THE RELATIONSHIP OF SELECTED ABILITIES TO GROSS MOTOR PERFORMANCE OF EDUCABLE MENTALLY RETARDED STUDENTS

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The problem of this investigation was the relationship of selected abilities to gross motor performance of educable mentally retarded students at different chronological age levels.

The purposes of this study were (1) to investigate the relationship of sex and of selected abilities to gross motor performance; (2) to examine the relationship of selected abilities at different chronological age intervals in order to determine which measures best predict gross motor performance; and (3) to develop guidelines for classroom teachers and physical educators who are involved in planning remedial programs for the retarded child.

Seventy-four male and female educable mentally retarded children, ages seven through twelve years, were utilized as subjects for this investigation. These subjects were enrolled in special education classes at an elementary school, a junior high school, and a university demonstration school.

The instruments utilized were the Frostig Developmental Test of Visual Perception, the Wechsler Intelligence Scale for Children, the Wepman Auditory Discrimination Test, and
a six-category gross motor performance test. The gross motor performance test included measures of body perception, gross agility, balance, locomotor agility, ball throwing, and ball tracking.

The statistical procedure of multiple linear regression was used to analyze the data. The data, for the total group, were analyzed to determine the relationship of the selected measures to gross motor performance, and to determine the best combination of variables for predicting gross motor performance. A further analysis was performed to determine if the variables for predicting gross motor performance for the total group were consistent for each age group. The age groups included subjects who were seven and eight years, nine and ten years, and eleven and twelve years. The .05 level of significance was selected for all statistical analyses.

The results of this investigation indicated that a negligible relationship existed between gross motor performance and figure-ground, form constancy, position in space, spatial relationships, verbal intelligence, and performance intelligence. The variables of eye-motor coordination, auditory discrimination, and sex showed a present, but slight, correlation with gross motor performance. It was determined that eye-motor coordination, spatial relationships, auditory discrimination, and sex were the best predictors of gross motor performance for the total group. The contribution of
each of these variables as a predictor of gross motor performance was significant at greater than the .05 level of significance. There was no significant statistical interaction between age, at three different levels, and eye-motor coordination, spatial relationships, auditory discrimination, and sex. Homogeneity of regression equations was established for the three age groups.

The conclusions drawn from the findings of this study were (1) eye-motor coordination, spatial relationships, auditory discrimination, and sex can be used as predictors of gross motor performance of educable mentally retarded students; (2) in terms of gross motor performance, the educable mentally retarded student, without auditory discrimination problems, tends to score higher than those with problems; (3) boys, within the age range of seven through twelve years, tend to perform better than girls on gross motor performance tasks; (4) age does not contribute significantly to the prediction of gross motor performance. However, during the administration of the six subtests it was observed that age appears to be a factor related to the performance of the ball throwing task.

Based on the review of the related research and the implications of the present study, guidelines were developed to assist classroom teachers and physical educators in planning better physical activity programs for the educable mentally retarded.
THE RELATIONSHIP OF SELECTED ABILITIES TO GROSS MOTOR
PERFORMANCE OF EDUCABLE MENTALLY RETARDED STUDENTS

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CHAPTER I

INTRODUCTION

The slow learner has become a vital problem in our educational system. The evolvement of special education classes for the mentally retarded in the public schools has introduced the educator to many new problems. These problems are concerned with individual readiness for learning and adequate educational programs for the retardate. Mentally retarded children are entitled to the kind of education and training which will enable them to function in society to the maximum of their capabilities. This can be accomplished only if the educator understands the factors involved in the individual growth and development processes.

The integration of the retarded student into the regular physical education classes has created a need for the physical educator to understand the developmental process of the retarded student.

The ability to control body movements in gross motor activity is basic to the performance of specific motor skills. Additional information regarding gross motor performance as it relates to the developmental process of the retardate must be sought if relevant education programs are to be developed.
Statement of the Problem

The problem of this study was the relationship of selected abilities to gross motor performance of educable mentally retarded students at different chronological age levels.

Purposes of the Study

The purposes of this study were

1. to investigate the relationship of sex and of selected abilities to gross motor performance. The selected measures were visual perception of eye-motor coordination, figure-ground, form constancy, position in space, and spatial relationships; verbal intelligence; performance intelligence; and auditory discrimination (gross motor performance was determined by measures of body perception, gross agility, balance, locomotor agility, ball throwing, and ball tracking);

2. to examine the relationship of the selected abilities at different chronological age intervals in order to determine which measures predict gross motor performance;

3. to develop guidelines for classroom teachers and physical educators who are involved in planning remedial programs for the retarded child.

Questions to be Answered

To accomplish the purposes of this study, the following questions were considered:
1. What is the relationship of scores of gross motor performance to the following?

   (a) Visual perception of eye-motor coordination, figure-ground, form constancy, position in space, and spatial relationships as measured by the Frostig Developmental Test of Visual Perception.

   (b) Verbal intelligence and performance intelligence scores as measured by the Wechsler Intelligence Scale for Children.

   (c) Auditory discrimination as measured by the Wepman Auditory Discrimination Test.

   (d) Sex.

2. What is the best combination of selected variables for predicting gross motor performance without regard to age?

3. Will the regression equation established for the total group be applicable for each of the three age intervals without a significant loss of predictive ability?

4. What implications can be drawn from the results of this investigation which may be used by educators in developing programs for the mentally retarded?

   Background and Significance of the Study

   Professional services for the mentally retarded are less than a century old in this country. The residential school movement developed in the early twentieth century and has spread to almost every state in the Union. The first schools,
designed as training schools rather than asylums, often did not admit severely retarded persons because the schools were dedicated to the curing of mental retardation. The cure, however, did not occur. Today, the purpose of most state residential schools has changed radically. The present trend is to admit those extremely retarded persons who require constant and complete care or who present serious social problems.

This new policy on the part of the day schools has placed the responsibility for educating a larger percentage of the moderately retarded students with the public education system in each state. Because this responsibility is being fulfilled through the public day schools and classes, the physical educator, as a part of that system, has become involved in developing programs that will enable the retarded to improve movement capabilities for proficient motor performance.

For years investigators have been interested in the factors associated with motor development and its relationship to learning. In recent years, however, several researchers have directed efforts toward the mentally retarded population in order to examine the perceptual motor process in slow motion. In general, studies comparing motor and mental attributes indicate low but at times significant relationships between the two attributes.
Fait and Kupfers (8) compared retardates' scores on a simple motor act to intelligence and obtained no significant relationship. However, when a score of a four-count task was compared to intelligence, a moderate relationship occurred. The conclusion drawn was that the second motor act involved an ability to remember similar to that required for items on the intelligence test.

Several studies to determine the causative effects of physical activity on measures of intelligence have been conducted in recent years. The structured movement programs formulated by Doman and Delacato (7) have been examined extensively for the effects of movement on intellectual development.

Robbins (18) investigated the influence of the Doman-Delacato program upon a group's ability to read and to distinguish left from right. The results showed no significant improvement in laterality and that the program exerted no significant influence on reading ability.

Whitsell (24), in reporting the methods used by Doman and Delacato had not been subjected to experimental verification, caused some members of the medical profession to question the validity of the program. The physical demands placed upon the child are not recommended by some pediatricians and neurologists.
The results of these investigations point to the need for more information regarding movement abilities of the retarded population.

Early motor behavior and its relationship to learning have provided the foundation for several interesting and sometimes conflicting theories. However, educators and child specialists agree that perceptual motor development is a vital part of the individual growth process. Kephart (12) places considerable emphasis on early motor learning and on the development of learning patterns, rather than specific skills. This theoretical construct implies that the more complex activities such as perception, concept formation and symbolic manipulation depend upon and utilize in their acquisition the more basic motor learnings. Kephart suggests that the motor activities of the child become vitally important for the contributions they must make to the more complex activities which the individual will be required to perform at later stages of development. A deficiency in early motor learning tends to impede the later, more complex, learnings.

The basic factors involved in the formulation of the perceptual motor theory include balance, body perception, perceptual-motor match, and visual perception.

Several studies have been conducted to test the relationship of Kephart-type activities to academic success. Brown (1) found that while certain measured of perception were improved after his subjects engaged in the tasks
Kephart suggests, no significant improvement was found in reading scores.

LaPray and Ross (13), using first graders who were low in both reading and visual perception, found that one group, after being instructed in simple reading materials, improved in reading. A second group, having participated in large-muscle and visual activities, improved in these attributes but not in reading.

Generally, the Kephart-type activities are designed to improve the motor functioning of children with neurological handicaps. Kephart's concept of perceptual-motor development has focused attention on the importance of motor activities in the development of the learning process itself.

Cratty (3), who has done extensive research in the area of motor performance with the retarded during the last five years, recommends that more research is needed which investigates the influence of Kephart's perceptual-motor training program upon the attributes of retardates. It is on the basis of Cratty's work that the six-category gross motor test was here used as a measure of gross motor performance.

This study was an attempt to gain additional information about the gross motor performance of the retarded child and some factors which may be used to predict this performance. The results of this study will be useful for program planning in physical education for the retarded student.
Definition of Terms

For the purposes of this study the following definitions were used:

1. **Ability** is the quality or state of being able to perform physically or mentally.

2. **Balance** is the ability to maintain a stationary position on one foot for five seconds.

3. **Body perception** is the ability to identify specific body parts.

4. **Educable mentally retarded** refers to mentally retarded special education students with intelligence quotient scores which range from fifty-five to eighty-five, as measured by the Wechsler Intelligence Scale for Children.

5. **Gross agility** is the ability to change body positions in a vertical direction.

6. **Gross motor performance** is short term movement which involves large muscle groups.

7. **Gross motor performance score** is the total score obtained on six specific gross motor tasks.

8. **Locomotor agility** is the quality of movement of the body as a whole through distance or space.

9. **Mental retardation** "refers to subaverage general intellectual functioning which originates during the developmental period and is associated with impairment in adaptive behavior" (11, p. 3).
10. Perception "is knowledge through the senses of the existence and properties of matter and the external world" (17, p. 82).

11. Perceptual-motor refers to "the inseparable integration of perceptual and motor function or activities as one interdependent and interrelated behavioral area" (10, p. 305).

Delimitations of the Study
This study was limited to educable mentally retarded enrolled in special education classes within the same school district. The subjects were males and females ranging in age from seven through twelve years.

Basic Assumption
It was assumed that a maximum effort was put forth by the public school personnel to obtain optimum test results.

Instruments
Four tests were utilized to measure the abilities selected for this study. The Wechsler Intelligence Scale for Children was used to obtain measures of verbal intelligence and performance intelligence. The Frostig Developmental Test of Visual Perception was administered for measures of eye-hand coordination, figure-ground, form constancy, position in space, and spatial relationships. The third instrument used was the Wepman Auditory Discrimination
Test for auditory discrimination. The six-category gross motor test that was developed by Cratty (3) was used in this study as the Gross Motor Performance Test.

Procedures

The study was conducted during the spring semester of 1971 with public school special education students. Seventy-four male and female educable mentally retarded children, ages seven through twelve years, were utilized as subjects for this investigation. These subjects were enrolled in classes at an elementary school, a junior high school, and a university demonstration school.

The Wechsler Intelligence Scale for Children, the Frostig Developmental Test of Visual Perception, and the Wepman Auditory Discrimination Test were administered to each of the students under the auspices of the public school special education counselor. These test scores were made available to the investigator at the end of the academic school year.

The Gross Motor Performance Test was administered individually to each of the subjects by the investigator. Seven test days were required for the administration of the six gross motor tasks selected for this study. Each student was tested in his respective school during the regular school day. The order in which the gross motor tasks were administered was body perception, gross agility, balance, locomotor
agility, ball throwing, and ball tracking. The total of the six scores constituted the subject's gross motor performance score.

The data collected were analyzed for the total group to determine the relationship of the selected ability measures to gross motor performance. The statistical procedures of multiple correlation and multiple linear regression were used to determine the best combination of variables for predicting gross motor performance. The data were also analyzed to determine if the variables for predicting gross motor performance for the total group remained the same for each of the two-year age intervals. The statistical findings are reported in appropriate tables for further classification.


CHAPTER II

REVIEW OF THE LITERATURE

The major concern of this study was to investigate the relationship of selected abilities to gross motor performance of educable mentally retarded children. The review of the literature in this chapter is presented in two major areas. The first area includes those studies which have investigated the relationship of various abilities to motor performance with emphasis on those studies pertaining to the educable mentally retarded. Selected studies that investigated the relationship of intelligence, perceptual-motor skill, and gross motor performance of normal children are included for comparative purposes. The second area of review focuses upon investigations which dealt with training programs designed to aid intellectual, perceptual, and gross motor performance.

Studies that Report Relationship of Abilities to Motor Performance

Hofmeister stated, "A great deal of research has been concerned with the nature of relationships between different psychological and physical variables; the relative importance of the variables has received little attention" (23, p. 264). He conducted a study to investigate the interrelationships
between motor proficiency, mental age, chronological age, school attainment, sociometric status, and classroom behavior of thirty-one educable mentally retarded boys and girls enrolled in a public school program. The study was specifically designed to determine the relationship of motor proficiency to school achievement, sociometric status, and behavioral disturbance of intermediate level retarded children in special education classes. The results showed motor proficiency to be related to all the areas investigated, even when mental and chronological age factors were statistically controlled.

Francis and Rarick (16) examined the motor characteristics of 284 mentally retarded children attending public schools. The purposes of the study were to determine age and sex trends in certain gross motor abilities of mentally retarded children, to compare the motor achievement levels of the mentally retarded with normative data on normal children, to determine whether the interrelationships among gross motor functions of the mentally retarded are different from the interrelationships among those traits of children of normal intelligence, and to determine the extent to which the degree of mental retardation is related to the motor achievement levels of the slow learner (16, p. 792).

A battery of eleven motor performance tests designed to measure strength, power, balance, and agility was administered to the subjects. The data were analyzed for
interrelationships among motor abilities according to age and sex so that comparisons could be made with the motor abilities of normal children. The author reported that age and sex differences of the retardates on measures of strength, power, balance, and agility followed the same general performance patterns as those of normal children. A quantitative comparison between the motor proficiency scores of the mentally retarded and published data on normal children showed the mentally retarded children to be from two to four years behind on most measures of motor performance. The authors concluded that, although the general pattern of change by age and sex was similar to that of normal children, mentally retarded children used in this study were markedly inferior to normal children in all motor performance tests. In addition, with advancing age the deviations from the normal tend to become greater.

Howe (24) conducted an experiment in which he compared the motor skills of mentally retarded and normal children. The retarded group and the normal group each included forty-three elementary school children. The groups were matched with respect to chronological age, socioeconomic background, and sex. The motor tasks included a standing high jump, balancing on one foot, tracing speed, tapping speed, dotting speed, grip strength, zig-zag run, fifty-yard dash, squat-thrust, ball throw for accuracy, and paper and pencil maze tracing. The statistical design was that of treatment by
levels of chronological age and mental ability. The data were analyzed by an analysis of variance procedure. The results of this study indicated that the normal group of boys was significantly superior to the retarded group on each of the eleven motor tasks. For girls, differences favored the normal group for all tasks except throwing a ball for accuracy. The study revealed that the mentally retarded were unable to balance on one foot; only two children reached the maximum balance time of one minute. However, it was a relatively easy task for the normal group, with twenty-eight of the forty-three children being able to balance for the required time. The author concluded that a structured program of physical education may be a necessary part of the curriculum for the mentally retarded.

Thurstone (46) compared the performance on eight motor tasks of mentally retarded and normal children. The motor tasks consisted of a ball throw for distance, ball punt for distance, standing broad jump, ball throw for accuracy, side stepping, forty-yard run, strength of right grip, and strength of left grip. It was found that, on all tasks, the normal group was significantly better than the mentally retarded group.

Heath (22) explored the relationship of beam-walking performance to mental age and etiological type among the mentally retarded. Using 170 mentally retarded boys, Heath found a correlation coefficient of .66 between mental age
and beam-walking scores of endogenous mentally retarded.
As a result of this study, the possibility of an etiological
classification through test performance was suggested for
mentally retarded children.

Sloan (43) conducted a study to determine the relationship
between intelligence and motor proficiency. A secondary
purpose of this study was to demonstrate the applicability
of the Oseretsky Test of Motor Proficiency as a diagnostic
instrument for mental defectives in the United States.
Twenty mental defectives and twenty normal children were
matched according to age and sex. The subjects were ten
years of age. The test for motor proficiency included six
areas. The areas were general static coordination, dynamic
manual coordination, general dynamic coordination, speed,
simultaneous movement, and synkinesia. An analysis of vari-
ance was the procedure used to analyze the data. The results
showed a significant relationship between motor proficiency
and intelligence for both groups. However, the mentally
retarded children were significantly inferior to the children
of normal intelligence on all tasks of motor proficiency.
Sloan concluded that motor proficiency is not a distinct
aspect of functioning which can be separated from general
behavior. He recommended that an adequate evaluation of
adaptive capacity should include estimates of intelligence
with measures of social maturity and motor proficiency.
Malpass (33) conducted a study which compared normal children with institutionalized and non-institutionalized retarded children on the basis of motor proficiency. In addition, the relationship between motor proficiency and intelligence for each group was explored. Subjects for the three groups included fifty-two institutionalized children, fifty-six children from public school classes for the educable mentally retarded, and seventy-one children with normal intelligence. The groups were matched by chronological age and sex. The t test for independent samples was used to determine the significant differences between the motor performance scores of the groups. Partial correlations were used to determine the relationships between motor proficiency and intelligence for each group. The results of this study revealed no significant differences between institutional and public school retarded children on motor proficiency. However, when the retarded and normal children were compared, significant differences on motor proficiency scores were noted in favor of the normal children. The results of this study indicate that the motor proficiency of retarded children is more highly related to intellectual ability than that of normal children. It was concluded that motor performance scores can be used to differentiate retarded from normal children and that relationships between motor proficiency and intelligence can be predicted for mentally retarded but not for normal children. These
findings confirm reports by Tredgold (47) and Sloan (43) that motor proficiency is related to intellectual ability when comparing mildly retarded and normal children.

In another study, Rabin (38) investigated the relationship of age, intelligence, and sex to motor proficiency in mental defectives. Sixty endogenous, institutionalized, mentally retarded boys and girls were used to test the hypotheses of no relationship between motor proficiency and age, intelligence, sex and of no interaction between any pair of the independent variables. The subjects were assigned to one of five groups according to age, sex, and intelligence. Each subject was tested for intelligence and motor proficiency. The relationship of these measures was evaluated by an analysis of variance design. The findings indicated that motor proficiency has a significant positive relationship to age. The relationship of motor proficiency to intelligence approached, but did not show to be statistically significant in this study. Motor proficiency was not found to vary as a function of sex. The author concluded that the results of this study support the findings of earlier research conducted by Sloan (43).

The relationship of motor ability and peer acceptance of mentally retarded children was investigated by Smith and Hurst (44). Two groups of retardates, eighteen trainables and twenty-five educables, were compared on motor skill performance and social status as determined by peer
acceptance. The Lincoln-Oseretsky Motor Development Scale was administered to determine the motor skill of the subjects. Peer acceptance was determined by verbal, nonverbal, initiated, received, and total child contacts during twenty-two-minute observations. The data analysis consisted of multiple correlation and multiple regression procedures. The results of this study support the hypothesis that motor ability plays a significant role in peer acceptance for retarded children.

Doyle (15) conducted a study to explore the possibility that perceptual skill and intelligence develop independently. One hundred eight children were selected from public elementary schools in which there were special education classes for the mentally retarded. The study included mentally retarded and normal children. The children were assigned to one of eighteen treatment groups in various combinations of sex, mental age, and chronological age. Each group was subjected to horizontal-vertical illusion tests which involved sight, hearing, and touch. The task required each subject to judge whether a horizontal stimulus or a vertical stimulus was greater for each of the sensory modalities. The experiment was based on a three by three by two factorial design, with three levels of chronological age, three levels of mental age, and both sexes. The conclusion drawn from this study was that accuracy in perceptual judgment does not appear to be lock-stepped to intellectual development.
Ismail, Kane, and Kirkendall (27) conducted a study to determine the relationships among intellectual and non-intellectual factors among British children. The investigation was a cross-cultural validation of the study conducted by Ismail and Cowell (25) with American children. Forty-eight boys and forty-six girls from four primary schools in London were selected for this study. The ninety-four students represented high, middle, and low achievement levels. In addition, a wide socioeconomic background was represented within the group. Thirty-two intellectual and nonintellectual measures were obtained on each of the subjects. The nonintellectual items were age, height, weight, eighteen motor aptitude items, and two dimensions of personality. In order to identify the factors which were present, three factor analyses were run, one for the total group, one for boys, and one for girls. Eight factors were extracted for each of the three factor analyses. The findings of this study point to a positive relationship between the motor aptitude items, coordination and balance, and measures of intelligence and scholastic ability. The authors concluded that the relationship between measures of intellectual ability and measures of nonintellectual aptitude of British children follows a pattern similar to that of American children.
Studies Utilizing Developmental Training Programs

Haring and Stables (21) conducted a study to investigate the idea formulated by Kephart (29) that an organism's input-output functions occur in closed cycle with perceptual and motor activities working together in one process. Specifically, the study was designed to determine the effect of gross motor training on visual perception and on eye-hand motor coordination of educable mentally retarded children. Twenty-four retardates were divided into two equal groups. The control group received a normal structured pattern of classroom work without special emphasis on motor development. The experimental group received the same classwork as the control group, with additional training in gross motor coordination and visual perception. The training program was designed to emphasize the contribution which the task could make to a general skill, not the training task itself. The training program lasted thirty minutes a day, five days a week, for seven months. Both groups were given a pretest, posttest, and follow-up test on visual perception and eye-hand coordination. The follow-up test was administered four months after the posttest, with no special training given to either group. The t test for independent groups was used to test the significance of the difference between mean scores of the two groups. The results indicated that the mean gain for the experimental group was significantly greater than
the mean gain for the control group. This difference remained significant, favoring the experimental group, for the follow-up test which was administered four months after the posttest. The authors concluded that gross motor training affects, in a positive way, the child's development in motor areas which have a direct effect on the learning capabilities of the educable mentally retarded.

Lipton (32) conducted a study to determine the effects of a perceptual-motor development program on visual perception and reading readiness of first-grade children. Ninety-two children from four first-grade classes were divided randomly into control and experimental groups. The control group participated in a regular physical education program which included appropriate primary grade activities of rhythms, relays, stunts, and games of low organization as recommended by Bucher (2). The experimental group participated in a perceptual motor training program for twelve weeks. The first phase of the program involved activities based on the relationship of movement patterns and movement skills. The program was designed to include activities that emphasize directionality of movement as recommended by Kephart (29) and Godfrey (20). The second phase of the experimental program involved activities recommended by Painter (35) for improving perceptual-motor spatial abilities. These activities included the use of a balance beam, identifying objects by touch, movement to music, and flexibility
movements. Two-way analysis of variance was used to analyze the data. The results showed that the experimental program produced significantly greater gains in perceptual-motor development, visual perception, and reading readiness than the conventional physical education program. The findings of this study are consistent with the theory supported by Cratty (9), Delacato (14), Kephart (29), and Piaget (36) that certain levels of learning are directly influenced by programs of perceptual-motor training activities.

Chasey and Wyrick (5) investigated the effect of a gross motor developmental program on form perception skills of educable mentally retarded children. The authors hypothesized that a concentrated developmental program would significantly improve the perceptual-motor skills of the educable mentally retarded and that visual form perception would be improved as a result of the program. The thirty-two subjects ranged in age from six to twelve years. Twenty subjects were in the experimental group and twelve subjects were utilized as a control group. The experimental program was conducted one hour a day, five days a week for fifteen weeks. The program provided conditioning and coordination exercises, gymnastics, games, and modified sports based on the needs of the individual. Both groups were administered a pretest and posttest on seven components of form perception. An analysis of covariance was utilized to determine the differences of the posttest scores. After the
fifteen-week training program, the authors concluded that a developmental program of gross physical activity appeared to have no effect on the ability of the mentally retarded to perceive and copy geometric forms. They further concluded that gross motor activities probably do not substantially influence academic success in the early grades.

Chansky and Taylor (4) explored the effectiveness of a perceptual training program for educable mentally retarded children. The study was designed to investigate the effects of a perceptual training program on achievement levels of retarded children, to determine if perceptual training increases psychometric intelligence in trained children, and to investigate if children can be trained to perceive vertically. One control group and two experimental groups of educable mentally retarded children in special classes participated in the study. Thirteen children were in each group, and the age range was eight through eleven years. The subjects in the two experimental groups participated in the same perceptual training. However, individual instruction was utilized with one group, while group instruction was used with the second experimental group. The program included an hour of training each week for a period of ten weeks. During the ten-week training period, students received instruction for correct left-to-right orientation of reproduction of different block designs, organization of the reproduction, and form discrimination. Pretest and posttest
for intelligence, achievement, and visual perception were administered to each of the three groups. Performance curves and the t test were used to analyze the data. The experimental groups, in contrast to the control group, improved significantly in reading, vocabulary, and spelling. These findings support the postulate of Combs (6) that the ability to make perceptual discriminations and to organize the perceptual field is related to intelligence. The conclusions drawn from this study were that mentally retarded children, trained to make discriminations, to organize, to orientate themselves from left-to-right, and to make inferences, improved in measured achievement and intelligence.

In a similar study, Oliver (34) experimented with two groups of educable mentally retarded boys in two residential institutions in the United Kingdom. There were nineteen boys in the experimental group and twenty boys in the control group. The groups were matched for age, size, physical condition, and intelligence. The experimental group participated in systematic and progressive physical conditioning and recreational activities for two hours and forty minutes each day over a ten-week period. The control group continued their regular program, which involved two physical education classes each week. The t test was used to analyze differences between the two groups. The experimental group made significant gains over the control group on scores of intelligence and motor proficiency tests. The author concluded
that special physical education activities should be utilized for institutionalized retarded boys.

Gallahue (18) conducted a study to determine the effects of various figure-ground perception patterns on the performance of a selected gross motor task. Eighty kindergarten pupils were administered the figure-ground subtest of the Frostig Test and a gross motor task which involved walking in a lateral direction between the rungs of a ladder placed in a horizontal position over a floor pattern. The subjects were assigned to one of four treatment groups with each group being subjected to a different figure-ground pattern. An analysis of variance was used to determine the differences of gross motor performance among the groups. The Pearson product-moment correlation technique was utilized to analyze the relationships between the gross motor scores and the visual test scores. The findings of this study indicate that accurate performance of a gross motor task is influenced by the composition of various figure-ground patterns. It was concluded that figure-ground perception ability tends to influence a kindergarten child's ability to perform a gross motor task accurately.

Alley (1) conducted a study to determine if educable mentally retarded children make significant improvements in sensorimotor performance, visual perception, and concept formation activities after an extended, systematic training program of visual-perceptual activities. Forty-eight
educable mentally retarded children were divided into two age-matched, sex-paired groups of twenty-four subjects each. The experimental group was subjected to systematic visual-perceptual training activities. The activities were graduated in difficulty and included the areas of eye-motor coordination, figure-ground, form constancy, position in space, and spatial relationships. Each training session included the completion of five worksheets which were distributed equally over all five visual-perceptual areas. The data were subjected to analysis of covariance utilizing a treatment by pairs design. The results showed no significant difference between groups on sensorimotor performance, visual-perceptual performance, and concept formation performance. However, the experimental group made an observable visual perception gain from pretest to posttest administration on the Frostig Test, while no such gain was noted in the performance of the control group. It was concluded that there are no advantages to be derived by educable mentally retarded children from a systematic visual-perceptual training program over general special education classroom activities.

As a result of the studies by Howe (24) and Oliver (34), Corder (7) proposed to investigate the effects of a systematic and progressive program of physical education on the intellectual development, physical development, and social status of educable mentally retarded boys enrolled in special
education classes. All boys were between twelve and seventeen years of age. The subjects were divided into three groups of eight in such a manner that the groups were equated according to age and intelligence. The training group received a progressive and systematic program of physical activities for twenty days; each day the group was given a greater challenge than the previous day. One group, designated as officials, met each day with the training group. The officials were given the responsibility of rating and recording the performance results of the training group. This group was used to study the anticipated Hawthorne effect, and much praise was given to each official by the investigator. The control group received the usual classroom instruction. Each group was given a pretest and posttest on the Wechsler Intelligence Scale for Children, the Youth Fitness Test, and the Cowell Personnel Distance Scale. The data were analyzed by the use of analysis of variance. The training group made significant gains on intelligence scores over the control group, but not the officials group. The training group made significant gains on the fitness test over the officials group and the control group. There were no significant differences between the three groups in social status. The author concluded that a systematic program of physical activities contributes to the physical and intellectual development of the mentally retarded.
Geddes (19) investigated the effects of mobility patterning techniques from the theory of neurological organization upon motor skills of primary educable mentally retarded children. The experimental group was subjected to mobility patterns in creeping, crawling, and walking, while the control group participated in special physical education activities. The physical education activities included tumbling, ball handling, self-testing, trampolining, rope climbing, and simple relays. Both groups were given a pretest and posttest to determine the level of motor skill for leg power, dynamic balance, agility, and fine manual motor coordination. Each group participated in thirty-minute classes, five days a week, for three months. The analysis of covariance was used to analyze the data. The control group was significantly superior to the experimental group on leg power scores. No significant differences were observed between the two groups on measures of agility, dynamic balance, and fine manual motor coordination. It was concluded that the special physical education program contributed more than the mobility patterning techniques in terms of improving leg power of nine- and ten-year-old retarded children. It was further concluded that there was no difference in the effectiveness of the two programs for improving agility, dynamic balance, and fine manual motor coordination. These findings are consistent with Robbins (41).
who employed the same techniques of the theory of neurological organization and failed to confirm the validity of the theory.

Fretz, Johnson, and Johnson (17) used eighty-four children with coordination, emotional, or social problems in their experimental study. Fifty-three children enrolled in a physical developmental clinic and thirty-one children who were waiting to enroll in the clinic were compared on intellectual and perceptual-motor development. The clinical program consisted of a wide variety of gymnastic activities, conditioning and coordination exercises, and modified games. The training program involved eight weeks of therapeutic play activities. All subjects were male and ranged in age from five to eleven years. Both groups were pretested and posttested for measures of visual perception, kinesthesia and tactile perception, and intelligence. The authors concluded that the clinical perceptual motor development program significantly contributed to the development of generalized motor performance.

Summary

A majority of the studies dealing with the mentally retarded have been concerned with general behavior theory, intelligence, and the social competency of the individual, while less emphasis has been directed at motor function and development. Much of the research has been conducted outside the field of physical education. However, several
recent studies with a physical education orientation have focused on the problems of behavior change as a function of participation in planned physical education programs. The literature reviewed for this study indicates that certain trends have been observed in the performance of the mentally retarded. On most measures of motor proficiency, the mentally retarded are inferior to normal children of the same age and sex. However, the mentally retarded have shown progress patterns similar to those of the nonretarded population. Motor proficiency and intelligence are more highly correlated in the retarded than in normal children. The mentally retarded are much nearer the normal population physically than mentally. The retardate tends to achieve better in activities that involve simple rather than complex neuromuscular skills. The mentally retarded, as a result of planned and systematic programs of physical education, can improve on tasks which involve motor function and proficiency. However, there is a need for further research to determine the effects of these programs on intellectual development.

In general, research shows the importance of physical activity to the total growth and development of the mentally retarded. The need for more research dealing with the perceptual-motor development of the retarded is stated best by Stein:

"Long before Gessel and Spock, we evaluated an infant's progress on the basis of motor milestones. Physical development has long been"
looked upon as the foundation upon which an individual's total "self" rests. Research is pointing to the efficacy of this approach with the retarded. Let us hold in mind Aristotle's profound but simple observation, "If one should look at things as they grow from the beginning, it would be the best method of study" (28, p. 250).

The present study was an attempt to gain further information about the relationship of intellectual and motor characteristics of the mentally retarded child.
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CHAPTER III

PROCEDURES OF THE STUDY

Selection of the Subjects

The subjects for the study were selected from seven special education classes during the spring term of the 1970-71 school year. The criteria established for the selection of participants in this study required each subject to be classified as educable mentally retarded with no known physical impairment, and within the age range of seven through twelve years. Of the ninety-one students enrolled in the seven classes, seventy-four met the requirements and were selected as subjects for this investigation. The seventy-four subjects included thirty-six girls and thirty-eight boys.

Selection of Instruments

The instruments selected for this study were the Frostig Developmental Test of Visual Perception, the Wechsler Intelligence Scale for Children, the Wepman Auditory Discrimination Test, and the Gross Motor Performance Test.

The Frostig Developmental Test of Visual Perception (hereafter referred to as the Frostig Test) was utilized to evaluate five areas of visual perception of each subject. The Frostig Test was developed in 1958 and standardized in
1963. The 1963 standardization is based on responses of over 2,100 nursery school and public school children between the ages of three and nine years.

Reliability data are based upon a test and retest of fifty children with learning difficulties over a three-week period. The product-moment coefficient of retest reliability was .98, using the full range in ages.

Validity has been investigated by comparing test scores and teacher ratings of classroom adjustment, motor coordination, and intellectual functioning. The product-moment coefficient was .44, .50, and .50, respectively. In a study of twenty-five children, the Frostig Test proved to be highly accurate in identifying children who would not attempt to learn to read when exposed to reading material but not forced to use it. Low test scores are also reported to relate to the presence of severe learning difficulties. The Frostig Test has proved useful as a screening tool primarily because it permits identification of those children who need special perceptual training in five important areas of visual perception.

The test contains five subtests which assess the functions of eye-motor coordination, perception of figure-ground, perception of form constancy, perception of position in space, and perception of spatial relationships. Each of the five areas measured by the subtests was treated as a separate variable in this study. As recommended by Frostig (3), raw
scores on each of the five subtests were converted to a perceptual age equivalent, which represents the age at which the average child achieves this score.

The Wechsler Intelligence Scale for Children (hereafter referred to as the WISC) was utilized to obtain intellectual measures of verbal ability and performance ability. The WISC was standardized on 2,200 children ranging in age from five through fifteen years. The test yields three scores: verbal, performance, and total. Buros (1) reported the split half reliability coefficients range from .86 through .96 at different age levels on the verbal and performance scales. The split half reliability coefficient was .90 for the total score.

Concurrent validity has been established by comparing the WISC with the Stanford-Binet. The correlation coefficient was .80 between scores of both tests.

The Wepman Auditory Discrimination Test measures the ability to hear accurately. The test consists of thirty pairs of words which differ in a single phoneme in each pair, and ten pairs of words which are not different.

The test-retest administered to 109 subjects produced a reliability coefficient of .91. Wepman (5) reported that validation of the test involved 340 elementary children enrolled in remedial reading programs. In addition, eighty children in the first grade and seventy-six children in the
second grade in a non-urban school were used in the validation process.

The **Gross Motor Performance Test** was administered to acquire measures of body perception, gross agility, balance, locomotor agility, ball throwing, and ball tracking. The total of the six scores constituted the subject's gross motor performance score.

Cratty (2) developed norms for this test based on scores of 355 normal children, four through eleven years of age, and 151 educable and trainable retardates. The test battery is divided into two levels with six categories of tests at each level. The tests at the first level are designed to evaluate children with obvious movement problems; the tests at the second level are designed to evaluate children with mild perceptual-motor impairments. Level II was selected to evaluate the gross motor performance of the subjects in the present investigation. The test-retest administered to eighty-three children produced a reliability coefficient of .91. On the basis of this work, face validity of this measure was accepted for the present study.

**Testing of the Subjects**

The **Frostig Test**, the **WISC**, the **Wepman Auditory Discrimination Test**, and the **Gross Motor Performance Test** were administered to each participant of this study.
The WISC was administered during the school year as a part of the regular testing program by the special education counselor and the testing staff of the Center for Psychological Services at North Texas State University. The examiners were trained personnel, qualified and experienced in the administration of the WISC. The administration and scoring of all tests followed the procedures recommended by Wechsler (4). The test results were recorded in the student's permanent record folder.

The Frostig Test and the Wepman Auditory Discrimination Test were administered individually to each student in his school. The special education counselor administered, for the purposes of this study, all the tests in a quiet, well-lighted room in an effort to obtain optimum results. The administration and scoring of all tests followed the procedures recommended by Frostig (3) and Wepman (5). The counselor recorded the results of the tests in the student's permanent record folder. Each student's permanent record was made available to the investigator at the end of the school year, when the data were obtained for this study.

Administration of the Gross Motor Test

The Gross Motor Performance Test was administered individually to each subject in his respective school. The subjects were tested outside each of the three school buildings, with the mat placed on a smooth concrete or asphalt area of the playground.
The battery of tests was used to evaluate perceptual-motor functioning involving six categories of skill. Tests in each of the six categories are represented on two levels. Level II, which is the higher level of performance, was used in all cases for the purposes of this study.

**Body Perception**

The body perception test included tasks to evaluate the subject's ability to make right-left discriminations about his body and the accuracy of identifying selected parts of the body. Each student was asked to lie on his back in the center of the mat. The subject was told that he would be required to do certain things with his arms and legs as quickly and accurately as possible. The child was asked to close his eyes and do the following: raise your left arm in the air and return it to the mat; raise your left leg in the air and return it to the mat; raise your right arm in the air and return it to the mat; touch your left elbow with your right elbow, then return arms to the mat; and touch your right knee with your left hand. After the child completed all five tasks, he opened his eyes and stood up.

The subject scored one point for each correctly executed movement. Five points was the maximum score for this test.

**Gross Agility**

The gross agility test involved a task designed to determine how quickly the subject could move his total body
with control and accuracy. The student was placed in the center of the mat, facing the tester. The task of kneeling on one knee, then on the second, then arising to a standing position, without using the hands, was demonstrated by the examiner. After the demonstration, each child was asked to try the task.

The subject was scored on a five-point scale, with a maximum of five points for the total score.

The following scoring format was used: five points for execution of movement without errors; four points for execution of movement without the use of the hands, but with general unsteadiness; three points if the child used one or both hands only while getting up or if he fell to one knee while arising; two points if the child touched one or both hands to the thighs while ascending and descending; and one point if the child used his hands on the thighs and on the ground to assist in descending and/or arising.

Balance

The balance test included tasks designed to evaluate the subject's ability to maintain an upright position in space while his base of support underwent varying degrees of change, with or without visual cues.

Each subject stood on a level surface, ten feet away, facing the tester. Each of the five tasks was demonstrated by the tester before the subject was asked to perform. The
first task was to stand on one foot with the arms folded across the chest for five seconds. The second task was to stand on one foot, with arms at sides and eyes closed, for five seconds. The third task was to balance on one foot, with eyes closed and arms folded, for five seconds. The fourth task was to balance on non-preferred foot, with arms at sides and eyes closed, for five seconds. The last event was to balance on the non-preferred foot, with eyes closed and arms folded, for five seconds.

A stopwatch was used to time each event, and fifteen seconds were allowed as a rest period between trials. One point was scored for each of the five tasks successfully completed by the student.

**Locomotor Agility**

The locomotor agility test was administered to evaluate how accurately and efficiently the subject was able to move his body a distance of six feet using locomotor activity which included jumping and hopping.

The mat for this task was marked off in twelve one-foot squares. Each subject was required to perform five running and hopping tasks according to the instructions presented in Appendix B; he received one point for each trip down the mat with fewer than two errors.
**Ball Throwing**

The ball throwing test was selected to assess the subject's ability to throw a ball accurately. The object of this task was to throw a playground ball, which was eight and one-half inches in diameter, into a square target. The target was a piece of black oilcloth, two feet square, attached in the center of the four-by-six-foot mat. The mat was flat on the ground. (See Appendix C.)

The subject stood fifteen feet from the narrow end of the mat and threw the ball at the target five times. The task was demonstrated three times with the instructions that the ball could be thrown with one or two hands, using the method that was easiest for the individual.

Points scored on this task were determined on the following basis: five points if four or five throws landed within the target; four points if three attempts hit the target; three points if two attempts hit the target; two points if the five throws hit the mat, but not the target; and one point if three attempts hit the mat, but not the target. The highest possible score for this task was five points.

**Ball Tracking**

The ball tracking task was administered to evaluate the child's ability to anticipate and to react to a moving ball.
The task required the subject to touch, with the index finger, a softball in motion suspended by a fifteen-inch string.

The softball, suspended by the examiner's left hand, hung at a distance determined by the length of the subject's arm plus a clenched fist. The top of the ball, when motionless, was at the level of the child's chin. The suspended ball was then placed in the position with the string horizontal and released so that it would swing from the subject's left to right in a vertical plane, parallel to the one in which the student was standing. The subject was permitted to watch the ball swing back and forth six times but was not allowed to touch the ball. Each subject, with arms at his sides, was asked to touch the ball with his index finger as it passed in front of his body. Each subject was allowed five chances to touch the swinging softball. Each trial consisted of the ball swinging past the child three times after each release of the ball from the starting position. The ball was stopped as soon as the subject touched it or attempted to touch it.

One point was scored each time during the five sets of three swings that the subject was able to touch the softball. No score was given if the ball touched the subject's hand.
Grouping the Subjects

After the data were collected, the subjects were divided into three chronological age categories. The categories were as follows: Group I, subjects who were seven and eight years of age; Group II, subjects who were nine and ten years of age; and Group III, subjects who were eleven and twelve years of age. In addition, each subject was included in the Total Group, which was utilized in the statistical analysis of this study.

Treating the Data

The data, for the total group, were analyzed to determine the relationship of the selected measures to gross motor performance, and to determine the best combination of variables for predicting gross motor performance. A further analysis was performed to determine if the variables for predicting gross motor performance for the total group were consistent for each age group.

The statistical procedures of multiple correlation and multiple linear regression were utilized to analyze the data. The statistical computations were performed at the North Texas State University Computing Center.
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CHAPTER IV

ANALYSIS OF THE DATA

The statistical analysis of the data collected during administration of tests to seventy-four educable mentally retarded subjects is presented in this chapter. These data include scores representing eleven variables for each of the participants in the study. The results of the analyses are then discussed as they contribute to answers to the research questions selected for investigation in this study.

The scores on the various tests were organized in such a manner that they could be subjected to specific statistical analyses. First, the results of the six subtests which constitute the gross motor performance scores for Groups I, II, III, and Total, are descriptively reported. This same procedure was followed for comparing the performance of boys and girls on the six subtests. Next, simple order coefficients of correlation were utilized to determine the relationship between each of the selected variables, except age, and gross motor performance. Third, the data for the Total Group were subjected to multiple regression analysis to determine the best predictors of gross motor performance without regard to age. The last statistical analysis was a test of homogeneity of regression equations. This regression
technique was employed to determine if more than one equation was necessary for predicting gross motor performance for the three age groups.

The nature of the research design required the use of a multiple regression technique which would accommodate several predictor variables being used to predict gross motor performance of three groups. In addition, a statistical technique for testing the simultaneous homogeneity of equations was required. For these analyses the techniques selected were those described by Bottenberg (1). The multiple regression procedure includes the computation of means, standard deviations, simple correlations (r), the variance accounted for by the multiple correlation (R^2), and an analysis of variance reported as an F ratio to determine the level of significance of each variable as a predictor. The .05 level of significance was selected for all statistical analyses.

Results of the Gross Motor Performance Subtests

Gross motor performance was determined by measures of body perception, gross agility, balance, locomotor agility, ball throwing, and ball tracking. The data are reported in raw score units. Five points was the maximum score for each of the tests and the total of the six scores constituted the gross motor performance score.
The means and standard deviations of the scores on each of the subtests and of the gross motor performance scores for each of the groups and for the total number of subjects are presented in Table I.

For Group I (seven and eight years) on gross motor performance, the highest score was 25 and the lowest was 12, with a range of 13. The mean was 16.47 and the standard deviation was 3.64. An examination of the six subtests shows that the ball throwing task, with a mean of .63, was the most difficult task for Group I. The low mean is the result of 12 of the 19 subjects scoring zero on this test. For Group II (nine and ten years), the highest score on gross motor performance was 28 and the lowest was 9, which resulted in a range of 19. The mean was 16.73 and the standard deviation was 4.44. Of the six subtests, gross agility produced the highest mean score of 3.85, while the ball throwing task resulted in the lowest mean of 2.00. For Group III (eleven and twelve years), the highest gross motor performance score was 25 and the lowest was 7, which resulted in a range of 18. The mean was 18.19, and the standard deviation was 4.10. Both body perception and gross agility provided the highest means of 3.80, while the ball throwing task resulted in the lowest mean of 2.23. For the Total Group (seven through twelve years) on gross motor performance, the highest score was 28 and the lowest was 7, which resulted in a range of 21. The mean was 17.08 and the standard
<table>
<thead>
<tr>
<th>Group*</th>
<th>Body Perception</th>
<th>Gross Agility</th>
<th>Balance</th>
<th>Locomotor Agility</th>
<th>Ball Throwing</th>
<th>Ball Tracking</th>
<th>Gross Motor Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>3.68 .58</td>
<td>3.84 .60</td>
<td>2.26 1.79</td>
<td>2.89 1.14 .63 .06</td>
<td>3.15 1.60</td>
<td>16.47 3.64</td>
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</tr>
<tr>
<td>II</td>
<td>3.55 .74</td>
<td>3.85 .60</td>
<td>2.55 1.46</td>
<td>2.55 1.25 2.00 1.34</td>
<td>2.20 1.45</td>
<td>16.73 4.44</td>
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<tr>
<td>III</td>
<td>3.80 .67</td>
<td>3.80 .60</td>
<td>2.80 1.50</td>
<td>3.19 1.53 2.23 1.54</td>
<td>2.38 1.16</td>
<td>18.19 4.10</td>
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<tr>
<td>Total</td>
<td>3.66 .68</td>
<td>3.83 .59</td>
<td>2.55 1.55</td>
<td>2.82 1.32 1.71 1.70</td>
<td>2.50 1.45</td>
<td>17.08 4.16</td>
<td></td>
</tr>
</tbody>
</table>

*Group 1, 19 subjects; Group II, 34 subjects; Group III, 21 subjects; Total, 74 subjects.
deviation was 4.16. The gross agility test provided the highest mean of 3.83, and the mean score of 1.71 on the ball throwing test was the lowest for the Total Group.

Table II contains the data on the six measures of gross motor performance for boys and girls.

An examination of the means for the six tests reveals that balance and ball throwing accounted for the major difference between the gross motor performance means for the two groups. The difference between these means was 2.59, of which 1.87 was accounted for by balance and ball throwing. Locomotor agility accounted for .42 of this difference. Body perception, gross agility, and ball tracking accounted for the remaining .30 difference in gross motor performance means. The boys' performance was equal to or greater than that of the girls on five of the six subtests.

Results of the Analyses of Variable Relationships and Predictors of Gross Motor Performance

Simple order coefficients of correlation were utilized to determine the relationship between each of the selected variables and gross motor performance. For these computations, the scores representing eye-motor coordination, figure-ground, form constancy, position in space, and spatial relationships are reported as a perceptual age in years; verbal and performance intelligence are reported as intelligence quotients. Sex and auditory discrimination are
### TABLE II

MEANS AND STANDARD DEVIATIONS FOR BOYS AND GIRLS ON EACH OF THE SIX SUBTESTS AND FOR GROSS MOTOR PERFORMANCE

<table>
<thead>
<tr>
<th>Group*</th>
<th>Body Perception</th>
<th>Gross Agility</th>
<th>Balance</th>
<th>Locomotor Agility</th>
<th>Ball Throwing</th>
<th>Ball Tracking</th>
<th>Gross Motor Performance</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Boys</td>
<td>3.66</td>
<td>.75</td>
<td>3.89</td>
<td>.56</td>
<td>2.92</td>
<td>1.44</td>
<td>3.03</td>
</tr>
<tr>
<td>Girls</td>
<td>3.67</td>
<td>.63</td>
<td>3.78</td>
<td>.64</td>
<td>2.17</td>
<td>1.59</td>
<td>2.61</td>
</tr>
</tbody>
</table>

*Boys, 38 subjects; Girls, 36 subjects.*
reported as dichotomies. For statistical analysis, sex was
coded with a value of 1 for males and 2 for females. Aud-
tory discrimination was coded with a value of 0 if there
were no auditory discrimination problems and 1 if there were
problems. Gross motor performance is reported in raw score
units.

For purposes of verbal discussion, the general classi-
fication for interpreting coefficients of correlation follows:
.00 to .20 denotes indifferent or negligible relationship;
.20 to .40 denounces present, but slight relationship; .40
to .70 denotes substantial or marked relationship; and .70
to 1.00 denotes high to very high relationship (2, p. 176).

Table III contains a correlation matrix indicating re-
lationships between gross motor performance and nine other
selected measures for the Total Group. Investigation of the
data in Table III reveals a negligible to low relationship
between gross motor performance and the selected measures.
Figure-ground (.02), form constancy (.13), position in space
(.14), spatial relationships (-.04), verbal (.17), and per-
formance (.12) show an indifferent or negligible relation-
ship with gross motor performance. The measures of eye-motor
coordination (.25), auditory discrimination (-.22), and sex
(-.31) show a present, but slight correlation with gross
motor performance. The inverse relationship associated with
the sex and auditory discrimination variables is a function
<table>
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<th>SD</th>
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<th>X3</th>
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<th>X5</th>
<th>X6</th>
<th>X7</th>
<th>X8</th>
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<td>17.08</td>
<td>4.14</td>
<td>.25</td>
<td>.02</td>
<td>.13</td>
<td>.14</td>
<td>-.04</td>
<td>.17</td>
<td>.12</td>
<td>-.22</td>
<td>-.31</td>
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<td>1.8</td>
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<td>Figure-Ground (X3)</td>
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<td>1.3</td>
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<td>1.3</td>
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<td>.9</td>
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<td>9.34</td>
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<td>Performance (X8)</td>
<td>74.23</td>
<td>12.71</td>
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<td></td>
</tr>
<tr>
<td>Sex* (X10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Dichotomized measures.
of the coding procedures utilized in the design. A positive relationship would result if the coding procedures were reversed.

The multiple linear regression techniques, as described by Bottenberg (1), were utilized to determine the best predictors of gross motor performance without regard to age. The first phase of the regression analysis involved ten steps in order to examine the proportion of variance accounted for by the combined nine variables and the unique contribution of variance accounted for by each variable. The unique contribution of each variable is the difference between two squares of multiple correlation coefficients ($R^2$'s). One $R^2$ was obtained for the regression model in which all predictors are used (referred to as full model), and the other $R^2$ was obtained from a regression equation in which each variable was deleted.

In step one, the full model was established. This model included the nine variables that follow: eye-motor, figure-ground, form constancy, position in space, spatial relationships, verbal, performance, auditory discrimination, and sex. The full model was tested to determine if its value as a predictor of gross motor performance was significantly different from zero. The full model $R^2$ was .2457, and the F ratio of 2.32 was significant at the .05 level of significance.
In steps two through ten, each variable was dropped from the full model to determine the unique contribution proportion of variance accounted for by each predictor variable. Table IV contains the order in which each variable was dropped from the full model, the $R^2$ values for each step, and the unique contribution proportion of each predictor variable. An examination of Table IV reveals that four variables accounted for the major portion of the total $R^2$ value. At step two, an $R^2$ of .2042 and a unique contribution proportion of .0416 resulted when eye-motor coordination was dropped from the full model. At step six, an $R^2$ of .1849 and a unique contribution proportion of .0608 resulted when spatial relationships was dropped from the full model. At step nine, an $R^2$ of .2012 and a unique contribution proportion of .0446 resulted when auditory discrimination was dropped from the full model. At step ten, an $R^2$ of .1899 and a unique contribution proportion of .0558 resulted when sex was dropped from the full model.

Eye-motor coordination, spatial relationships, auditory discrimination, and sex were selected, as a result of the unique contribution proportion accounted for by each, as the variables to be tested to determine if each contributes significantly to the prediction of gross motor performance. These four variables formulated a new full model which was tested to determine if it was significantly better than chance prediction.
<table>
<thead>
<tr>
<th>Step</th>
<th>Model</th>
<th>Predictor Variable</th>
<th>$R^2$</th>
<th>Unique Contribution Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Full Model</td>
<td>All nine variables</td>
<td>.2457</td>
<td>.2457</td>
</tr>
<tr>
<td>2</td>
<td>Full Model Minus</td>
<td>Eye-Motor</td>
<td>.2042</td>
<td>.0416</td>
</tr>
<tr>
<td>3</td>
<td>Full Model Minus</td>
<td>Figure-Ground</td>
<td>.2455</td>
<td>.0003</td>
</tr>
<tr>
<td>4</td>
<td>Full Model Minus</td>
<td>Form Constancy</td>
<td>.2438</td>
<td>.0020</td>
</tr>
<tr>
<td>5</td>
<td>Full Model Minus</td>
<td>Position in Space</td>
<td>.2409</td>
<td>.0048</td>
</tr>
<tr>
<td>6</td>
<td>Full Model Minus</td>
<td>Spatial Relationships</td>
<td>.1849</td>
<td>.0608</td>
</tr>
<tr>
<td>7</td>
<td>Full Model Minus</td>
<td>Verbal Intelligence</td>
<td>.2428</td>
<td>.0030</td>
</tr>
<tr>
<td>8</td>
<td>Full Model Minus</td>
<td>Performance Intelligence</td>
<td>.2457</td>
<td>.0000</td>
</tr>
<tr>
<td>9</td>
<td>Full Model Minus</td>
<td>Auditory Discrimination</td>
<td>.2012</td>
<td>.0446</td>
</tr>
<tr>
<td>10</td>
<td>Full Model Minus</td>
<td>Sex</td>
<td>.1899</td>
<td>.0558</td>
</tr>
</tbody>
</table>
In Table V, the regression analysis is presented for the four-variable full model and the significance of each variable as a predictor of gross motor performance for the Total Group. Step one established the full model which included four variables: eye-motor coordination, spatial relationships, auditory discrimination, and sex to determine if the full model was significantly different from zero for the prediction of gross motor performance.

The full model $R^2$ was .2251 and the $F$ ratio of 5.01 was significant at the .002 level of significance. The full model was accepted as being significantly better than chance for predicting gross motor performance.

In steps two through five, each variable was dropped from the full model to determine if the variable contributed significantly to the prediction of gross motor performance. At step two, eye-motor coordination was dropped from the full model. The $R^2$ was .1594 and the $F$ ratio of 5.86 was significant at the .02 level of significance. Eye-motor coordination was accepted as a significant contributor to the prediction of gross motor performance. At step three, spatial relationships was dropped from the full model. The $R^2$ was .1693, and the $F$ ratio of 4.97 was significant at the .03 level of significance. Spatial relationships was accepted as a significant contributor to the prediction of gross motor performance. At step four, auditory discrimination was dropped from the full model. The $R^2$ was .1702, and


<table>
<thead>
<tr>
<th>Step</th>
<th>Model</th>
<th>Predictor Variable</th>
<th>Degrees of Freedom</th>
<th>R²</th>
<th>Error Sum of Squares</th>
<th>F Ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Full Model Minus</td>
<td>All Four Variables</td>
<td>4,69</td>
<td>.2251</td>
<td>980.62</td>
<td>5.01</td>
<td>.002</td>
</tr>
<tr>
<td>2</td>
<td>Full Model Minus</td>
<td>Eye-Motor</td>
<td>1,69</td>
<td>.1594</td>
<td>1063.84</td>
<td>5.86</td>
<td>.02</td>
</tr>
<tr>
<td>3</td>
<td>Full Model Minus</td>
<td>Spatial Relationships</td>
<td>1,69</td>
<td>.1693</td>
<td>1051.25</td>
<td>4.97</td>
<td>.03</td>
</tr>
<tr>
<td>4</td>
<td>Full Model Minus</td>
<td>Auditory Discrimination</td>
<td>1,69</td>
<td>.1702</td>
<td>1050.16</td>
<td>4.89</td>
<td>.03</td>
</tr>
<tr>
<td>5</td>
<td>Full Model Minus</td>
<td>Sex</td>
<td>1,69</td>
<td>.1556</td>
<td>1068.55</td>
<td>6.19</td>
<td>.02</td>
</tr>
</tbody>
</table>
the F ratio of 4.89 was significant at the .03 level of significance. Auditory discrimination was accepted as a significant contributor to the prediction of gross motor performance. At step five, sex was dropped from the full model. The $R^2$ was .1556, and the F ratio of 6.19 was significant at the .02 level of significance. Sex was accepted as a significant contributor to the prediction of gross motor performance.

As a result of the initial low correlations between the nine variables and gross motor performance, a stepwise regression analysis was employed to substantiate the selection of the best predictor variables. In the stepwise approach, each variable is added to the regression equation, one at a time, according to highest predictive ability. In the stepwise approach, sex, auditory discrimination, eye-motor coordination, and spatial relationships were the first four variables added to the regression equation. The $R^2$ for these four variables was .2251, the $R^2$ for all nine variables, the full model, was .2457. The unique contribution proportion for the last five variables added was .0206. These five variables accounted for 2 percent of the variance which confirmed the original regression analyses.

To determine whether predictors of gross motor performance for the Total Group would be equally effective for each of the age groups involved an additional statistical analysis. This analysis involved a test of the homogeneity
of regression equations and was utilized to determine if more than one equation was necessary for predicting gross motor performance for the three age groups.

The regression equation for the Total Group included eye-motor coordination, spatial relationships, auditory discrimination, and sex as the four predictors of gross motor performance. These four predictors comprised the restricted regression model which was compared to a full model. The full model included the four predictors and the three chronological age groups. The full model was established to determine the interaction between chronological age at each of the three levels, and the four predictor variables. The full model, which represented the three age groups, the four predictor variables, and the interaction of age and the predictor, was compared to the restricted model to determine the homogeneity of the regression equations. The techniques presented by Bottenberg (1) were utilized to test the simultaneous homogeneity of the equations. The question was whether or not the same equation could be used to make predictions for the three age groups.

In Table VI, the results of the computations used in the comparative analysis of the two models are reported. The $R^2$ was .2859 for the full model and .2251 for the restricted model, with an $F$ ratio of 0.50. The $F$ ratio needed to reach the .05 level of significance with 10 and 59 degrees of freedom is 1.99; the significance level as indicated in
Table VI did not approach the .05 level of significance. Homogeneity was established as a result of no significant difference between the two regression models. It was accepted that age does not contribute significantly as a predictor and that only one regression equation would be necessary for predicting gross motor performance. The restricted model, which included the variables eye-motor coordination, spatial relationships, auditory discrimination, and sex was accepted as the model to formulate the equation for predicting gross motor performance of the educable mentally retarded.

To utilize the predictors, a regression equation was formulated. Table VII contains the data relevant to formulating the regression equation for the prediction of gross motor performance. The $R^2$ for the four predictors was .2251, which accounted for 22.5 percent of the variance. The $X$ weights are raw score weights rather than standard score weights. An examination of the $X$ weights in Table VII
TABLE VII

VARIABLES AND X WEIGHTS UTILIZED IN FORMULATION OF A REGRESSION EQUATION FOR PREDICTING GROSS MOTOR PERFORMANCE FOR THE TOTAL SAMPLE

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>X Weights</th>
<th>R²</th>
<th>Error Sum of Squares</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1 - Eye-Motor Coordination</td>
<td>0.6890</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>X2 - Spatial Relationships</td>
<td>-1.2102</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>X3 - Auditory Discrimination*</td>
<td>-2.0449</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>X4 - Sex**</td>
<td>-2.2756</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>24.0668</td>
<td>.2251 (Total)</td>
<td>980.62</td>
</tr>
</tbody>
</table>

*Auditory discrimination dichotomy code = 0 represents no problems and 1 represents problems.

**Sex dichotomy code = 1 represents males and 2 represents females.

shows that eye-motor coordination has a weight of .6890, spatial relationships has a weight of -1.2102, auditory discrimination has a weight of -2.0449, sex has a weight of -2.2756, and the constant weight established was 24.0668.

The techniques described by Bottenberg (1) were utilized in formulating the following equation for predicting gross motor performance:

\[
Y = 0.6890(X_1) - 1.2102(X_2) - 2.0449(X_3) - 2.2756(X_4) + 24.0668
\]
where:

\[ Y = \text{the predicted gross motor performance score}; \]
\[ X_1 = \text{eye-motor coordination score}; \]
\[ X_2 = \text{spatial relationships score}; \]
\[ X_3 = \text{auditory discrimination (dichotomy)}; \]
\[ X_4 = \text{sex (dichotomy)}. \]

In the equation, \( X_1 \) has a positive weight which adds to the predicted gross motor performance score, while \( X_2, X_3, \) and \( X_4 \) have negative weights which subtract from the predicted gross motor performance score. However, \( X_3 \) was dichotomized with a value of 0 if there were no auditory discrimination problems and 1 if there were problems. When these values are substituted into the formula, assuming the other three scores are the same for two individuals, the individual with no auditory discrimination problems would have a predicted gross motor performance score that would be 2.0449 points greater than that of the individual with auditory discrimination problems. An example is as follows:

\[-2.0449 \times 0 \text{ (no problems)} = 0\]
\[-2.0449 \times 1 \text{ (problems)} = -2.0449.\]

\( X_4 \) was a dichotomy with a value of 1 for males and 2 for females. When these values are utilized in the formula, assuming the other three scores are the same, a boy's predicted gross motor performance score would be 2.2756 greater than a girl's score. An example is as follows:
Summary of Findings

The findings of the study are reported in terms of contribution to answers to the following research questions:

1. What is the relationship of scores of gross motor performance to the following?
   
   (a) Visual perception of eye-motor coordination, figure-ground, form constancy, position in space, and spatial relationships.

   (b) Verbal intelligence and performance intelligence scores.

   (c) Auditory discrimination.

   (d) Sex.

   The findings indicate a negligible relationship between gross motor performance and figure-ground, form constancy, position in space, spatial relationships, verbal intelligence, and performance intelligence. The variables of eye-motor coordination, auditory discrimination, and sex showed a present, but slight correlation with gross motor performance.

2. What is the best combination of selected variables for predicting gross motor performance without regard to age?

   The results of this study show that the variables of sex, auditory discrimination, eye-motor coordination, and
spatial relationships were the most significant predictors of gross motor performance without regard to age.

3. Will the regression equation established for the total group be applicable for each of the three age intervals without a significant loss of predictive ability?

The regression equation for the Total Group was established as the equation for predicting gross motor performance. Homogeneity of regression equations was established which revealed that age did not contribute significantly as a predictor of gross motor performance.

4. The fourth question was related to the use of results of the investigation for developing guidelines, which may be utilized by educators in developing programs for the mentally retarded. These guidelines are presented in Chapter V.
CHAPTER BIBLIOGRAPHY


CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, GUIDELINES,
AND RECOMMENDATIONS

Summary

This study was an investigation of the relationship of selected abilities to gross motor performance of educable mentally retarded students at different chronological age levels.

The purposes of this study were

1. to investigate the relationship of sex and of selected abilities to gross motor performance. The selected measures were visual perception of eye-motor coordination, figure-ground, form constancy, position in space, and spatial relationships; verbal intelligence; performance intelligence; and auditory discrimination (gross motor performance was determined by measures of body perception, gross agility, balance locomotor agility, ball throwing, and ball tracking);

2. to examine the relationship of the selected abilities at different chronological age intervals in order to determine which measures best predict gross motor performance;

3. to develop guidelines for classroom teachers and physical educators who are involved in planning remedial programs for the retarded child.
The subjects were selected from seven special education classes during the spring term of the 1970-71 school year. The criteria established for the selection of participants required each subject to be classified as educable mentally retarded with no physical impairment, and within the age range of seven through twelve years. The seventy-four subjects included thirty-six girls and thirty-eight boys.

The instruments utilized were the Frostig Developmental Test of Visual Perception, the Wechsler Intelligence Scale for Children, the Wepman Auditory Discrimination Test, and the Gross Motor Performance Test. These tests were administered to all seventy-four subjects. The scores made by the subjects on each of these tests were organized in such a manner that relationships of the selected abilities to gross motor performance could be determined for each of three groups, divided according to chronological age, and for the total number of subjects.

The statistical technique of multiple linear regression was employed to answer the following questions:

1. What is the relationship of scores of gross motor performance to the following?

   (a) Visual perception of eye-motor coordination, figure-ground, form constancy, position in space, and spatial relationships, as measured by the Frostig Developmental Test of Visual Perception.
(b) Verbal intelligence and performance intelligence scores, as measured by the Wechsler Intelligence Scale for Children.
(c) Auditory discrimination, as measured by the Wepman Auditory Discrimination Test.
(d) Sex.

2. What is the best combination of selected variables for predicting gross motor performance without regard to age?

3. Will the regression equation established for the total group be applicable for each of the three age intervals without a significant loss of predictive ability?

Findings

Based on the statistical analysis of the data, the findings of the study for Questions 1, 2, and 3 are presented as follows:

1. It was found that a negligible relationship existed between gross motor performance and figure-ground, form constancy, position in space, spatial relationships, verbal intelligence, and performance intelligence. The variables of eye-motor coordination, auditory discrimination, and sex showed a present, but slight correlation with gross motor performance.

2. It was determined that eye-motor coordination, spatial relationships, auditory discrimination, and sex were
the best predictors of gross motor performance for the Total Group. The contribution of each of these variables as a predictor of gross motor performance was significant at greater than the .05 level of significance.

3. There was no significant statistical interaction between age, at three different levels, and eye-motor coordination, spatial relationships, auditory discrimination, and sex. Homogeneity of regression equations was established for the three age groups. The equation formulated for predicting gross motor performance follows:

\[ Y = 0.6890(X_1) - 1.2102(X_2) - 2.0449(X_3) - 2.2756(X_4) + 24.0668 \]

where:

- \( Y \) = the predicted gross motor performance score;
- \( X_1 \) = eye-motor coordination score;
- \( X_2 \) = spatial relationships score;
- \( X_3 \) = auditory discrimination (dichotomy);
- \( X_4 \) = sex (dichotomy).

Conclusions

Based upon the findings, within the limitations of this study, the following conclusions were drawn:

1. Eye-motor coordination, spatial relationships, auditory discrimination, and sex can be used as the most significant predictors of gross motor performance of educable mentally retarded students.
2. In terms of gross motor performance, the educable mentally retarded student, without auditory discrimination problems, tends to score higher than those with problems.

3. Boys, within the age range of seven through twelve years, tend to perform better than girls on gross motor performance tasks.

4. Age does not contribute significantly to the prediction of gross motor performance. However, it was observed during the administration of the six subtests that age appears to be a factor related to the performance of the ball throwing task.

Guidelines

The following guidelines have been developed as a part of this study. These guidelines are based on the review of the related research and the implications of the present study. The purpose of these guidelines is to assist classroom teachers and physical educators in planning better physical activity programs for the educable mentally retarded.

1. Programs for the retarded should be based on educational principles of effective teaching and learning. The physical education program should be coordinated with classroom experiences—these experiences should progress from the known to the unknown and from the simple to the complex.

2. The limited intellectual ability of the retardate should be considered in providing experiences that will
enable the individual to develop physically, mentally, emotionally, and socially. The mentally retarded are capable of learning gross motor skills when necessary practice is given. Motor ability should not be judged through the use of intelligence tests.

3. The student should be introduced to activities that emphasize total body movement which develop basic movement patterns before complex skills are taught.

4. Programs should be planned around the interests and abilities of the retarded child.

5. Instructions should be simple. The student should work on one aspect of a skill at a time. By working on a single phase of the skill, the student can place all of his mental efforts into performing this act, which should increase his chance for success.

6. Activities should be presented which require students to make simple decisions during the task; as improvement occurs, increase the demands on the child.

7. Programs should be designed so that each student can successfully perform and demonstrate skills to the class. Success enhances a child's confidence; the retarded child needs acceptance by others.

8. Activities should be presented that will expose the retarded child to a wide range of skills and games. Controlled body movement which will enable the student to relate
Recommendations

The findings of this investigation suggest the following recommendations for further research:

1. A similar investigation should be conducted with older retarded students to determine the relationship of age to gross motor performance.

2. A similar study should be conducted which compares the performance on each of the six subtests to the selected variables of this study.

3. Further investigations should be conducted using different perceptual- and gross-motor tasks.

4. It is recommended that studies should be conducted to determine the effect of gross motor training programs on the academic achievements of the educable mentally retarded.

5. More studies should be conducted to determine the best methods of teaching physical activities to the retarded.
APPENDIX A

EXPERIMENTAL EQUIPMENT

The equipment utilized in the administration of the gross motor performance tests was the following:

1. One white rubber air-filled playground ball, 8½ inches in diameter.

2. One green canvas-covered mat, four by six feet.

3. One white rubber softball, twelve inches in circumference, suspended from a white string fifteen inches in length.

4. A stopwatch.

5. A five-foot tape measure.

6. One-inch wide tan masking tape for marking lines on the mat and a piece of black oilcloth, two feet square, which was used as the ball throwing target.
APPENDIX B

DIRECTIONS FOR ADMINISTERING THE LOCOMOTOR AGILITY TEST

1. The subject began, after a demonstration, by standing at the end and mid-point of the four-foot side of the mat.

2. The subject then jumped with two feet at a time forward down the mat into six consecutive squares.

3. The subject then jumped forward down the mat, using only the unmarked squares of one row.

4. Next the subject jumped backwards down the mat, using both feet, and landing in all six squares. The subject was allowed to look backwards as he jumped.

5. The subject then hopped with both feet down the mat into six consecutive squares.

6. Finally, the subject hopped on one foot in the unmarked squares. Each hop moved him forward and from side to side.
APPENDIX C

TARGET AREA FOR BALL THROWING TEST

[Diagram showing the target area with dimensions and a restraining line.]
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