4	2	.144	10	18
5	3	.146	10	18
6	1	.162	9	16
7	1	.152	10	18

------ RANKED SCORES ------

TRIAL NUMBER		SCORE
4		10
5		10
7		10
2	*MEDIAN*	10
3		10
6		9
1		9

TRIAL-SET 2

TRIAL	FP	TIME	POINTS	NORM
1	3	.167	9	16
2	1	.147	10	18
3	2	.150	10	18
4	2	.178	9	16
5	3	.152	10	18
6	1	.176	9	16
7	1	.165	9	16

------ RANKED SCORES ------

TRIAL NUMBER		SCORE
2		10
3		10
5		10
7	*MEDIAN*	9
1		9
6		9
4		9

DOE, JANE
SCREEN RESULTS
[1-2]

TRIAL-SET 3

TRIAL	FP	TIME	POINTS	NORM
1	2	.156	10	18
2	3	.160	10	18
3	3	.155	10	18
4	2	.165	9	16
5	1	.159	10	18
6	1	.160	10	18
7	1	.162	10	18

------ RANKED SCORES ------

TRIAL NUMBER		SCORE
3		10
1		10
5		10
2	*MEDIAN*	10
6		10
7		10
4		9

TRIAL-SET 4

TRIAL	FP	TIME	POINTS	NORM
1	3	.139	11	20
2	3	.159	10	18
3	2	.155	10	18
4	1	.166	9	16
5	3	.157	10	18
6	1	.154	10	18
7	1	.145	10	18

------ RANKED SCORES ------

TRIAL NUMBER		SCORE
1		11
7		10
6		10
3	*MEDIAN*	10
5		10
2		10
4		9

TRIAL-SET 5

TRIAL	FP	TIME	POINTS	NORM
1	1	.175	9	16
2	3	.085	13	24
3	2	.153	10	18
4	1	.168	9	16
5	3	.149	10	18
6	1	.158	10	18
7	1	.160	10	18

------ RANKED SCORES ------

TRIAL NUMBER		SCORE
2		13
5		10
3		10
6	*MEDIAN*	10
7		10
4		9
1		9

DOE, JANE
SCREEN RESULTS
[1-2]

TRIAL-SET 6

TRIAL	FP	TIME	POINTS	NORM
1	1	.156	10	18
2	1	.154	10	18
3	3	.043	15	27
4	3	.143	10	18
5	2	.178	9	16
6	1	.148	10	18
7	1	.147	10	18

------ RANKED SCORES ------

TRIAL NUMBER		SCORE
3		15
4		10
7		10
6	*MEDIAN*	10
2		10
1		10
5		9

TRIAL-SET 7

TRIAL	FP	TIME	POINTS	NORM
1	2	.132	11	20
2	3	.140	11	20
3	2	.136	11	20
4	3	.146	10	18
5	3	.154	10	18
6	1	.157	10	18
7	1	.140	11	20

------ RANKED SCORES ------

TRIAL NUMBER		SCORE
1		11
3		11
2		11
7	*MEDIAN*	11
4		10
5		10
6		10

TRIAL-SET 8

TRIAL	FP	TIME	POINTS	NORM
1	1	.174	9	16
2	3	.145	10	18
3	3	.144	10	18
4	2	.149	10	18
5	3	.189	8	15
6	1	.137	11	20
7	1	.150	10	18

------ RANKED SCORES ------

TRIAL NUMBER		SCORE
6		11
3		10
2		10
4	*MEDIAN*	10
7		10
1		9
5		8

APPENDIX E

Raw Data

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0020000351351

0030203313298

0040000351351

0050000344351

0060001351334

0070000351351

0080000341351

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0170000351351

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0200000351351

0210001351326

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0260000351351

0270507250213

0280000351351

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0310004351269

0320001351334

0330000351351

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0380005351258

0390305278250

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0730606219230

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1140506240230

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1180707216230

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1200607225209

1210709203178

1220507240216

1230508247193

1240406270225

1250406261237

1260808196188