This dissertation has been
microfilmed exactly as received 70-6770

ELLIS, Anna Jane, 1930-
DEVELOPMENT OF TESTS TO MEASURE PERCEPTUAL-MOTOR
PERFORMANCE OF FIRST, SECOND, AND THIRD GRADE
CHILDREN.

The Ohio State University, Ph.D., 1969
Education, physical

University Microfilms, Inc., Ann Arbor, Michigan
DEVELOPMENT OF TESTS TO MEASURE PERCEPTUAL-MOTOR PERFORMANCE
OF FIRST, SECOND, AND THIRD GRADE CHILDREN

DISSERTATION

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

By

Anna Jane Ellis, B.A., A.M.

The Ohio State University
1969

Approved by

[Signature]
Adviser
Department of Physical Education
The child moves to learn as have all men before him . . . He moves and he perceives. He perceives and he moves. He is a perceptual-motor being. All of his learning is perceptual and all of his learning is motor. Only as we come to understand the remarkable complexity of his perceptual-motor unity, will we find ways to assist him to achieve the highest possible level of Movement Efficiency.”

- Barsch
ACKNOWLEDGMENTS

A great many people have given generously of their time and effort to make this study possible. Sincere appreciation is expressed to all of them whether or not they find their names written here.

For the wise counsel of Dr. Mordy, I am indeed grateful. It has been a privilege to have received her guidance throughout my doctoral program.

A special kind of inspiration has come to me as a result of my studies with Miss Allenbaugh. Her scholarship and her warm interest in people have stimulated me greatly.

The cooperation and helpfulness of officials, teachers, and boys and girls of the Oshkosh schools made the experimental work possible. It was a pleasure to work with them.

To friends, colleagues, and college students who listened, asked questions, and offered assistance as well as suggestion, I hereby acknowledge my gratitude. Their interest and enthusiasm increased my own determination to continue.

A special thank-you goes to my parents, who have continually given support for the effort needed to pursue not only advanced degrees, but self-fulfillment.
VITA

January 18, 1930
Born - Upper Sandusky, Ohio

1952
B.A., Ohio Wesleyan University, Delaware, Ohio

1952-1954
Physical Education Teacher, Dunedin Elementary School, Dunedin, Florida

1954-1959
Member of Elementary School Physical Education Staff, Shaker Heights Public Schools, Shaker Heights, Ohio

1959-1960
Teaching Assistant, Department of Physical Education for Women, University of Michigan, Ann Arbor, Michigan

1960
A.M., University of Michigan, Ann Arbor, Michigan

1960-1965
Supervisor of Physical Education, Buzzard Laboratory School, Eastern Illinois University, Charleston, Illinois

1966-1969
Assistant Professor, Department of Physical Education for Women, Wisconsin State University - Oshkosh, Oshkosh, Wisconsin

1969
Ph.D., The Ohio State University, Columbus, Ohio

PUBLICATIONS

FIELDS OF STUDY

Major Field: Physical Education
Minor Field: Developmental Psychology
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION AND STATEMENT OF THE PROBLEM</td>
<td>1</td>
</tr>
<tr>
<td>II. SURVEY OF RELATED LITERATURE</td>
<td>10</td>
</tr>
<tr>
<td>III. PROCEDURE</td>
<td>46</td>
</tr>
<tr>
<td>IV. ANALYSIS AND INTERPRETATION OF DATA</td>
<td>93</td>
</tr>
<tr>
<td>V. SUMMARY AND CONCLUSIONS</td>
<td>111</td>
</tr>
<tr>
<td>APPENDIX</td>
<td>118</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>126</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Reliability Coefficients for the Experimental Tests</td>
<td>94</td>
</tr>
<tr>
<td>2.</td>
<td>Mean and Standard Deviation for Angle Board</td>
<td>95</td>
</tr>
<tr>
<td>3.</td>
<td>Differences Between Group Means</td>
<td>97</td>
</tr>
<tr>
<td>4.</td>
<td>Mean and Standard Deviation for Hopping Over Lines</td>
<td>98</td>
</tr>
<tr>
<td>5.</td>
<td>Mean and Standard Deviation for Block Maze</td>
<td>100</td>
</tr>
<tr>
<td>6.</td>
<td>Mean and Standard Deviation for Log Roll</td>
<td>102</td>
</tr>
<tr>
<td>7.</td>
<td>Mean and Standard Deviation for Bowl Between Pins</td>
<td>103</td>
</tr>
<tr>
<td>8.</td>
<td>Mean and Standard Deviation for Balloon Tapping</td>
<td>105</td>
</tr>
<tr>
<td>9.</td>
<td>Intercorrelations of the Experimental Tests</td>
<td>106</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Angle Board</td>
<td>77</td>
</tr>
<tr>
<td>2.</td>
<td>Hopping Over Lines</td>
<td>78</td>
</tr>
<tr>
<td>3.</td>
<td>Block Maze</td>
<td>81</td>
</tr>
<tr>
<td>4.</td>
<td>Log Roll</td>
<td>84</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

Importance of this Study

Rapidly increasing knowledge about child growth and development and greater understanding of the interrelationships among perception, learning, and movement behavior have prompted many proposals for revision of the physical education curriculum for the elementary school child. One impetus for change has come from work being done with slow-learning children and others who exhibit various learning disabilities. Psychologists, educators, and some optometrists have noted with great interest certain relationships between perceptual abilities, motor activity, and scholastic success. Among the notable proponents of motor therapy programs are Kephart, Frostig, Delacato, Getman, and Kane. Although each of the remedial programs differs from the others in some respects, all of them include a set of motor experiences as a vital part of the therapeutic program. The apparent success of gross-motor training programs in ameliorating perceptual problems has raised many questions about the desirability of incorporating these techniques, or at least some of them, in the physical education program for all children. If gross-motor activity is an important factor in perceptual development, then no child should be deprived of such activity.
Another impetus toward revision has come from professional physical educators in this country and abroad who have focused their attention on the movement experiences to be included in the curriculum as well as the teaching approaches to be utilized. The programs focus upon the development of a core of basic movement skills which serve as a common foundation to the more specialized skills in sports, dance, and gymnastics. Through participation in carefully designed movement tasks, children are made aware of the infinite number of ways in which the body can move through space. The emphasis is upon the development of body management and control by learning to use the elements of movement (time - space - force - flow) properly. Integral to each lesson is the study of concepts which underlie the production of efficient movement. Each child is encouraged to develop, at his own pace, a wide variety of basic movement skills rather than to perfect any given group of specialized motor skills. The children achieve a freedom to move, unhampered by the need to concentrate on the mechanics of the movement itself. Children who are able to move freely and with abandon, can use their movement skills purposefully in achieving their objectives in work, in play, and in self-expression.

In addition to these two major influences upon the curriculum, there exists a general point of view which is supportive of changes both large and small. It stems from a widely held belief that elementary school children are capable of much more in terms of motor learning and performance than educators have realized. Indeed, many individuals have charged that the majority of elementary school children are not
being challenged sufficiently by the content of present programs. Children are capable of learning fundamental skills earlier; they are able to master complex skills at earlier ages; and they have neuro-muscular and physiological capacities which enable them to sustain their efforts over longer periods of time. The numbers of young boys and girls who have exhibited outstanding athletic prowess in a variety of activities is indicative that this position must be considered.

Whether one is primarily interested in children with learning disabilities, children who progress normally in school, or children who exhibit superior talents and abilities, the desire for change is present. Throughout education, the emphasis is upon the necessity for finding better ways to help children master fundamental concepts and skills. In each subject matter area curriculum designers are seeking to identify the key concepts and to design materials and teaching approaches which will promote the mastery of necessary skills and habits of thought.

The achievement of increased efficiency in voluntary movement is a goal of physical education programs. The elementary school curriculum is composed of movement experiences which require the child to organize sensory information and to make appropriate motor responses. Experiences in movement have both perceptual components and motor components. Each experience presents many challenges to the developing powers of the child. Successful performance depends upon the ability to perceive task requirements and to deal with these requirements through overt motor behavior. Barsch expresses it thusly,
"Movement efficiency is derived from the information the organism is able to process from an energy surround."

The crucial questions for curriculum designers are: What movement experiences provide greatest opportunity for improving perceptual-motor efficiency? At what age levels are these experiences of most value? What changes in perceptual-motor behavior result from various combinations of movement experiences? In which sequences should experiences be presented to achieve the purposes of the program. Should physical education programs include activities which are more specifically directed toward the development of certain perceptual skills and abilities? How shall we identify those children who require remedial help in certain areas of perceptual-motor functioning?

These and other questions can only be answered tentatively at the present time. Currently, evaluation of the effectiveness of educational and therapeutic programs is based upon observation and subjective analysis rather than upon less biased sources. In a discussion of implications for elementary physical education derived from current motor therapy programs, Smith states:

If, in fact, selected gross motor experiences increase a child's awareness of his own relation to the space around him and increase the objectivity of his perceptions of events and objects in his environment, it may be incumbent upon physical educators to include in their immediate purposes, for designing the elementary school physical education program, just such perceptual training goals. This would dictate subtle, but important, modifications not only in the physical education program itself but in the

---

control of the physical stimuli available in the environment. It is perhaps uneconomical and unproductive to continue to assume that motor performance is improved only by playing games, doing forward rolls, and performing the Danish Shoemaker's Dance. It is perhaps a propitious moment to begin designing valid and reliable test instruments to determine what youngsters are perceiving as well as continuing to measure the outcomes resulting from motor performance. We may find that those problems which we have assumed to be motor problems are not motor problems per se, but perceptual problems. If what one perceives affects voluntary motor responses, we probably need to be more concerned with perception than we have been in the past.2

Motor ability tests focus upon the measurement of motor achievement rather than upon what youngsters are perceiving. While the tests do require the individual to process information in order to complete the tasks, scoring is usually based upon a measurement of maximum output, such as the number of movements completed within a time limit, or the gross speed of the performance, or the maximum muscular effort displayed. Few tests take into consideration the differences among individuals in various aspects of body build such as height, weight, length and size of the body segments, and proportionate amount of muscle mass.

Current perceptual-motor screening tests have been designed for clinical use with children who have been observed to have some kind of learning disability. In many cases they are composed of pass-fail items or depend upon the judgment and personal observation of well trained test administrators. Tasks are designed to permit the observation of the child's functioning in several areas of perceptual-motor interest. While useful in making clinical observations, such tests do

not provide information about the level of perceptual-motor functioning of those children who do not require remedial programs.

Believing that it is indeed time for physical educators to begin designing valid and reliable test instruments to use in assessing the perceptual-motor status of all children in the elementary school, the writer proposed to design a test of perceptual-motor performance. In order to obtain more specific knowledge about the perceptual-motor capacities of young children, the test was to be focused upon the perceptual abilities of children as revealed in gross-motor tasks. The identification of varying degrees of perceptual-motor ability was the major purpose of the study.

Statement of the Problem

The purpose of this study was to establish a practical and valid method of determining perceptual-motor achievement among elementary school children, in tasks which have particular relevance to physical education, in order to gain more information about the learning process.

More specifically the sub-problems were:

1. To identify ways in which perceptual abilities are demonstrated in movement behaviors representative of physical education activities.

2. To select tasks based upon these behaviors which are suited to objective measurement.

3. To determine the interrelationships of measures, and the contributions of each measure to the concept of perceptual-motor achievement.
4. To ascertain the levels of perceptual-motor achievement, as measured by these tests, among a representative group of elementary school boys and girls.

**Basic Assumptions**

1. It is possible to define an abstract concept such as perceptual-motor achievement in behavioral terms. Further, the definition can be made specific enough to permit the generation of a number of behavioral objectives relevant to physical education programs.

2. Analysis of the behavioral objectives will yield examples of responses which can provide evidence of various aspects of perceptual-motor achievement.

3. Tasks based upon these responses can be selected which will reveal individual differences in several aspects of perceptual-motor functioning.

**Delimitations of the Study**

The investigator accepted the following requirements to be met by the tests:

1. Tests must require overt, gross-motor expression from subjects.

2. Tests must be interesting for young children.

3. Tests should employ tasks which are representative of movement experiences commonly included in physical education programs for elementary school children.
4. Tests must deal with perceptual abilities which are fundamental to performance in a wide variety of more specialized motor tasks.

5. Tests should permit accurate and objective scoring.

6. Tests should differentiate sufficiently between levels of achievement.

7. Tests should require materials which are commonly available.

Limitations of the Study

1. Subjects in the study were boys and girls in first, second, and third grades.

2. Subjects in the study were enrolled in Franklin Elementary School, Oshkosh, Wisconsin.

Terms and Definitions

The following terms and definitions were used in this study:

1. Gross-motor: An adjective referring to activities involving the total musculature of the body or large portions of it. ³

2. Movement behavior: Behavioral responses resulting in movements which are readily observed in contrast to responses which are relatively minute and which frequently require the use of complex instrumentation in order to obtain a record of performance.

3. Motor ability: Aptitude for learning and performing movement sequences involved in fundamental locomotor, non-locomotor, and manipulative skills.

4. **Perception**: A process by which stimulation is structured, and the result of a stimulation structuring process.\(^4\)

5. **Perceptual-motor achievement**: The ability to select, organize and respond overtly to sensory cues while engaged in voluntary movement.

---

CHAPTER II

SURVEY OF RELATED LITERATURE

Interest in perceptual-motor training programs has been increasing at a great rate of speed. This interest is reflected in the volume of published material concerning various aspects of the subject as well as the number of diverse professions involved. Study of perceptual and motor development is directed to both children and adults, normal and exceptional individuals.

The material presented in this chapter represents a selection of writings and researches which appeared to be most pertinent to the purpose of this study. In an attempt to identify basic areas of perceptual-motor functioning, the writer reviewed the following:

1. Tests which purport to measure one or more aspects of perceptual-motor function.

2. Motor development scales and motor achievement tests.

3. Studies dealing with relationships between perceptual abilities and motor performance.

4. The writing of theorists who hypothesize about the nature of perceptual-motor development.

5. Training tasks and the rationale for using such tasks in gross-motor and perceptual training programs.
The material which follows has been organized and presented in sections corresponding to the classifications indicated above.

Tests of Perceptual-Motor Function

Surveys which purport to assess certain aspects of perceptual-motor functioning have been designed by several individuals and groups. To date, efforts have centered primarily upon the identification of children who exhibit deficiencies in functioning. Gross-motor tasks which require the individual to integrate sensory and motor inputs are used as clinical instruments to observe and to rate the individual's performance.

A perceptual survey rating scale published by Kephart in 1960, includes motor tasks designed to reveal the perceptual-motor performance of children six to nine years of age. The examiner must be familiar with examples of inadequate performance in balance and postural flexibility, knowledge of the body and how to control its parts, laterality, directionality, making spatial-temporal translations, visual-motor coordination, form perception, ocular control in pursuing visual targets, general postural and gross-motor coordination. Directions are given for rating performance in the following tasks:

1. Walking Board. Walking forward, backward, and sideward on a wooden beam four inches wide.

2. Jumping. Controlling the body in symmetrical, asymmetrical, and alternating activities.

---

3. Identification of Body Parts. Pointing to parts named by the examiner.

4. Imitation of Movements. Observing and repeating the movements of the examiner's arms.

5. Obstacle Course. Moving over, under, and between objects.


7. Stepping Stones. Eye-foot coordination under conditions which demand irregular performance.


9. Ocular Pursuits. Control in following the movement of visual targets.


Later, Roach and Kephart\(^2\) collaborated in publishing a revision of the survey. The primary purpose was to present normative data obtained on school children in grades one through four, and to give instructions for administering and scoring the items in the survey. Eleven sub-tests consisting of twenty-two scorable items were grouped into three major sections: laterality, directionality, and skills of perceptual-

motor matching. According to the authors, "these three constructs play a definite role in perceptual-motor development." The authors advocate its judicious use in detecting qualitative errors in perceptual-motor development. They point out that the survey is not a test, and at its present level of development, should be regarded as an instrument which allows the examiner to observe a series of perceptual-motor behaviors and to identify areas which may require further study. For each item, the child's performance is rated numerically from one to four in accordance with specific behavioral criteria.

Members of the elementary physical education staff of the Pontiac, Michigan public school system, published a manual describing a perceptual-motor screening test to be used as part of an extensive series of diagnostic procedures in the area of physical development. The test utilizes many of the Kephart items, and adds informal observations in ball throwing, catching, bouncing, rolling, and kicking.

The Marianne Frostig Developmental Test of Visual Perception contains items designed to establish levels of performance in five

---

3 Ibid., p. 3.
4 Ibid., p. 11.
areas: perception of position in space; perception of spatial relationships; perceptual constancy; visual-motor coordination; and figure-ground perception. Results of testing 1800 pre-school and school children showed a definite age progression from three to seven and one-half years but little after that. The items are paper-and-pencil tasks.

In a factor-analytic study of perceptual-motor dysfunction in six and seven-year-old children, Ayres utilized a battery of thirty-six tests dealing with aspects of sensory perception, motor activity, and selected areas of cognitive function. Three of the Frostig sub-tests as well as a number of items developed by Ayres to measure motor accuracy, kinesthesia, manual form perception, finger identification, graphesthesia, and localization of tactile stimuli were included in the analysis. The study was undertaken in an attempt to identify basic areas of perceptual-motor dysfunction. Five syndromes characteristic of dysfunction were hypothesized as follows:

1. Developmental apraxia, distinguished by deficits in motor planning, tactile perception, and finger identification.

2. Tactile, kinesthetic, and visual perception dysfunction in form and position in space.

3. Tactile defensiveness demonstrated by hyperactive, distractible behavior, faulty tactile perception, and defensive responses to tactile stimuli.

4. Deficit of integration of two sides of the body, identified by difficulty in right-left discrimination, avoidance in crossing the mid-line, and incoordinate bilateral hand movements.

5. Deficit of visual figure-ground discrimination.

Tests of Motor Proficiency and Motor Development Scales

Studies of the development of common locomotor and ball-handling patterns have been summarized by Espenschade and Eckert. Both the period of early childhood, extending roughly from ages two through six, and the period of later childhood, ages six through twelve, were discussed. Early observational studies of children at play as well as the more precise techniques of cinematographical analysis provided basic information about stages in progression from rudimentary patterns to more mature, mechanically-efficient performances. Skills of walking, running, climbing, jumping, hopping, skipping, galloping, kicking, throwing, catching, ball bouncing, striking, swimming, and balancing were described.

Direct reference to the studies cited yielded interesting information concerning the motor tasks utilized by the various researchers in eliciting the desired patterns. Also of interest was the listing of criteria used in rating performance, and the scoring techniques employed in objective tests of skill. In some studies, the authors made interpretive statements regarding the possible contributing factors in the

---

successes and failures of subjects, which provided insight into the perceptual as well as the motor requirements of various tasks. Information gleaned from studies cited by Espenschade and Eckert was selected by the writer as particularly significant to the purpose of this study, and presented here.

In 1937, Wellman\(^9\) reported the achievements of ninety-eight pre-school children, aged two through six on common motor tasks. Twenty-three tasks were performed by the children in the following areas: ascending and descending steps and ladders; ball throwing, catching, and bouncing; jumping from various heights; hopping, skipping, and walking in straight and circular paths. The tasks were scored in reference to the method used by the child to accomplish the task. Motor age norms were provided for seventy-three stages of development. Although many of the tasks used in this study were accomplished by most of the children before age five, the following facts reported by the author and summarized below seemed pertinent to this investigation.

1. Hopping on one foot was more difficult than making a two-foot takeoff and landing. The number of consecutive hops the children were able to accomplish increased with age.

2. Three stages in skipping were observed: shuffle; skip on one foot; alternate feet. By age five and one-half, half of the children had mastered the art of skipping by alternating the feet.

3. Stages in jumping from heights were: jumping with help; jumping alone with one foot ahead of the other; and jumping alone with feet together. Children who had accomplished the superior method on low heights, reverted to inferior methods at higher levels.

4. In catching, the superior method of advancing both hands to meet the ball was beyond the six year level in motor age. The superior method was used with a larger ball earlier than with a smaller ball.

Analysis of these tasks reveals the fact that they require many perceptual-motor skills which appear to be important to a child's functioning, such as: recovery and maintenance of balance; visual-motor coordination; manipulative efficiency; use of both sides of the body in alternating action; awareness of and ability to utilize space behind the body.

Wild identified four stages in the evolution of the throw from an immature pattern to a mature pattern typical of the adult. According to the author, "the outstanding trend disclosed by the movement types is to change from movement in the anteroposterior plane to movements largely in the horizontal plane, and from an unchanging base of support to a left-foot-step forward." In conclusion, she stated simply that the "development of the basic pattern seems to depend upon the development of neuromuscular powers, as equilibration and orientation."

---


11 Ibid., p. 22.

12 Ibid., p. 24.
Gutteridge\textsuperscript{13} noted that even at age six, only eighty-four percent of the children could be rated as proficient in throwing ability.

An early test of dynamic balance developed by Bass\textsuperscript{14} was named the Stepping Stone Test. Subjects were required to leap and land in a series of ten small circles arranged in a prescribed pattern. Scores were computed on the basis of the number of seconds the individual could maintain balance (up to a maximum of five seconds) in each circle without committing errors in overstepping the boundaries.

Seashore\textsuperscript{15} reported the development of a beam-walking test as a measure of dynamic balance in children and adults. Subjects were required to walk ten consecutive steps heel-to-toe, with hands placed upon the hips. A series of beams, ranging in width from one-fourth inch to four inches, provided progressively more challenging balance tasks. Subjects were instructed in the method of walking heel-to-toe, and allowed to practice on the floor. They began on a beam which was wide enough to permit them to have success, and then proceeded to narrower beams. The test was scored according to the zone in which the second "fall-off" occurred.

\textsuperscript{13}Mary V. Gutteridge, "A Study of Motor Achievements of Young Children," \textit{Archives of Psychology}, XXXIV, No. 244 (1939), pp. 5-178.


Penman designed a device which measures dynamic balance ability, the "dynabalometer." It consists of a circular platform connected to the base by means of a ball-and-socket joint, allowing motions forward, backward, laterally, in rotation, and any combination of these. Validity studies were made by correlating performance on the dynabalometer with scores on other tests measuring balance, and with a balance complex consisting of an accumulated score received on six tests of balance. The author states, "Although intercorrelations between the balance tests were low (.13 to .44), the dynabalometer had higher correlations with other tests than any other single testing device with the rest of the tests. Scores received on the dynabalometer correlated .87 with the total balance complex scores." Due to the nature of its design, the device will accommodate subjects of various sizes. The task is simple enough so that small children can receive a score as well as poorly skilled and highly skilled adults.

Various researchers have been interested in measuring components which are thought to be basic to the performance of a wide variety of motor skills. Brace designed a battery of stunt-type items which he believed were graded in terms of difficulty. The twenty items were selected to measure control, balance, agility, and flexibility. Of

---


17 Ibid., p. 234.

positive value is the fact that the test is fairly objective and reliable, and that it has been shown to measure abilities which are only slightly related to height or weight. Several drawbacks exist. Items are scored on a pass-fail basis. Some individuals are able to pass all the tests in the battery, making it inadequate for individuals of superior ability. Many of the items are commonly included in a stunts and tumbling program, thus testing the learning and achievement of some children while presenting novel tasks to others. The Iowa revision of the Brace test utilizes only half the number of items. The Brace test and the Iowa-Brace have been widely used with children above the fourth-grade level.

In 1942, Vickers and associates adapted the instructions and the test items of the Brace Scale of Motor Ability so that it could be used with children five through nine years of age. Sixteen test items of the stunt-type recommended by Brace were scored on a six point scale based on the experimenter's rating of the child's attempt to perform. Three variables were found to be related to motor ability as measured by the Brace Scale. A high score of motor ability was associated with good abdominal muscles and high intelligence, and found to be inversely related to obesity. The authors noted that the younger children "revealed an amazing ignorance as to the meaning of various parts of the body. Knees, elbows, chest, and heels all had to be pointed out repeatedly." 

---

20 Ibid., p. 300.
In 1932, Johnson designed a series of tests in an attempt to measure "native neuromuscular skill capacity." Believing that the existing physical skill tests did not measure skill in general, but rather specific skills, he sought to eliminate "all exercises which involved any pronounced elements of strength, speed, endurance, fear, familiarity, strangeness, or practice." The ten exercises which he selected involved various methods of locomotion performed within the boundaries of a rectangular grid for a distance of fifteen feet. Three of the tests specified the performance of tumbling skills while the remaining seven involved jumping, hopping, and making directional changes in the air. Errors, including failure to maintain the hands-on-hips position, lack of rhythm, and over-stepping the bounds, were subtracted from a maximum score of ten for each of the tests. Johnson reported that the test had been given to pupils of both sexes and ages, ranging from eleven to thirty-eight years, and that neither age nor physical size appreciably affected the functioning of the test.

Carpenter designed a battery of motor tests for children in grades one through three. Items included six Brace-type tests; five Johnson-type tests; grip-strength tests; Burpee test; Sargent jump; and a variety of other running, jumping, and throwing tasks. With the exception of the Johnson-type tasks, the items were scored for maximum

\begin{footnotesize}

\bibitem{Ibid.} \textit{Ibid.}, p. 129.

\end{footnotesize}
motor output in terms of strength, speed, or distance. The five Johnson-type tests were scored according to Johnson's directions, focusing upon the accuracy with which the individual performed and his ability to maintain a rhythmical form of locomotion. Tasks necessitated the use of a modified form of the rectangular pattern designed by Johnson, and included: single hop left; diagonal hop; backward hop right; left sideward hop; and right sideward hop. Perceptual-motor skills involved in the performance of these tasks appeared to include: balance and postural flexibility; motor planning; appropriate use of force and time in projecting the body through space; visual-motor coordination; ability to repeat basic locomotor movements rhythmically; and ability to perform movements in different directions.

The Scott Motor Ability Battery has been widely used with high school girls and college women. It is based upon the concept that general motor ability reflects the combined influence of native capacity and achievement due to experience. Scott lists the following requirements for this type of test battery.

1. It is necessary to have unusual situations or motor acts relatively new to the subjects.

2. Students should not practice on the test as such.

3. It is essential that students be given a clear idea of the problems presented by the test. However, the explanation should not include specific coaching or instruction on techniques to be used.

4. Principal activities in the physical education program should be analyzed for the skills that they have in common. For example, balance and weight control, eye-hand coordination, strength, agility, and speed are more or less essential to all activities. The tests should be set up to include as many of these as possible.
5. Tests combining more than one element in a significant way should be used when possible.

6. Parts of the test should give opportunity to demonstrate skill developed by those who have worked hard previously.

7. The tests should not put undue emphasis on endurance, strength, or any other one factor.

8. The battery should have some variety in the skills represented so that the results are at least partially indicative of the strengths and weaknesses of the students.24

Items included by Scott were: obstacle race; basketball throw for distance; standing broad jump; wall pass; and dash. An analysis of these items revealed the following requirements: ability to remember verbal directions; adjusting mentally and posturally for the next movement while in the act of performing a preceding movement; control of body weight and posture; total body coordination; judgment in the use and control of force and speed in moving one's own body through space, and in propelling objects; eye-hand coordination; understanding of the resultant movement caused by throwing a ball against a wall; and perceptual speed, including speed of reaction.

Motor ability tests for elementary school boys and girls have been designed to include tasks in running, throwing, and jumping. Latchaw25 utilized seven tasks in running, jumping, ball throwing, striking, and kicking to measure the motor abilities of boys and girls


in grades four through six. The ball-handling tasks required accuracy in propelling balls toward a target as well as ability in judging and recovering rebounding balls.

Magnusson proposed five tasks in ball handling, jumping, running, and balance as a motor ability supplement to a battery of muscular fitness tests. Children in the first and second grades were tested on their ability to control a ball by means of a ball bouncing task, while older children were required to volley or to throw and catch, using the wall as the rebounding surface. Other tasks were standing broad jump, obstacle race, throw for distance, and a measure of static balance without vision.

In a factor-analytic study of motor coordination variables, Cumbee et al. administered twenty-three items that had been used to measure some aspect of motor coordination. Subjects were ninety-two third and fourth grade girls. Nine factors were extracted. Five of the factors were identified as follows: balancing objects; total body quick change of direction; speed of change of direction of arms and hands; body balance; and vertical total body quick change of direction.

Many investigators have been interested in body awareness as an essential component of ability in performing motor tasks. Scott's study of kinesthesis was undertaken in an attempt to define kinesthesis.

26 Scott and French, pp. 386-89.


and to structure tasks which could give objective measurement of the various facets of kinesthesia. Items in the trial battery represented the various components of kinesthesia as follows: ability to repeat muscle contractions with a force identical to that which one had just exerted; ability to put the arms, legs, and trunk in positions prescribed by visual or oral cues; balance and weight control; manipulative precision with the hand; orientation in space; and the ability to imitate promptly a simple coordination which had been demonstrated.

Scott's analysis of the data led to the conclusion that kinesthesia is highly specific to the various areas of the body, and that there is no single test which can be used to measure kinesthesia as yet. Many of the tasks used by Scott were to be done with the eyes closed, thus eliminating the visual sense. A test of dynamic balance, Sideward Leap, presented an interesting variation of the Bass Stepping Stone task.

According to Scott, "acuity of kinesthesia is closely related to general motor ability as we have defined it. The person who perceives his own efforts, positions, and motor adaptations, and has developed empathy for observing movement of others will learn quickly and perceive motor problems readily." 29

Witte 30 studied the relation of kinesthetic perception to a selected motor skill for elementary school children. Four measures of arm-positioning and two measures of ball-rolling provided the basis for study of the performance of first and second grade boys and girls. The

---


results of the study indicated that: (a) there is no significant relationship between ball rolling and positional measures of kinesthesis; (b) there are no real differences between boys and girls in their ability to accurately repeat positional measures of kinesthesis; and (c) boys are significantly superior to girls in their ability to manipulate accurately large and small balls, as measured by the tests used in this study. All tests were found to be highly reliable.

An interesting test from the standpoint of the uniqueness of the items is the Oseretsky scale, published in 1925. The scale which originally contained eighty-five items has been extensively revised by Sloan, and now contains thirty-six items. It is known as the Lincoln-Oseretsky Motor Development Scale. The test is highly reliable, requires a small amount of commonly-available equipment, and includes motor activities that are interesting to boys and girls from six through fourteen years of age. Oseretsky designed the tasks to reveal performance in six areas of functioning which he named general static coordination; dynamic manual coordination; general dynamic coordination; speed of movements; ability to perform simultaneous movement (with more than one extremity); and absence of synkinesia (or superfluous side movements). In Thompson's opinion, the scale "taps some of the more complex aspects of motor coordination and skills ... and will prove to be useful in research and in evaluating the motor development of children.

recovering from orthopedic handicaps or children undergoing special programs of remediation or enrichment in motor skills. ³²

In a recent factor-analytic study of the Lincoln-Oseretsky test, Vandenberg³³ identified eight factors among the thirty-six items. Inspection of the tests and their loadings on various factors indicated that the original six components set forth by Oseretsky are not independent. In discussing the results of his analysis, Vandenberg noted the existence of two factors which resembled some neurological tests. Items required behavior which alternates from the right to the left hand or foot, and the ability to touch various parts of the body quickly and accurately with and without visual inspection. Other factors were related to precise control of large muscle groups, dynamic control of the whole body, speed, and balance.

Kiphard and Schilling³⁴ developed a skill test to determine deficiencies in movement coordination of the body. The battery was developed as a diagnostic tool for use with healthy children of five through twelve years of age who had been referred to the Westfälisches Institut für Jugendpsychiatrie und Heilpädagogik, in Hamm, Germany.


³⁴Ernst J. Kiphard and Friedhelm Schilling, "Hammer Geschicklichkeitstest: in der Modifizierung nach F. Schilling (Marburg)," (Wisconsin State University - Oshkosh: Lectures sponsored by the Departments of Special Education and Women's Physical Education, March 17, 1969), (Mimeographed).
Six items presented the child with motor tasks of total body coordination, balance, and eye-hand coordination. The tests, with brief descriptions, follow.

1. Adaptability of the upper extremities. Tap a balloon with a spoon, keeping it in the air.

2. Dynamic balance of the lower extremities. Maintain body balance on one foot after jumping down from a height.

3. Body balance. Walk forward and backward on balance beams of three different widths without touching the ground.

4. Dynamic energy of the lower extremities. Hop forward on one leg for a short distance, hop over a small obstacle, and continue hopping.

5. Quickness of alternating movements. Jump sideways, going over a fifty cm. pole on the floor, making as many changes as possible in fifteen seconds.

6. Quickness of moving self and objects. Move across the floor as far as possible in thirty seconds by stepping from one box to another, standing on one box while picking up and placing a second box.

According to Kiphard, a factor-analytic study of the test revealed the fact that all of the items except the balloon task were represented by one major factor which was identified as total body coordination.

---

Ibid.
Perceptual Abilities and Motor Performance

Recent studies have dealt with the relationships between various perceptual abilities and performance in gross-motor tasks. Doudlah studied the perceptual-motor performance of kindergarten children with low scores on selected physical tasks. Seven motor tasks, known as the Experimental Classification Tests for Kindergarten, were administered as an adequate basis on which to determine physical education readiness. Two of the items, Ball Kicking, and Bounce and Catch, were chosen by the author to select subjects for the study. In analyzing the tests, Doudlah concluded that these two items made the most varied perceptual-motor demands upon the children. Thirty children, judged to be low in motor performance were given a perceptual-motor function battery devised by Ayres. Comparisons made between the fifteen children with the highest and the fifteen children with the lowest motor performance scores yielded statistically significant data in support of the following assumptions:

1. The performance of kindergarten children who do poorly on motor tasks did serve as an index of certain types of perceptual-motor dysfunction as measured by the Ayres battery.

2. Low motor performance and perceptual-motor dysfunction may not show a direct relationship unless motor items are carefully scrutinized in terms of their perceptual-motor demands.

3. Sex differences in motor performance must be considered in the design of a diagnostic motor performance battery.

---

4. Low motor performance in kindergarten children may be most suggestive of developmental apraxis as described by Ayres.

5. Early identification of the child with perceptual-motor dysfunction is essential. The trend demonstrated by these data indicated an increase in deficit with age.

6. Influences resulting from developmental lag and deprivation must be considered in evaluating the perceptual-motor performance of young children.

7. It is reasonable to assume that a battery of motor items for the purpose of identifying perceptual-motor dysfunction in kindergarten children can be designed.37

Doudlah recommended that a battery of three to five motor items be developed to use in identifying children with perceptual-motor dysfunction. She indicated that the battery must include the components of balance, visual-motor tasks, tactual inputs, and integration of two sides of the body. Her suggestions for motor tasks included rebounding a ball against a wall, walking on a two-inch board, leaping from one foot to the other, guiding a ball through obstacles by means of a stick, and sorting objects while blindfolded.

In a pilot study, Painter38 investigated the effects of a rhythmic and sensory-motor activity program on perceptual-motor spatial abilities of kindergarten children. The training program was designed to implement Barsch's constructs concerning the need for a space-oriented curriculum. Items from the Purdue Perceptual-Motor Survey and the Beery Geometric Form Reproduction tests were used to assess performance in

---


perceptual-motor integration, body image, and psycholinguistic competence. All hypotheses for gains were tentatively confirmed.

McCormick et al. 39 compared the improvement in reading achievement made by three groups of first-grade children who participated in a perceptual-motor training program, a regular physical education program, and no additional training. The perceptual-motor training group made significantly greater gains than the other two groups. The perceptual-motor group participated in cross-lateral crawling and walking, balancing, and rope jumping. Attention was given to the use of proprioceptive cues during early training, with later visual control over performance. Progressions were from control of gross musculature to control of fine musculature. The regular physical education group participated in Squirrels in Trees, Hokey Pokey, simple dodgeball, tumbling, rope jumping, throwing and catching skills, locomotor skills to rhythm, and relays. In the authors' opinions, the improvements of the perceptual-motor training group were due largely to the emphasis, during training, on listening, looking, and focusing attention—all components of self-control.

In a study of relationships between children's body image boundaries, estimates of dimensions of body space, and performance of selected gross motor tasks, Woods 40 utilized tasks which were


representative of physical education activities. Subjects were boys and girls, aged eight, ten, and twelve. The tasks were:

1. Catching-Throwing. Manipulating a ball, using a wall as the rebounding surface.

2. Target Jump. Broad jumping to specified lines with accuracy.


According to Woods, these particular tasks were selected "because the nature of each task represented a different organization and manipulation of space, force, and time factors." The jumping task required the children to use the broad-jumping technique, landing on target lines which were well within the distances which could be achieved by all subjects. Inasmuch as the factor of strength was minimized, the problem became one of matching accurately the perception of distance and other spatial factors with an appropriate expenditure of effort. The task presented a unique example of motor planning while eliminating the need for a scoring procedure based upon the measurement of maximum output.

Keough and Oliver used six motor performance tests to identify a group of ten physically awkward boys for clinical study. The

---

41 Ibid., p. 97.

six tests were beam balance, beam walk, fifty-foot hop, standing broad jump, alternate foot hopping, and simultaneous foot-finger tapping. Subjects were educationally subnormal boys of nine and ten years of age. During a subsequent instruction program, six training tasks were used which required rhythmical use of limbs in various ways and involved gross use of the total body in a standing rather than a sitting position. The following noticeable performance difficulties were observed: slow and deliberate movements; total response without control of force and speed; inability to perform a prescribed rhythmical count; and inability to perform a task on one side of the body. The authors suggested that these observed difficulties may represent basic areas of perceptual-motor functioning which are essential to the performance of a wide variety of motor tasks.

As a means of investigating bilaterality among elementary school children, Curran tested the jumping and rolling performance of fourth-grade boys and girls. Subjects were required to jump repeatedly on a trampoline, landing in the same space each time. The rolling task was to roll from stomach to back in a straight line along the floor. Each of the tasks presented problems in orienting the body to the pull of gravity, and maintaining alignment by equalizing the thrusting movements of the two sides of the body. None of the sixty-five children in the study was able to perform a non-deviating roll. One-third of the children were able to correct their body positioning to the midline of the body.

rolling path. Two-thirds of the children were unable to coordinate their bodies to return to the midline. Among the total group, fully thirty-six percent were classified as erratic, displaying totally inconsistent patterns of rolling from one trial to the next, and lacking the ability to return to the midline even though they had visual reference points as guide lines, and tactual clues to aid their performance.

In jumping and landing on the trampoline, ninety-five percent of the group deviated significantly from the canvas mid-point. The findings were unrelated to sex, handedness, or trampoline sophistication.

Results of statistical intercorrelations between all aspects of the jumping task and the rolling performance indicated that the rolling task was statistically significant within its individual variables, but there was a lack of statistical significance within the jumping variables. Rolling performances apparently could not be predicted by the trampoline performances. The two skills should not be used interchangeably in evaluation. According to Curran:

only rolling has resulted as a significant test of bilaterality. This study suggests that because rolling is a more familiar task, the many involved variables of the skill are exposed. In jumping on the trampoline there are many pertinent factors that must be better evaluated in order to determine the bilateral relationship of the two skills. There are many additional variables that are involved in jumping on a trampoline that are not present in regular jumping tasks such as the broad jump and the standing jump. A lack of significance of the trampoline performance may have resulted because of inadequate definitions of the variables.44

44 Ibid., p. 62.
Oxendine\(^{45}\) studied the degree of generality and specificity in the learning of fine and gross motor skills. Junior high school students practiced mirror-tracing, a pencil maze, disc tossing, and a hopscotch-type skill. The two gross-motor tasks contained interesting requirements. Disc toss required the subjects to sling or "toss" a shuffleboard disc along the floor into a circular target area by rebounding the disc off the wall. The skill involved making a judgment regarding the angle of rebound as well as accuracy in pushing the disc for direction and degree of force. The hopscotch-type test required speed and precision in gross bodily movement in reproducing a prescribed pattern. Subjects hopped through a pattern consisting of twenty boxes, alternating feet to prevent fatigue and making directional changes in the air. Errors were moving into an incorrect box, stepping on a line, or allowing both feet to touch the floor at the same time. The score was obtained by adding the speed score and the error score.

Vincent\(^{46}\) studied the transfer effects between motor skills judged to be similar in perceptual components. The purpose of the study was twofold: (1) to investigate the value of analyzing tasks into their perceptual components and motor components, and (2) training for a criterion motor skill by developing first a high competence in its perceptual components through the use of practice tasks which were


similar to the criterion in perceptual components, but not similar in motor components. Subjects were college students. The criterion tasks were a beam balance test of static balance and a novel jump board test in which the individual was required to employ both speed and accuracy in following a pattern of footprints painted on a rectangular board. Elements of the task included the use of both one-foot and two-foot take-offs and landings as well as the ability to perform various directional changes in the air. The practice tasks included beam-balancing on various parts of the body and a manual task in which the subject was required to use both hands in following a pattern of dots printed on a sheet of paper. Results of the investigation substantiated the hypothesis that practice in performing the perceptual components of a task would assist the subject in performing another task which contained similar perceptual components but different motor components.

Although the author did not report the details of his analysis of the perceptual components of the jump board test, it appeared obvious that successful performance depended upon abilities which have been cited by various authors as basic areas of perceptual-motor functioning. These functions include: dynamic balance; use of the two sides of the body simultaneously and in alternation; control of force and speed; visual guidance of the extremities; ability to visualize the body's position in space and to use the various dimensions of space; and ability to translate a visually-perceived pattern into a sequence of motor acts.
Theories of Perceptual-Motor Development

Efforts have been made by various theorists to identify and to classify basic perceptual-motor abilities, and to hypothesize about the course of development of these functions. Summaries of the writings of individuals whose works have had particular influence on the writer's orientation to perceptual-motor achievement follow.

One of the most useful theories for this study was set forth by Barsch in his book entitled, Achieving Perceptual-Motor Efficiency: A Space-Oriented Approach to Learning. A summary of that theory follows.

The goal, movement efficiency, involves all facets of human functioning, and refers to movement or progress in social, emotional, and cognitive spheres as well as physical development and motor performance. Because movement occurs in space, all of the exploratory experiences of man are considered to be part of his space-oriented curriculum. Thus, the perceptual-motor-cognitive achievement of human beings is the product of learning experiences which are characterized by movement in one or more of the domains of space.

The term, "movigenics," is used to describe Barsch's theory of movement as it relates to learning. In explaining the term, he states:

The name resulted from combining two Latin words, movere - "to move" - and genesis - "origin and development." It is, therefore, the study of the origin and development of patterns of movement in man and the relationships of those movements to his learning efficiency. Its constructs and assumptions have application to the understanding of human behavior at all ages and in all circumstances. 48

---

47 Barsch, pp. 1-365.
48 Ibid., p. 33.
The theory is based upon a set of ten constructs which deal with the process of human development in terms of movement, as follows.

1. The fundamental principle underlying the design of the human organism is movement efficiency.

2. The primary objective of movement efficiency is to economically promote the survival of the organism.

3. Movement efficiency is derived from the information the organism is able to process from an energy surround.

4. The human mechanism for transducing energy forms into information is the percepto-cognitive system.

5. The terrain of movement is space.

6. Developmental momentum provides a constant forward thrust toward maturity and demands an equilibrium to maintain direction.

7. Movement efficiency is developed in a climate of stress.

8. The adequacy of the feedback system is critical in the development of movement efficiency.

9. Development of movement efficiency occurs in segments of sequential expansion.

10. Movement efficiency is symbolically communicated through the visual-spatial phenomenon called language.49

The course of development of movement efficiency begins with the young child and his attempts to achieve "postural-transport orientations." Five components are essential to the organization of motion through space. They are: (1) muscular strength, (2) dynamic balance, (3) body awareness, (4) spatial awareness, and (5) temporal awareness.

49 Ibid., pp. 35-59.
The interaction of these components provides the foundation for independent locomotion with efficiency and grace.

Six "percepto-cognitive modes," designed to implement the organization and development of fundamental movement sequences, add meaning to the individual's movement. They are: (1) gustatory, (2) olfactory, (3) tactual, (4) kinesthetic, (5) auditory, and (6) visual. The modalities are more than sensory systems. They are multi-dimensional, interactive channels for processing information. Building upon basic skills, the child processes information, making purposeful adaptations in his movements.

The preceding eleven "core components" make survival possible. They constitute the foundation stones of movement efficiency. Four additional components have been postulated which serve to enrich the basic structures and provide the learner with "degrees of freedom" to move toward the full expression of his capabilities. Bilaterality, the ability to utilize both sides of the body harmoniously, is an asset to skillful movement. The concept stresses the functional efficiency of body parts in initiating and completing movement which crosses the midlines of the body. Rhythm contributes comfort and ease to movement by providing an organizational pattern for the stresses and intensities which are involved in all effort. Flexibility provides for range of movement and variation in basic patterns. Motor Planning refers to the ability of the individual to synthesize all of his efforts and to direct his own performance.

The theory of movigenics is comprehensive, referring to the development of all aspects of the individual. It is not a theory of
physical education. In this study, however, the application of the theory to the concerns of physical educators as they work with elementary school children was of great value.

Chaney and Kephart have outlined the theory which has guided their work and the work of their associates with slow learning children. A resume of the theory follows.

The authors prefer to view development in the child, not so much as a sequence of specific skills and performances, but as the sequential development of certain basic generalizations. Because the first learnings of humans are motor learnings, the earliest generalizations are motor generalizations. A motor generalization consists of a repertoire of related acts, forming the basis for variation in movement responses. Failure to develop clusters of related movement patterns may result in "splintering," or the learning of a specific skill pattern which is used rigidly in one situation only. Successful development results in the ability to utilize motor patterns freely, devoting attention to the purpose of the movement rather than to the mechanisms involved.

Four motor generalizations are considered to be of particular significance in education. They are: (1) Balance and Posture, (2) Locomotion, (3) Contact, and (4) Receipt and Propulsion.

In developing the Balance and Posture generalization, it is essential that the child learn to identify the line of gravity within his body, becoming constantly aware of his position in space and the direction of the pull of gravity through his body.

---

50 Clara M. Chaney and Newell C. Kephart, Motoric Aids to Perceptual Training (Columbus, Ohio: Charles E. Merrill Publishing Company, 1968).
The second generalization, Locomotion, includes all activities which result in moving the body through space. Locomotion permits the child to investigate the relationships between objects in space, gradually building up a space structure which supports concepts such as direction, level, and distance. Such spatial information must be gathered systematically and consistently without the need for giving undue attention to the mechanics of moving about.

The Contact generalization, composed of manipulative skills, permits the child to investigate the relationships within objects. Exploratory handling of objects has three aspects: (1) reach, by which contact is made with an object; (2) grasp, by which contact is maintained while the manipulatory activities are completed; and (3) release, by which contact is broken. The three aspects must be related temporally to one another, developing a synchronous interplay. Manipulatory activity is fundamental to the development of form perception and figure-ground perception.

The generalization, Receipt and Propulsion, enables the child to deal with movement in the environment. It includes activities with which he relates to an object moving toward him, as well as activities with which he relates to an object moving away from him. Speed is one of the dimensions of movement with which he must learn to deal accurately.

Exploratory movement is necessary for building the four generalizations as well as to gather information about the environment. Environment includes the body of an individual as well as other persons and
Inanimate objects. Awareness of one's body and its capabilities is the essence of the concept of "body image." The concept of "laterality" is derived from an appreciation of right and left within one's own body. It precedes and supports the child's ability to deal with directions outside his body.

During exploratory activity, the child receives sensory information through the various sensory mechanisms. It is important that the correlation between incoming perceptual information and outgoing responses is achieved. This process is called "perceptual-motor matching." When perceptual-motor matching is properly accomplished, the child can begin to explore his environment by means of perceptual data only, making it unnecessary to move to touch each object of attention.

Building perceptual efficiency through the development of motor generalizations and perceptual-motor matching is the foundation of cognition.

**Perceptual-Motor Training Tasks**

Individuals and groups who have worked to develop training programs for remedial and enrichment purposes have devised a great number of interesting tasks which were useful in this investigation. The writer had frequent reference to both published and unpublished materials. From these sources, ideas were gathered about exercises, training techniques and devices which could have value as potential test items. Some of the training tasks have been a part of physical education programs for many years. Others were designed to fulfill specific needs of individual children.
Commonly, the tasks presented a series of challenges to the maintenance of balance, the development of well-coordinated and rhythmic locomotor movements, the ability to focus upon and to pursue moving targets, and the ability to exert conscious control over the movements of the body and its parts, both with and without reference to objects in the environment. In general, the tasks consisted of relatively simple motor patterns which require the child to integrate sensory inputs and to utilize motor patterns in a great variety of contexts.

**Summary**

The review of literature reported in this chapter revealed a variety of perceptual-motor skills which were considered to be important to the individual's functioning. Certain components, such as balance, were emphasized by all of the theorists and investigators. Terminology used in describing balance functions was also similar. Other aspects of functioning were important in the schematizing of some researchers, but not in the work of others. Some of these differences were only apparent, stemming from the choice of words and phrases used to identify and to describe the functions. The following collection of words and phrases illustrates the number and variety of abilities which have been considered to be components of perceptual-motor function.

- Balance and postural flexibility
- Perception of the body's midlines and its center of gravity
- Body image
- Awareness of body shape and body size
Identification of body parts
Differentiation and integration of body parts
Kinesthetic awareness
Perception of motion
Figure-ground perception
Form perception
Awareness of position in space
Ability to repeat muscular contractions
Ability to imitate movements
Laterality
Directionality
Bilaterality
Ability to deal with a space structure
Perceptual-motor matching
Perception of depth and distance
Tactile perception
Visual focusing
Eye-hand coordination
Fine finger skills
Memory for form and position in space
Temporal-spatial translation
Inter-sensory equivalence
Perceptual flexibility
Perceptual selection
Reaction time
Utilization of the contact pattern
Perception of rhythmically recurring intervals
Voluntary control of force and speed
Sequencing and memory of perceptual and motor elements
Motor planning
Ocular pursuit

The above list which must be considered incomplete, indicates broad areas of concern. Since it appeared that learning of all types is influenced in part by one or more of these perceptual-motor abilities during some stage of development, the writer investigated a great many sources pertaining to these abilities. Those which were most pertinent to the present study were reviewed in this chapter.
CHAPTER III

PROCEDURE

Overview

Those who are interested in observing the perceptual-motor functioning of children have become interested for various reasons. The special interest of an individual directs him to observe certain aspects of the child's abilities while disregarding others. Consequently, the occupational therapist, the optometrist, the psychologist, the reading specialist, the student of child development, and the physical educator have observed the child’s ability to function from many different points of view. All are interested in the underlying, general supports of a variety of behaviors. In all cases, researchers are interested in what the child does as an expression of the way in which he interprets sensorally received information. A child’s responses to a task can give clues to the nature of his perception of the requirements of the task itself, and the means which he has available in meeting those requirements. Ultimately, the purpose for making this kind of observation of children is to discover basic causes of their successes and failures in a variety of important life situations.

The writer sought to construct a battery of tests which could be used to assess the level of achievement of primary school children in motor tasks which focus on basic perceptual abilities. The problem
was one of test construction. The process was a multi-dimensional one in which the writer sought to answer the following questions in order to develop motor tasks appropriate to the problem and within the delimitations of the study:

1. Which aspects of perceptual-motor behavior would be selected for investigation? How would the writer define this behavior? In what ways might this behavior be expressed by children?

2. Which movement tasks focus on basic perceptual abilities and could be incorporated into an overt motor act interesting to first, second, and third grade boys and girls? How would the writer identify the perceptual requirements of the tests? What would be the response of children to a variety of perceptual-motor tasks?

3. Which tests would lend themselves to the development of a test battery appropriate to the conditions of this study?

In order to accomplish the above, it was necessary to formulate tasks which could be scored objectively; to try them out with children both informally and in a pilot program; to modify the tasks and select a limited number of tests to be administered to the public school sample; to analyze the data and make recommendations for perceptual-motor tests appropriate to boys and girls of grades one, two, and three.

Determining What to Evaluate

In constructing a framework from which to study perceptual-motor achievement as it concerns elementary school physical educators, the writer used extensively the processes described by Furst in his
book entitled, *Constructing Evaluation Instruments*.\(^1\) Formulating a concept of perceptual-motor achievement in terms of behavior significant to the purposes of physical education was the necessary first step. The types of behavior to be evaluated had to be established as highly relevant to the purpose for developing an evaluative instrument.

Simply stated, the writer's purpose for developing a test of perceptual-motor performance of elementary school children was to discover levels of achievement in basic areas of functioning. In order to be useful in curricular planning, these areas of functioning had to be established as being truly foundational in character, encompassing all of the more important aspects of motor activity. A further requirement was that the areas be sufficiently distinct from one another to permit the classification of various motor tasks.

In accordance with the foregoing purpose, the writer selected the following aspects of perceptual-motor behavior as those which are particularly relevant to physical education programs for elementary school children:

1. Ability to maintain orientation to gravity while moving about.

2. Ability to make and to avoid making contact with stationary objects and persons while moving about in space.

3. Ability to make and to avoid making contact with moving objects and persons.

4. Ability to project objects accurately toward targets in space.

For this investigator, then, the concept of perceptual-motor achievement was defined as the ability to select, organize, and respond overtly to sensory cues: (a) in maintaining orientation to gravity while moving about; (b) in making and avoiding contact with stationary objects and persons while moving about in space; (c) in making and avoiding contact with moving objects and persons; and (d) in projecting objects accurately toward targets in space.

In order to define each aspect of perceptual-motor achievement in terms of specific behavior, it was necessary to complete two additional steps. First, the writer described the behavior, indicating the types of responses which should be included. Second, an analysis was made, listing the critical perceptual and motor requirements of the behavior, and noting points of contrast between good performance and poor performance. Each of the components of perceptual-motor achievement to be evaluated was treated separately as outlined below.

Ability to Maintain Orientation to Gravity While Moving About

Each of the descriptive phrases listed below points to and helps to define the ability to maintain orientation to gravity while moving about.

1. Can deliberately change from one base of support to another without falling.

2. Can change from one base of support to another repeatedly, using patterns of locomotion.
3. Can regain balance when equilibrium is momentarily lost by means of counterbalancing movements which require adjustment of muscular tension and changes in body shape.

4. Can move in balance under conditions of relative insecurity such as small supporting surfaces, uneven terrain, unstable surfaces which tilt, bounce, sway, or move in other ways.

5. Can maintain alignment while supporting weight on body parts not commonly used for weight bearing.

6. Can maintain balance while moving in different directions, such as forward-backward, side-to-side, up-down, and combinations of these.

7. Can maintain movement in balance in the event of unexpected shifts in the location of the body's center of gravity due to the addition of weight to a body part or the imposition of force directed against the body or one of its parts.

8. Can maintain total body balance while performing operations with one or more body parts which tend to disturb alignment.

The ability to make continuous postural adjustments is influenced by muscular strength, by awareness of the location of the body's center of gravity and its midlines, and by knowledge of the nature of supporting surfaces over which the body must move.

Data are received through the various sensory modalities. Perception of verticality is derived from visual and proprioceptive cues. Information regarding the rate, extent, and forcefulness of movement
is a part of kinesthetic sensitivity. Tactual cues contribute to the awareness of the nature of the supporting surfaces.

Excellent performance probably results from the variety and extensiveness of the individual's experiences in moving as well as the structural and functional integrity of the various organs of reception. Poor performance may result from impaired sensory receptors, from insufficient practice in making controlled postural adjustments, from lack of muscular strength, or from failure to focus attention on the solution of balance problems.

Ability to Make and to Avoid Making Contact With Stationary Objects and Persons While Moving About in Space

Each of the kinds of behavior listed below points to capacities which enable the individual to direct his movements with reference to stationary objects and persons.

1. Can use locomotor patterns singly and in combination, altering the direction of the movement to attain one's goal. The goal may be to deliberately follow a pathway, or it may be to avoid touching or brushing against obstacles. The result is the selection and use of appropriate locomotor movements, giving attention to the purpose of the movement rather than the mechanics of the movement.

2. Can control the force and speed of the movement, stopping quickly if necessary.

3. Can move through enclosures which are limited in the vertical dimension, changing the levels at which the body moves. Can
move under and over obstacles, or go through the space between a high and a low obstacle.

4. Can move through enclosures which are limited in the horizontal dimension, changing body leads and altering the body shape. Can move forward, backward, sideways, feet first, or head first, and can change the contours of the body to conform to straight, angular, or curving spaces.

5. Can extend and withdraw body parts to touch or to avoid touching objects in the environment.

6. Can use the small muscles of hands and fingers to make contact in many different ways, such as pat, grasp, tap, stroke, slap, and poke.

Physical acts of avoidance include stopping the motion of the body, changing the direction and rate of movement, and withdrawing body parts in order to move among objects without touching them. Making desired contact with object~ in the environment involves moving toward the object and touching it in some manner with a given body part. Visual fixation is necessary as well as the ability to manage muscular effort so that the individual as well as his eyes may converge upon the object.

Building upon the ability to maintain equilibrium while in motion, the individual must also be capable of directing the movement of the body. He must be aware of spatial relationships between himself and objects as well as the relationships among two or more objects. Perception of depth, distance, and the size and shape of objects is necessary in this regard.
Data regarding the objects are derived primarily from visual inspection. Information about the body's position and contours comes from an awareness of the size and shape of the body and the relationships existing among body parts. This awareness may be thought of as a body image. It implies knowledge of the body as a moving image as well as a stationary one.

Control of the movements of the body, by means of visual guidance, is an essential component of success in both making and avoiding contact with objects. Making decisions about the speed, force, and direction of movement constitutes a complex process called motor planning.

Ability to Make and to Avoid Making Contact
With Moving Objects and Persons

Each of the phrases below helps to identify instances in which the ability to relate to moving objects is involved.

1. Can time the movements of the body to coincide with the arrival of a moving object which is approaching one's personal space, thus avoiding contact with the object. Movements of avoidance include: (a) changing the level of the body (e.g. ducking down, stepping over, jumping over); (b) withdrawing body parts and/or changing the alignment of body segments (e.g. lifting a foot, pulling an arm inward, twisting to move a shoulder); (c) making changes in the location of the body (e.g. stepping aside, leaping forward, rolling over).

2. Can time locomotor movements in traveling from a given position into the pathway of an approaching object.
3. Can make contact with an approaching object for the purpose of stopping or controlling the movement of the object in some way (e.g. touching, blocking, grasping).

4. Can make contact with an approaching object for the purpose of changing the direction of movement of the object (e.g. deflecting, hitting, kicking).

5. Can relate to objects which move rhythmically in pendular and circular motions.

Making accurate judgments about what segments and parts of the body to move, where to move, when to move, and how fast to move in order to relate to moving objects requires many complex skills. It is essential that the individual be able to detect a moving figure against a relatively stationary ground. In addition, one must be able to track the moving object visually, maintaining eye contact throughout the approach.

Perception of rate of motion lays the groundwork for an estimate of the amount of time it will take for the object to arrive at a given place. The ability to project the position of an object in time and in space requires intuitive computations based upon an infinite number of experiments in relating oneself to moving objects. In addition to judging the flight of the object, one must time his own movements to coincide with the arrival of the object. In regard to making adjustments to an object which moves rhythmically, the individual must also be able to perceive the interval of time between the recurring movements.
The Ability to Project Objects Accurately Toward Targets in Space

Each phrase below describes behavior involved in projecting objects accurately.

1. Can utilize a variety of manipulative skills accurately (e.g. rolling, pushing, throwing, kicking).

2. Can control the direction of projectiles within horizontal limitations.

3. Can control the direction of projectiles with reference to vertical limitations.

4. Can control the path of projectiles in the horizontal and vertical coordinates of space simultaneously.

5. Can control the force with which objects are projected into space.

Two major factors account for accuracy in propelling objects toward targets: application of an appropriate amount of force; and application of force in the proper direction. In order to accomplish the directional task, the individual must be aware of the spatial relationships between himself and the target, and he must be able to control the release of the object toward that target. Sometimes, as in rolling a ball toward an Indian club, the horizontal or right-left dimension is the major consideration. At other times, as in throwing a ball to a partner, both the horizontal and the vertical dimensions must be considered.

Whenever the problem is one of judging distance, neither over-estimating nor under-estimating, one must match his perception of
distance with an appropriate amount of force. Many tasks require a high degree of accuracy in controlling both direction and force, as in pushing a shuffleboard disc into a specific target area. Making judgments of these kinds requires the ability to make complex spatial discriminations and to match perceptual data about distance and direction with motor activity of an appropriate kind and amount.

It was deemed desirable to select test situations which could be used in the school setting by teachers of young children with equipment and time allotments commonly available to them. In addition to these practical requirements, the writer used extensively a checklist of characteristics of effective measuring tools proposed by Scott and French.²

Several sources were studied for test possibilities. The most important of these were the descriptive lists of behavior for each of the four parts of the definition. Examples from work, play and daily living were explored for potential testing situations. Tasks commonly used in instructional programs in elementary physical education were studied for their use as tests which might be scored objectively. Tasks proposed by other investigators and tests already in existence were considered for their usefulness in this study. From a compilation of approximately fifty test potentials, the writer selected twenty for preliminary administration. Brief descriptions of the tests follow.

Balance Beam: Ten Steps. Walk heel-to-toe along the two inch surface of a standard two-by-four, ten feet long. Score: number of steps taken to the second "step-down."

Balance Beam: Slide and Move Blocks. Slide sideways on the balls of the feet along the four inch surface of a standard two-by-four, ten feet long. Stoop and manipulate plastic blocks at each end of the beam. Score: number of trips completed out a maximum of six.

Angle Board. Roll a softball up an inclined plane with enough force to reach a target box. Score: number of successful rolls out of ten trials.

Toss and Catch. Toss a volleyball over a rope six feet high and catch it on the other side before it touches the floor. Score: number of successful catches out of ten trials.

Rope Board: Time. Walk forward and backward on a length of half inch hemp rope fastened to the four inch surface of a standard two-by-four. Score: number of seconds subject continues to move to a maximum of fifteen seconds.

Rope Board: Displace Blocks. Walk forward on a length of half inch hemp rope fastened to the four inch surface of a standard two-by-four. Use a yardstick to push plastic blocks into target areas marked on the floor on both sides of the rope board. Score: number of blocks displaced correctly when task is completed.

Target Toss: Underhand and Shot Put. Use underhand pattern and shot put pattern to toss beanbags into a floor target of concentric circles. Score: sum of points earned in six trials with each pattern.
Jump and Land: Maintain Balance. Jump over a foam rubber block four-by-eight-by-twelve inches. Land on two feet inside a target circle and maintain balance on the balls of the feet for five seconds. Score: number of seconds balance is held.

Path Skipping. Skip within the boundaries of a "snail" pattern four feet in diameter. Score: distance attained minus boundary violations and breaks in rhythm.

Sideward Leap. Leap sideways, bend forward to move an object on the floor and maintain balance to a maximum of five seconds. Score: number of seconds balance is held.

Disc Slide. In a kneeling position, push a shuffleboard disc with the hand toward a target of concentric circles on the floor. Score: sum of points earned in ten trials.

Block Maze. Guide a four-by-four-by-two inch block of wood through the paths of a zigzag maze with a wand forty inches long. Score: distance covered in fifteen seconds minus line violations.

Log Roll. With body extended, roll in a straight line. Score: number of deviations from a center zone.

Wall Bounce and Catch. Toss a volleyball against the wall from behind a restraining line and catch it on the first bounce. Score: number of successful catches out of ten trials.

Target Jump. Broad jump to a specified line. Score: number of deviations from the target line.

Target Bounce. Bounce an eight inch playground ball into a floor target with force enough to cause it to rebound directly and touch the wall. Score: number of successful bounces in ten trials.
Balloon Tapping. Use a wooden kitchen spoon to tap a balloon, keep-it in the air. Score: number of successful taps in fifteen trials.

Ball Bounce. Make consecutive one-hand bounces without moving the feet outside a circular base twenty inches in diameter. Score: number of consecutive bounces made without boundary violations to a maximum of ten.

Bowl Between Pins. Roll a softball through a space bounded by two plastic bowling pins. Score: number of successes out of ten trials.

Hopping Over Lines. Hop over lines on the floor in three different patterns: (a) side-to-side; (b) forward-backward; (c) square. Score: number of successful hops out of twelve trials.

The Pilot Testing Program

Rose C. Swart Campus School located at Wisconsin State University - Oshkosh was selected as the site for the pilot testing program. The program was designed to make preliminary observations and evaluations of the tests and the procedures involved before administering a selected number of tests to the public school sample.

Seventy-six children from the first, second, and third grades served as subjects. The breakdown of subjects tested at each grade level was:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Grade</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Second Grade</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Third Grade</td>
<td>10</td>
<td>14</td>
</tr>
</tbody>
</table>
Twenty college students at Wisconsin State University - Oshkosh were trained by the writer to administer the tests. Two students were assigned to each of nine testing stations. Two additional students were prepared to assist the children or the testors in any unanticipated need. In addition to training in the conduct of tests to be given at the stations for which they were responsible, the testors were given the following instructions concerning the techniques to be employed with the children.

1. Greet each group of children in a friendly way, helping them to feel comfortable and relaxed.

2. When it is time for the groups to rotate, go part of the way with them to the next station, making the transition from one station to another as orderly as possible.

3. Designate a space away from the test apparatus where the children are to sit as they wait for their turns. The space selected should be close enough for the waiting children to see a subject performing, but not so close as to be distracting to the performer.

4. Voice your approval of each child's efforts at some one time during each test by saying, "Good" ... "That's good" ... or "Good for you." Speak with sincerity but avoid loudness or unnecessary emphasis.

5. Whenever scores are communicated to the recorder, children may be permitted to hear them, but do not discuss the scores with the children otherwise. If a child asks for an evaluative comment from you, simply say, "You did a good job, didn't you?"
6. Before the first subject begins, tell the children that they may watch and speak quietly to one another, but that you want each person to be able to do his best without being bothered by noise and by moving about.

Four thirty-minute periods per classroom group were devoted to testing. Nine testing stations were set up in the gymnasium. Tests to be administered at each station were selected with reference to the amount of time required to complete each test, equipment and space needed, and the energy demands made upon the children. Children rotated to each of the testing stations in turn. They wore numerals as a means of quick identification. The numerals corresponded to a roster of names which the administrators used in recording scores.

**Analysis of the Pilot Testing Program**

Observation of the children and the test administrators at work revealed the need for improvements in both the testing equipment and the process of administration. The test data were used in evaluating the trial tasks. Summaries follow.

**Balance Beam: Ten Steps**

The scoring technique was adapted from Seashore's beam-walking test. Permitting each subject to step down once without penalty made the test very easy. Six trials were recommended. This took a great deal of time. The use of a two inch beam only, did not discriminate well between individuals. Many children had perfect scores in all the trials. The task was especially easy for third-grade children.
Twelve out of fifteen subjects in third grade made perfect scores. In second grade, seven out of nineteen, almost one-third of the children, made perfect scores. The task was more difficult for first graders. One child out of twenty-one had a perfect score. However, fully one half of the group had scores within three points of perfect.

**Balance Beam: Slide and Move Blocks**

It was difficult for the observer to make a decision about the requirement for moving on the balls of the feet only. It was especially difficult to observe this during the stooping down portion of the task. Consideration was given to the possibility of placing further restrictions on the placement of the subject's feet in order to make the scoring procedure more objective. One such possibility was to consider it a miss when the toes extended beyond the edge of the board. This would help the observer, but it seemed to demand an inordinate amount of control from the subjects, causing them to pay strict attention to the placement of the feet rather than to the dynamic balancing task as it was originally constructed. In general, third-grade subjects performed better than the first and second-grade subjects. Few individuals completed the entire task. Out of a total of fifty-seven subjects, five were able to make six complete sliding trips and stooped each time to manipulate the blocks without losing their balance.

**Angle Board**

This task was an intriguing one for all subjects. It was not difficult to understand the task requirements, but it was difficult to make a good score. The best score recorded was seven out of ten. Two subjects, one from first grade, and one from third grade made this top score.
Twenty of the seventy-six subjects scored zero. This made it appear that the task was too difficult. However, some of the failures resulted from an inability to release the ball in the proper zone at the end of the board. This release zone could be made larger without altering the general requirement for making an accurate judgment about the amount of force needed to roll the ball up the incline and into the target box.

Scores on the two practice trials should be recorded for use if desired. It did not appear that there was an appreciable increase in successes, among the group as a whole, from trial one through trial ten. A consultant in experimental psychology suggested that ten trials would provide sufficient data.

**Toss and Catch**

This task was easily and quickly administered. The scoring procedure was clear-cut and objective. The distribution of scores was from zero to six with no subjects making a perfect score at any grade level. Of sixty subjects, ten were not able to make any score. Of these ten, three were second graders, and seven were first graders. Some few additional successes might have been registered had the two practice trials been recorded.

One distinct value of this test was the fact that it presented a task in which the subject had to relate to a moving object. Suitable situations of this type were difficult to construct without involving another person (as an examiner in tossing the ball) or a mechanical device.
It was difficult to see how the task might be altered, either in terms of the requirements, or in terms of the scoring procedure, to make it easier. Both the height of the rope (six feet) and the width of the floor space (six feet) seemed to be well chosen. The height of the children did not appear to be a factor in their success or failure in the task, probably due to the rule of starting the throw from below the waist.

**Rope Board: Time**

This task was difficult to score objectively. The placement of the shoe on the rope determined, to a large extent, the subject's success. Subjects who tried very hard to place the whole shoe on top of the rope were penalized for their attempts to do it "just right." In addition to this, the portion of the task which involved walking backward was not achieved by many subjects within the fifteen second time limit. Subjects who did get that far were actually performing a different task. Directions to the recorder about starting and stopping were unclear.

**Rope Board: Walk and Displace Blocks**

The same criticism about the placement of the feet was made about this task. The nature of the apparatus made it difficult to score the individual's performance accurately. Performance in the block-pushing portion of the task was interesting to observe in terms of the ability of subjects to control objects beside them by means of a yardstick. Some subjects insisted upon transferring the stick from one hand to the other rather than crossing the mid-line of the body, even though this was clearly forbidden in the instructions. It might be desirable to reconstruct this test, using a simple two inch beam rather than the rope board.
Target Toss: Underhand and Shot Put

Both versions of this task yielded a satisfactory range of scores. The tasks were interesting for the children, but the shot put pattern was difficult for most of them. The administrators found it difficult to make an immediate judgment about the zone in which the beanbag first landed. The concentric-circles-type target was constructed of sash cord to facilitate the making of judgments, as well as to restrict the sliding of the bags along the floor.

Jump and Land: Maintain Balance

The major difficulty was in knowing when to start and when to stop timing a trial. The observer had to be very quick to stop the clock when the subject moved one or both feet. In an attempt to structure a situation in which the subject had to perform a sequence of movements (run-jump) followed by holding balance in a stationary position, the rules for performing became too involved. The movement was so prescribed that it was difficult to observe all of the chances for making mistakes. Scores, as recorded under these circumstances, were widely distributed, but were not objective and accurate enough to use.

Path Skipping

The skipping task was performed on a "snail" pattern which proved to be much too small to permit the range of movement necessary for true skipping. It required finely controlled movement, and proved to be too difficult for most of the children to perform.

Sideward Leap

This test was administered according to the directions given in
Scott-French. The suggested alternate plan for scoring was used. The number of seconds balance was held was recorded instead of recording pass or fail for each of the twelve trials.

The test had been used with young children and found to be fairly reliable, as noted by the authors. We found, however, that the subjects were extremely inaccurate in their performance of the leap from one foot to the other, sometimes merely stepping over to the mark on the floor.

Timing the test was difficult for the administrator in this test, also. Too many conditions had to be met by the subject, and observed carefully by the administrator. Another drawback was the amount of time needed to administer the recommended twelve trials, six with the right leg and six with the left leg.

**Disc Slide**

This task was easy to explain and to administer. The ten trials were completed by each subject rather quickly. Scores were well distributed. These were all points in favor of the test. In terms of the judgment-making requirements, it was similar to Angle Board. Both required the control of force, and the ability to repeat a given amount of force. The disc sliding task was easier than Angle Board, but not so interesting for the children.

**Block Maze**

Children found this task challenging and exciting. They exhibited various methods in applying force to the block of wood. Some

\[\text{Scott and French, p. 320.}\]
made a series of short pushes while others attempted to maintain contact between wand and block, sustaining their effort as they guided the block through the maze. One of the most interesting facets of this task was the necessity for using tactual and visual cues in guiding the block. Instructions to the observer and to the subject in regard to a continuing line violation needed to be improved. The scores were distributed normally from a low of five to a high of twenty-three, providing an adequate range of scores.

**Log Roll**

This task, with two trials to the right and two trials to the left provided an adequate range of scores. None of the seventy-six children tested was able to perform a non-deviating roll. The sum of deviations from the center zone ranged from two to thirty-seven. It did not appear that there was any learning effect from trial one to trial two in either the right side rolling or the left side rolling. The children did not experience dizziness or fatigue in doing this task. They seemed to find it interesting. It would be especially interesting to analyze their performance with regard to right- and left-hand dominance as well as the total number of deviations recorded.

**Wall Bounce and Catch**

This task was much too simple to obtain a range of scores. The majority of children in all three grade levels made perfect scores.

**Target Jump**

A score of ten was perfect in this task, and six trials provided opportunity to earn sixty points in all. Scores ranged from seventeen to
fifty-five. The scoring technique was found to contain a built-in error which could be eliminated. Mistrials could be eliminated by merely having the subject repeat a trial in which the following conditions were not met: feet must be behind the starting line; both feet must land simultaneously; and the feet must not be moved after landing. If these misses were eliminated, subjects would not be likely to get zero scores. This would be highly desirable.

A consultant in psychology suggested that fewer than six trials would be needed, since the performance of the group between trials did not appear to change substantially after the third trial.

**Target Bounce**

The task did not discriminate well among individuals. It was much too easy, especially for third graders. The task could be altered somewhat by marking a target on the wall having lines drawn parallel to the floor, thus making various scoring zones. In this case, it would be necessary to experiment with the distances between the restraining line and the wall, and with the placement and dimensions of the target.

**Balloon Tapping**

This task was intrinsically interesting for the children, and provided a good example of the ability to relate to a moving object. Adjustments needed to be made in the scoring system in order to avoid penalizing the subject for an early mistake. A subject should be permitted to complete fifteen attempts instead of stopping when a mistake was made. By subtracting the number of mistakes from fifteen, a more accurate score could be obtained for each subject.
**Ball Bounce**

This task, as it was scored, was much too easy to provide a range of scores. Other possibilities for scoring all seemed to involve a speed element which was thought to be undesirable in this type of test.

**Bowl Between Pins**

This task was challenging for the children. Scores ranged from zero to seven out of a possible ten points. The zero scores (four subjects out of seventy-four tested) were not desirable for our purposes. The four subjects who were unsuccessful in ten attempts were girls, one each from second and third grade, and two from first grade. Second grade Kathy approached the task with an extremely negative attitude, saying, "I can't ... I never do good at this ...." This negative attitude is typical of Kathy in physical education, according to her teacher. Third grade Mary typically had difficulty in focusing her attention on any task for a length of time. Otherwise, her performance was difficult to account for. Wendy, in first grade, had a hearing loss. In several tasks, we could not be certain that she understood exactly what was to be done. The other first-grader, Sheila, made poor scores in most of the tests. She was a large, heavy girl, but it was difficult to understand how this would affect her performance in the bowling task. Perhaps she had experienced failure in tasks which might be affected negatively by excessive weight, and therefore tended to avoid all kinds of physical performance tasks. Observation of the test situation seemed to indicate that the placement of the plastic pins twelve inches apart at a distance
of eight feet from the restraining line was well chosen for these children.

**Hopping Over Lines**

This test actually included three different tasks: hopping side-to-side, forward-backward, and in a square pattern. We found that two observers were needed to make accurate scoring possible. Also, there were omissions in the instructions for administering the test. The scores obtained were widely distributed, but without a more accurate and objective scoring system, we could not place enough confidence in them. The hopping tasks appeared to be excellent tests of dynamic balance demanding the ability to adjust the body weight in reference to the line of gravity.

**Selection of Tests for Experimental Use**

The tests which follow were selected for use with the public school population. Selections were made on the basis of the following criteria:

1. Each test tapped one or more aspects of perceptual-motor achievement as defined and described for use in this study.
2. Each test was capable of yielding a range of scores, and discriminated adequately among individuals in the group.
3. Each test was feasible in terms of the time, equipment, and facilities available for testing.
4. Each test presented an interesting challenge for both boys and girls at each of the three grade levels.

Since a major purpose of this study was to develop motor performance tests which focused upon perceptual abilities of significance
in activities representative of elementary school physical education programs, the following analysis was made in order to demonstrate content validity.  

**Angle Board**

This task poses a space-force problem. How much impetus will be needed to roll the ball far enough to reach the target, but not so far that it will go beyond the target? On the first trial the subject must estimate the distance and attempt to match his perception with an appropriately forceful sequence of movements. On succeeding trials, adjustments must be made, based upon the subject's judgment about the adequacy of the preceding trials. Whenever success is experienced, the subject must be able to repeat the sequence with accuracy. This involves memory for movement as well as control of balance and manipulative precision. Although the subject must be aware of the right-left dimension as it affects his release, the major concern has to be with the depth dimension in space. The behavior required by this task was classified as an example of the ability to project objects accurately toward targets in space.

**Hopping Over Lines**

The demands of the hopping tasks (sideward, forward-backward, and square pattern) appear to be threefold: (a) maintaining balance over a small base of support; (b) being aware of the body's midlines and its

---

center of gravity; (c) making postural adjustments in relation to direction, continuity of action, and floor pattern demands.

Making directional changes requires the ability to control the thrusting and counter-balancing movements of various body parts. This involves selection of the amount of force to be used, and the direction in which it is to be applied. It means bending the knee, leaning in the desired direction, and pushing against the floor with a given amount of effort. It is intuitive motor planning.

The repetitive aspect of the tasks, making twelve successive hops, requires differentiation and integration of the action of various groups of muscles. It demands a degree of timing in the contraction and relaxation of muscles. Rhythmic movement is the visible outcome.

Hopping in relation to a pattern of lines on the floor calls for visual guidance in restricting the movement of the body. Each portion of the task requires moving in balance in reference to one or more planes within the body, and in reference to various directions in space. In reference to the behavioral objectives established by the writer in the early part of this chapter, the hopping tasks would seem to relate to the ability to maintain orientation to gravity while moving about.

**Block Maze**

Success in this task is related to the amount of control which the subject exhibits in the demands of speed and accuracy. Speed is necessary because of the fifteen-second time limit for each trial; accuracy, because of the need to respond to the configuration of the maze drawn on the floor. Subjects respond to tactual and visual cues while manipulating the wand and block through the maze. Tactual cues
form the basis for decisions in selecting the amount of effort to be used, while visual cues aid primarily in directing the application of force. The problem posed by this task is one which is described by the behavioral objective, the ability to make and to avoid making contact with stationary objects and persons while moving about in space.

**Log Roll**

Rolling over and over from front to back is a relatively simple motor task. To roll in a straight line, however, requires orientation in space - knowing where one is, and how body parts relate to one another. The subject must be able to utilize the feedback from visual and tactual systems, making adjustments in the expenditure of effort and equalizing the thrusting movements of the legs, the trunk, and the shoulders.

Momentum is maintained through a rhythmical alternation of effort. The requirements of this task would seem to indicate that it should be classified as a motor activity which requires the ability to make and to avoid making contact with stationary objects and persons while moving about in space.

**Bowl Between Pins**

The basic task is the same as Angle Board - to roll the ball with accuracy toward a target in space. In bowling, however, the subject is not so much concerned with distance as he is with the side to side dimension. Emphasis is upon visual focusing on a target - in this case the space between two objects - and releasing the ball to travel a visualized path.

**Balloon Tapping**

This task is the only one which requires the subject to relate to
a moving object. The focus is upon coordination between the eyes and the hand, but the task also demands the positioning of the whole body so that wrist and fingers are able to deliver the finishing touches.

The choice of an appropriate style of action is an important element in achieving control of the balloon. This involves timing the action as well as utilizing an appropriate amount of force. Tactual cues involved in the use of a kitchen spoon as a striking implement provide feedback important to success in the task.

It appears that this task can be most clearly identified with the behavioral objective, the ability to make and to avoid making contact with moving objects and persons.

**The Testing Program**

In accordance with the procedures established by the administrative officials of the Oshkosh public schools and the School of Education of Wisconsin State University - Oshkosh, the writer requested and received permission to test a group of primary school children. The director of physical education of Oshkosh public schools assisted the writer in selecting a suitable school by suggesting those which could meet the requirements of the study as follows:

1. Students should be representative of the Oshkosh public school population.

2. Enrollment must include at least sixty children at each grade level.

3. Facilities and time for testing could be made available on the dates requested.
4. The school should be located within ten minutes driving time of the university campus.

Franklin Elementary School was chosen as the school which best met the above criteria.

The subjects were 178 children enrolled in regularly constituted classroom groups in first, second, and third grade. All of the children in a given classroom who were in attendance on the dates of testing were included in the testing program. The scores of students who had known physical handicaps were excluded from the study. Children with vision problems were instructed to wear their glasses. Following is a breakdown of the subjects retained for the study:

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Grade</td>
<td>27</td>
<td>33</td>
<td>60</td>
</tr>
<tr>
<td>Second Grade</td>
<td>32</td>
<td>28</td>
<td>60</td>
</tr>
<tr>
<td>Third Grade</td>
<td>29</td>
<td>29</td>
<td>58</td>
</tr>
<tr>
<td>Total</td>
<td>88</td>
<td>90</td>
<td>178</td>
</tr>
</tbody>
</table>

The testing program took place on May 22 and May 23, 1969, under the direction of the writer and one assistant. The testing team was composed of twenty-two university students trained in the administration and scoring of the experimental tests. These students had gained experience through participation in the pilot testing program.

Six testing stations were organized in the school's multi-purpose room as follows:

Station One: Angle Board
Station Two: Hopping Over Lines
(a) Side-to-Side
(b) Forward - Backward

Station Three: Block Maze
Hopping Over Lines
(c) Square Pattern

Station Four: Log Roll

Station Five: Bowl Between Pins

Station Six: Balloon Tapping

With the exception of Angle Board and Bowl Between Pins, all stations contained duplications of the testing apparatus, enabling two subjects to perform simultaneously. A corresponding number of administrators and recorders was assigned to each station.

Children wore numerals to provide for easy identification. The numerals corresponded to a roster of names provided by the classroom teachers. As the class came to the multi-purpose room, they were met at the door, divided arbitrarily into small groups, and escorted to a station to begin the testing. Upon a signal, groups were rotated to each station in turn until all of the subjects had completed the tests. Each group of subjects had forty-five minutes in which to complete the tasks. The testing situations which each of the subjects experienced, and the procedures employed by the test administrators are described in the following material.

Station One: Angle Board

Facilities and Equipment: A board six feet long and twelve inches wide supported in such a way that one end of the board is raised sixteen
inches from the base to form an inclined plane. The board has one-inch sideboards to restrain the sideward movement of balls rolling on the surface. A release zone, painted red, extends two feet upward from the bottom of the incline. A cardboard box measuring twelve by sixteen by sixteen inches is placed at a distance of twelve inches away from the top of the incline. The open end of the box measures sixteen by twelve inches, and serves as the target. The entire apparatus, including the box, rests upon a gym bench sixteen inches high. Regulation twelve-inch, leather-covered softballs are needed.

![Figure 1: Angle Board](image)

**Procedure:** The subject rolls the softball up the inclined plane using an underhand pattern with the preferred hand. The subject may stand wherever he wishes near the lower end of the incline, but, in order to be counted, a ball must touch the red zone before rolling upward. The
object is to roll the ball with force enough to drop into the target box. Each subject has ten trials. For each successful roll, one point is recorded.

Scoring: The score is the number of points earned out of ten trials.

Testing Personnel: The administrator observes each trial, calling out "good" or "miss" while the recorder enters a mark for each of the ten trials.

Administrative Procedure: "I want you to roll the softball up this wooden hill so that it will go into this box. You may stand wherever you want to stand, but you must roll the ball on the red part first (pointing). You should use the underhand pattern. That looks like this (simply swing arm without releasing the ball)."

Have subjects stand away from the board. Choose the first subject to perform and give him the bucket with ten softballs in it. Allow no practices. Observe misses: ball does not go into red part first; subject fails to use underhand pattern; ball does not go into box. Record marks as follows for each trial: 1 equals success; 0 equals miss.

Station Two: Hopping Over Lines

A. Side-To-Side
B. Forward and Backward

Facilities and Equipment: Two twenty-four inch strips of one inch masking tape fastened to the floor at right angles to one another to form a "plus" sign, as in the diagram below.

```
  2  3
  
  1  4
```

FIGURE 2: HOPPING OVER LINES
Procedure: In task (a), the subject stands in the space marked number one (1) on his right leg. On the signal to start, he hops from one to four to one until he completes twelve hops. After a brief rest he repeats the side-to-side sequence using the left leg. In task (b), the subject stands in the space marked number one (1) on his right leg and hops from one to two to one until he completes twelve hops. After a brief rest he repeats the forward-backward sequence using the left leg. The subject must face the top of the diagram throughout the test with his toes pointing forward at all times. He must not step on a line; hop two times in succession in a given space; or touch the opposite foot to the floor.

Scoring: The score is the number of hops completed without error.

Testing Personnel: One observer judges the hops in sequence by calling "good" for each successful hop and "miss" for each error. A second person records the hops, marking 1 for each success and 0 for each error. When a subject steps on a line or hops more than once in the same space, an error is recorded for that hop. If a subject falls or permits both feet to touch the floor, an error is recorded for that hop, and he must begin again in the space in which the error was committed.

Administrative Procedure: "I want you to notice the lines which I use in this task and the spaces to which I will hop. (Point out on the floor the plus sign made by the bisecting tape lines, and the numbers within each space). For the first task, I stand on my right foot in number one. Then I hop sideward into four, back to one, to four, to one, until I make twelve sideward hops. I try to do this without making a miss. It is a miss: if I step on a line; if I touch the floor more than once in the space; if I touch the floor with anything more than one foot."
Demonstrate the task again, this time substituting the left leg. Have the children count hops with you. Have them also note that throughout the task, the body and feet face forward. Work with two subjects alternately, having them do the sideward hopping task on right leg first, then on the left leg. The administrator calls out "good" or "miss" for each attempt, while the recorder makes a mark in each box for the twelve hops: 1 equals success; 0 equals miss. The action continues except if the individual falls or touches both feet to the floor. Should that happen, have him start again in the square in which the fall occurred. The count, however, resumes with the next number. When the twelve boxes are filled, the recorder calls "Stop." Repeat the procedure for task (b) Forward-Backward, starting with the right leg in one, and hopping to two, to one, etc.

Station Three: Block Maze

Hopping Over Lines: Square Pattern

Facilities and Equipment: A maze containing eight inch paths is constructed on the floor with one inch masking tape to resemble two letter N's as indicated in the diagram. The maze is thirty-six inches in height and eighty-two inches in width. It is divided into fifteen zones, each of which bears a number used in scoring. A wooden wand forty inches long with a strip of masking tape encircling it ten inches from one end. A block of wood four-by-four-by-two inches. A stop watch.
Procedure: The block is placed in front of the starting line. The subject takes the wand in his preferred hand holding it in the ten inch space. On the signal to start, the subject pushes the block with the wand through the paths of the maze, as quickly and as far as he can. It is an error each time the block touches a side line. The timekeeper calls "stop" at the end of each of three fifteen second trials. The point value of the zone in which the block rests at the end of the time limit, minus the number of line violations is recorded. A block which barely crosses the line into the next zone is given the value of the higher zone.

Scoring: The score is the sum of points earned on the three trials.

Testing Personnel: An observer gives the starting signal and counts the number of line violations. A timekeeper starts the stopwatch, calls time at the end of fifteen seconds, and records the score for each of the three trials. (Note: Each time the block touches a sideline, the observer calls "out." Before the test begins the subject is instructed that he must immediately push the block back into the maze. This is to prevent a subject from making one continuing line violation along the length of a given pathway).
Administrative Procedure: "I want you to hold this wand in one hand, then push this block with the wand so that the block goes inside this track from here to here (point out track sequence). It will look like this. (Demonstrate a small portion of the track). When it is your turn, you will get three chances. Each time, see how far you can push the block until I say "stop." I will watch for how many times you miss. It will be a miss: if the block of wood touches the tape; if your foot or hand touches the block of wood; if you use both hands on the wand; or if your hand goes below the tape on the wand. Whenever the block of wood touches the tape, I will say "Out" and you must push it back inside right away."

Have subjects sit on the floor while they wait for their turns. Each subject will have three trials of fifteen seconds each. The administrator should see that the subject holds the wand within the zone marked by tape, and that the block is positioned at the outside of the maze touching the starting line. Say "Ready...begin," and observe and count misses. If block touches tape, call "Out." This is to prevent subject from making a continuing line violation. The recorder acts as time-keeper, starting the stopwatch exactly on the word "Begin," and calling "Stop" exactly at fifteen seconds. Record the score by noting the zone in which the block rests at the signal to stop, and subtract the number of misses according to above listing. The remainder is the subject's score for that trial. The zone is considered attained if even a small portion of the block enters.

Hopping Over Lines: Square Pattern

Facilities and Equipment: Same as that described for Station Two.

Procedure: The subject stands in the space marked number one on his right leg and hops from one to two to three to four to one until he completes twelve hops. After a brief rest he repeats the square sequence
using the left leg. The subject must face the top of the diagram throughout the test with his toes pointing forward at all times. He must not step on a line; hop two times in succession in a given space; or touch the opposite foot to the floor.

**Scoring:** The score is the number of hops completed without error.

**Testing Personnel:** Same as that described for Station Two.

**Administrative Procedure:** "I want you to notice the lines which I use in this task, and the spaces to which I will hop. (Point out on the floor the plus sign made by the bisecting tape lines, and the numbers within each space). For this task, I stand on my right foot in number one. Then I hop forward into number two, sideward into three, backward into four, sideward into one, forward into two, and I just keep going until I make twelve hops in a row. I try to do this without making a miss. It is a miss: if I step on a line; if I touch the floor more than once in the space; if I touch the floor with anything more than one foot."

Work with two subjects alternately, having them do the square hopping task on the right leg first, then on the left leg. The administrator calls out "good" or "miss" for each attempt, while the recorder makes a mark in each box for the twelve hops: 1 equals success; 0 equals miss. The action continues except if the individual falls or touches both feet to the floor. Should that happen, have him start again in the square in which the fall occurred. The count, however, resumes with the next number. When the twelve boxes are filled, the recorder calls "Stop."

**Station Four: Log Roll**

**Facilities and Equipment:** A strip of plastic cloth twelve feet long and fifty-four inches wide on which is indicated a starting line and five interval lines. Each interval line is divided into zones to provide a scoring grid. Zones are seven inches wide with the two zones at the
extremes extending beyond the confines of the cloth. Each zone is marked with a number value as noted in the diagram which follows. An elastic belt two and one-half inches wide, with hooks and eyes to provide for variations in waist size, is used to judge the position of the subject on the grid.

**FIGURE 4: LOG ROLL**

**Procedure:** The subject stands with his arms stretched overhead as the administrator fastens the belt around his waist. He then lies on his back with his right side next to the starting line in such a way that the belt is in line with a mark at the midpoint of the center zone. The legs are extended and together and the arms are extended overhead. On the signal to start, the subject rolls to the end of the strip in as straight a
line as possible. If the subject begins to roll crooked, he may try to correct his position, but may not lift his body. After a brief rest, he repeats the right side rolling, and then takes two trials, interspersed with rest, from the left side.

**Scoring:** The score is the sum of deviations from the center zone, which is represented on the grid by number four. Zone four, therefore, equals no deviations; zones three and five equal one deviation; zones two and six equal two deviations; zones one and seven equal three deviations. Subjects who roll beyond the numbered zones on either side of the grid score four deviations.

**Testing Personnel:** One observer calls out numbers to correspond with the position of the belt at each of the five interval lines. A recorder marks these numbers on the score sheet. The deviation score must be computed later.

**Administrative Procedure:** Choose one student from the group. "I will fasten this belt tightly around each of you when it is your turn. Hold your arms up over your head. Next you must lie down on your back so that the belt is in line with this yellow mark in the center, your arms overhead, your legs straight. I want you to roll down the strip keeping your body as straight as you can. If you think you are going crooked, try to roll back toward the center, but do not lift your body. When you come to the end, lie still and rest until I tell you to walk back and start again."

Stand at the mid-point of the starting edge. Observe the position of the belt each time the subject rolls across a line into the next interval. Call out a number corresponding with the zone in which the belt lies. At the end of a trial, tell the subject to lie still and rest. Count silently to ten seconds, then ask him to walk back and lie down. Each subject has two trials with his right side next to the starting line and
two trials with his left side next to the starting line. Record the zone point value for each of five intervals during each of the four trials.

Station Five: Bowl Between Pins

Facilities and Equipment: Two plastic bowling pins with bases two inches in diameter are set with their centers twelve inches apart on a line parallel to a restraining line eight feet away. Regulation twelve inch, leather-covered softballs are needed.

Procedure: The subject stands behind the restraining line and rolls the ball using an underhand pattern with the preferred hand. The object is to roll the ball through the space without toppling the pins. Each subject has ten trials. The subject's feet must remain behind the line throughout. For each successful roll, one point is recorded.

Scoring: The score is the sum of successful rolls in ten trials.

Testing Personnel: The observer calls out "good" or "miss" for each trial. The recorder enters a mark for each of the ten trials.

Administrative Procedure: "I want you to roll the ball so that it goes between the two pins. You may use whichever hand you choose, but always use the same hand. When it is your turn, stand with both feet somewhere behind this line. It is a miss: if your feet go over the line; if a pin is knocked down; or if the ball goes outside the pins."

Demonstrate once. Have subjects seated behind, but away from, the restraining line. Each subject has ten trials with no practices. Watch for misses as described above. Record a mark for each trial as follows: 1 equals success; 0 equals miss.
Station Six: Balloon Tapping

Facilities and Equipment: A wooden kitchen spoon twelve inches in length with the bowl painted red to facilitate observation of contacts made between the spoon and the balloon. A standard nine inch, round, rubber Qualatex balloon as manufactured by Pioneer Rubber Company, Willard, Ohio (Order Number P5940). The balloon is inflated to a circumference of sixteen inches. After inflation, the mouthpiece should be knotted and forced inside the balloon and sealed with a piece of masking tape one inch square.

Procedure: The administrator hands the spoon to the subject, noting which hand he chooses to use first. The spoon must be held at the end of the handle rather than in the middle. The examiner instructs the subject in the proper technique for tapping and demonstrates, hitting the balloon with the bowl of the spoon. At the beginning of each trial, the examiner tosses the balloon into the air in such a way that the subject can make the first tap. All subsequent taps must be made with the bowl of the spoon. It is a foul if the balloon touches the handle of the spoon, the subject's hand(s), or the floor. If the balloon touches the floor, it is again tossed into the air, and tapping continues until fifteen attempts are recorded. Wall and ceiling touches are permitted. There are two trials with the right hand and two trials with the left hand.

Scoring: The score is the sum of successful taps made.

Testing Personnel: The administrator tosses the balloon into the air and counts the fifteen attempts while the recorder counts the number of fouls.
Administrative Procedure: "I want you to tap the balloon with this spoon and keep it in the air, like this. (Demonstrate by tapping the balloon several times, noting that only the red part, or bowl, of the spoon makes contact). Try to hit the balloon straight up, so you can hit it again. Every time you hit the balloon, count out loud: one, two, three, until you come to fifteen. Stop when you get to fifteen. You should also stop when the balloon touches the floor. Your job, then, is to see how many good taps you can make. My helper will count the mistakes you make. It is a mistake: if the balloon touches your hand; if the balloon touches the handle instead of the red part of the spoon; or if the balloon touches the floor."

Each subject has two trials with the right hand and two trials with the left hand. A trial is over when the subject has made a total of fifteen hits and/or misses. To start, the administrator says, "Ready... begin," and tosses the balloon into the air so that the subject can tap it with the spoon. Observe the number of taps and/or attempts made, calling "Stop" when the subject reaches fifteen. If the balloon touches the floor, begin again by tossing the balloon, and resume counting with the number following the one in which the mistake was made. The recorder counts the number of mistakes made during the trial, and records a score for each trial (fifteen attempts minus the mistakes). The maximum is fifteen per trial. Every hit counts so long as the balloon remains in the air. Wall and ceiling touches are permitted.

Analysis of the Experimental Tests

In order to ascertain the usefulness of the experimental tests, it was necessary to study the quality of each test in reference to commonly-accepted standards of testing. Validity, objectivity, and reliability are acknowledged to be qualities of major concern in the process of test development.
The process of test construction utilized by the writer dictated the development of tasks with reference to the definition of perceptual-motor achievement used in this study. Because the tests were derived from the description of perceptual-motor achievement in behavioral terms, validity was considered to be inherent in the tasks themselves. By means of logical analysis, noting the content of the task, and the processes which each required, the writer identified each test with reference to the previously defined aspects of perceptual-motor achievement.

One of the sub-problems of this study was to design tests which could be accurately and objectively scored. Errors in measurement arise from a variety of sources. Among the conditions which are likely to produce inconsistency in test scores are: (a) individual response variation due to fatigue, lack of motivation, or fluctuation in mood; (b) variation in the administrative procedure; and (c) variation in observing and recording the subject's responses. The writer attempted to eliminate inconsistencies, insofar as possible, by means of the following procedures.

In selecting situations from which tests could be developed, effort was made to choose tasks and materials which would be interesting for children at the primary school level. Interest was believed to be a major factor in the motivation of children. Groups of subjects assigned to the testing stations were small, averaging five subjects per group. This made it possible to keep children actively involved, and helped to prevent them from becoming impatient.
In designing tests, the writer attempted to utilize tasks which did not require an inordinate amount of strength or endurance. Fatigue was held to be a detrimental factor in securing representative samples of the individuals' performance abilities. In tests which demanded rather continuous exertion, such as the hopping tasks, two subjects alternated in performing and resting. In the rolling task, the subjects were instructed to lie still and rest between trials in order to prevent dizziness and fatigue.

Explicit written directions for the administration of the tests were given to the members of the testing team. Administrators practiced the verbal instructions to subjects as well as the actions required in performing demonstrations. The pilot testing program provided ample opportunity for experience in administering tests and recording observations under conditions which approximated the experimental situation as nearly as possible.

Recorded observations were totaled and checked by the writer and an assistant during the process of reading and transferring scores onto data sheets for use by the personnel at the computer center.

In designing the tests as well as in organizing the testing program, efforts were made to minimize inconsistencies in measurement. No attempt was made to determine statistically the stability between examiners. The components of the property of objectivity are essential to the dependability of tests, and as such, have a major influence on the reliability of tests. In discussing the property of reliability, Scott⁵ states:

⁵Scott, p. 19.
Reliability, or consistency of measurement of the same degree of ability, is possible only if the performer is interested enough to put forth maximum effort, if his own skill only is measured, if equipment and test conditions are uniform, if the trials are sufficient in number to eliminate chance variations, and if scoring of performance is objective.

Test scores of the 178 subjects in grades one, two and three provided the data used in computing reliability estimates for each test. The intraclass correlation method was employed to derive two reliability coefficients, one estimating the reliability of the total test score, and a second estimating the average reliability of single measures within the test. According to Baumgartner this method is well suited for use in physical performance tests in which all of the trials are administered on the same day. He indicated that the intraclass correlation coefficient is the best estimate of reliability with multiple-trial tests, since this method can take into account many sources of variation in test scores. Scores of subjects in this study were subjected to the single factor repeated measures analysis of variance technique and processed electronically at the Computer Center, Wisconsin State University - Oshkosh.

In order to determine the extent to which tests appeared to be measuring the same abilities, intercorrelations were computed.

To permit a more detailed study of performance, the sample, consisting of 178 subjects, was divided into sub-samples according to

---


grade level and sex. Means and standard deviations for these groups as well as for the entire sample were computed on each test. The results of statistical procedures are presented and interpreted in the following chapter.
The focus of this study was on the development of valid and reliable tests which could be used to assess the perceptual-motor achievement of elementary school boys and girls. In order to establish the validity of the tests in relation to the definition of perceptual-motor achievement used in this study, logical analysis was used. The analysis preceded the administration of the experimental tests to the public school sample. The scores of subjects comprising the sample were used to obtain estimates of reliability on the tests selected for experimental use.

Data for this study were programmed and processed by the Computer Center, Wisconsin State University - Oshkosh. The single factor repeated measures analysis of variance program provided data for computing estimates of reliability by means of the intraclass correlation method.

The sample of 178 boys and girls in grades one, two, and three was divided into sub-samples according to grade level and sex. Means and standard deviations were computed for the various groups, in order to describe the performance of representative groups of children on each test. In order to study the relationships among the experimental tests, intercorrelations were computed.
Reliability estimates for each of the tests will be presented in this chapter along with the results of the performances of the sample groups. The interrelationships of the various measures will be shown by means of a table of intercorrelations.

Table 1 presents the reliability estimates for the experimental tests in reference to each of the grade levels and in reference to the entire sample. The coefficient (.511) for the entire sample on Test 1, Angle Board, was considered to be low. It may be seen that the correlation coefficients differed from grade level to grade level, with the lowest, .339, at the second grade level. It is generally true that tests composed of items scored on a success-failure basis produce low reliability coefficients unless a large number of trials are administered. By means of the Spearman-Brown prediction formula,\(^1\) it was estimated

\begin{table}
\centering
\caption{Reliability Coefficients for the Experimental Tests}
\begin{tabular}{lcccccc}
\hline
 & Angle Board & Hopping Over Lines & Block Maze & Log Roll & Bowling & Balloon Tapping \\
\hline
Grade 1 & .513 & .720 & .579 & .728 & .486 & .858 \\
Grade 2 & .339 & .752 & .458 & .330 & .473 & .887 \\
Grade 3 & .422 & .799 & .737 & .659 & .537 & .751 \\
Grades 1, 2, 3 & .511 & .785 & .693 & .619 & .544 & .856 \\
\hline
\end{tabular}
\end{table}

\(^1\)Winer, p. 127.
that forty trials would be required to obtain an overall reliability coefficient of .80, and eighty-five trials would be needed to achieve a reliability of .90.

Table 2 presents the mean score and the standard deviation for each of the sample groups on Test 1, Angle Board. The maximum score was ten. The mean score of the entire population of 178 boys and girls was 2.5, with a standard deviation of 1.86, indicating that this test was too difficult for these children. An optimal distribution of scores would place the mean nearer the midpoint of the range from zero to ten. This might be accomplished in several ways: by increasing the size of the target; by placing the target closer to the top of the incline; or by designing a target with three compartments instead of one.

**TABLE 2**

**MEAN AND STANDARD DEVIATION FOR ANGLE BOARD**

| Grade | Boys and Girls | | | | | | | | | | | | | |
|-------|----------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
Grade 2 vs. Boys and Girls Grade 3; Boys and Girls Grade 1 vs. Boys and Girls Grade 3; Boys All Grades vs. Girls All Grades. Differences between the group means on the experimental tests are presented in Table 3.

The data for Test 1, Angle Board, suggested an improvement across the grade levels. Statistically significant differences between means were found in each of the grade level comparisons. Based upon the developmental principle of increasing control of neuro-muscular processes during the period of childhood, this trend was to be expected.

The performance of boys surpassed the performance of girls, the difference in mean scores being significant at the .01 level of confidence. This phenomenon has been observed many times by other investigators, especially in regard to activities involving ball-handling skills.

In general, the variability in performance of the older children was greater than that of the younger children. This is indicated by the size of the standard deviations (Table 2) for the composite groups of boys and girls at each grade level. Exceptions are between second grade and first grade for boys, and between third grade and second grade for girls. The contrast between the standard deviation for boys in grades one, two, and three, and for girls in grades one, two, and three, indicates that there was a greater dispersion among the boys' scores than among the girls' scores.

Table 1 shows the reliability estimates for Test 2, Hopping Over Lines. The coefficient (.785) for the entire sample was considered
### TABLE 3

**DIFFERENCES BETWEEN GROUP MEANS**

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Angle Board Mean</th>
<th>Diff.</th>
<th>Hopping Over Lines Mean</th>
<th>Diff.</th>
<th>Block Maze Mean</th>
<th>Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>1.533</td>
<td></td>
<td>50.117</td>
<td></td>
<td>11.067</td>
<td></td>
</tr>
<tr>
<td>Grade 2</td>
<td>2.617</td>
<td>1.084</td>
<td>54.883</td>
<td>4.766</td>
<td>13.050</td>
<td>1.983</td>
</tr>
<tr>
<td>Grade 2</td>
<td>2.617</td>
<td></td>
<td>54.883</td>
<td></td>
<td>13.050</td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>3.379</td>
<td>0.762</td>
<td>58.034</td>
<td>3.151</td>
<td>15.069</td>
<td>2.019</td>
</tr>
<tr>
<td>Grade 1</td>
<td>1.533</td>
<td></td>
<td>50.117</td>
<td></td>
<td>11.067</td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>3.379</td>
<td>1.846</td>
<td>58.034</td>
<td>7.917</td>
<td>15.069</td>
<td>4.002</td>
</tr>
<tr>
<td>All Boys</td>
<td>3.284</td>
<td></td>
<td>51.273</td>
<td></td>
<td>13.886</td>
<td></td>
</tr>
<tr>
<td>All Girls</td>
<td>1.733</td>
<td>1.551</td>
<td>57.267</td>
<td>5.994</td>
<td>12.211</td>
<td>1.675</td>
</tr>
</tbody>
</table>

**Comparison Log Roll**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>12.967</td>
<td></td>
<td>3.750</td>
<td></td>
<td>36.050</td>
<td></td>
</tr>
<tr>
<td>Grade 2</td>
<td>10.933</td>
<td>2.034</td>
<td>4.983</td>
<td>1.233</td>
<td>39.183</td>
<td>3.133</td>
</tr>
<tr>
<td>Grade 2</td>
<td>10.933</td>
<td></td>
<td>4.983</td>
<td></td>
<td>39.183</td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>10.966</td>
<td>0.033</td>
<td>5.414</td>
<td>0.431</td>
<td>41.707</td>
<td>2.524</td>
</tr>
<tr>
<td>Grade 1</td>
<td>12.967</td>
<td></td>
<td>3.750</td>
<td></td>
<td>36.050</td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>10.966</td>
<td>2.001</td>
<td>5.414</td>
<td>1.664</td>
<td>41.707</td>
<td>5.657</td>
</tr>
<tr>
<td>All Boys</td>
<td>10.875</td>
<td></td>
<td>5.375</td>
<td></td>
<td>41.250</td>
<td></td>
</tr>
<tr>
<td>All Girls</td>
<td>12.367</td>
<td>1.492</td>
<td>4.056</td>
<td>1.319</td>
<td>36.700</td>
<td>4.550</td>
</tr>
</tbody>
</table>

\(^a\) Significant at the .05 level

\(^b\) Significant at the .01 level
acceptable. The reliabilities for the grade level groups were similar in magnitude, indicating that this test would be suitable for use at all three grade levels. Application of the Spearman-Brown prediction formula indicated that a reliability coefficient of .87 might be attained if subjects were required to perform each of the three hopping tasks two times with the right foot and two times with the left foot. This would make a total of 144 hops.

Table 4 gives the mean and standard deviation for each group on Test 2, Hopping Over Lines. The score on this test was a composite of three hopping tasks: (a) side-to-side; (b) forward-backward; and (c) in a square pattern. The maximum score was seventy-two. The mean for the entire sample was 54.303, with a standard deviation of 9.51. Due to the location of the mean and size of the standard deviation, there might be some question as to the capacity of this test to discriminate among children of superior ability.

**TABLE 4**

MEAN AND STANDARD DEVIATION FOR HOPPING OVER LINES

<table>
<thead>
<tr>
<th>Grade</th>
<th>Boys and Girls</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>S.D.</td>
<td>S.D.</td>
</tr>
<tr>
<td>1</td>
<td>50.117</td>
<td>46.778</td>
<td>52.848</td>
</tr>
<tr>
<td></td>
<td>8.56</td>
<td>7.76</td>
<td>8.31</td>
</tr>
<tr>
<td>2</td>
<td>54.883</td>
<td>53.781</td>
<td>56.143</td>
</tr>
<tr>
<td></td>
<td>8.99</td>
<td>7.76</td>
<td>10.21</td>
</tr>
<tr>
<td>3</td>
<td>58.034</td>
<td>53.724</td>
<td>63.379</td>
</tr>
<tr>
<td></td>
<td>9.47</td>
<td>9.39</td>
<td>5.89</td>
</tr>
<tr>
<td>1, 2, 3</td>
<td>54.303</td>
<td>51.273</td>
<td>57.267</td>
</tr>
<tr>
<td></td>
<td>9.51</td>
<td>8.79</td>
<td>9.34</td>
</tr>
</tbody>
</table>
In Table 3, it may be seen that the difference between the means of grades one and two was significant at the .01 level of confidence. The difference between the means of grades two and three, however, was not of comparable significance. The t ratio between these two means was 1.8542. A ratio of 1.979 was required to demonstrate significance at the .05 level.

The performance of girls surpassed the performance of boys of the entire sample. The difference between the means was significant at the .01 level of confidence. This task clearly relates to dynamic balance, and it has been noted by many investigators that females tend to score better than males in tests of balance.

The standard deviation (Table 4) for the composite groups of boys and girls at each grade level indicated that variability was greater among the scores of older children than among the scores of younger children. In reference to boys only, the standard deviation for first grade boys was the same as that for second grade boys, with an increase in variability at the third grade level. In reference to girls only, there was an increase in variability between grade one and grade two, but the variability among scores for third grade girls was less than that of any grade. The standard deviation of 5.89 for third grade girls was smaller than that of any of the sub-groups. The mean score for these girls (63.379) was within nine points of the perfect score. This suggested that the test was not sufficiently challenging for third grade girls in particular.
The reliability data for Test 3, Block Maze, are presented in Table 1. The coefficient for the entire sample was .693, with coefficients of .579, .458, and .737 for grades one, two, and three respectively. This test was considered to be reasonably reliable for third grade children, but less dependable for first and second grade children. It was estimated by means of the Spearman-Brown prediction formula that six trials would be needed to attain an overall reliability of .81, and that twelve trials would be required to achieve a reliability of .89. Subjects in this sample had three trials.

Table 5 gives the mean and standard deviation for each group on Test 3, Block Maze. The maximum score for this test was forty-five. The mean score for the entire sample was 13.039, with a standard deviation of 3.84. This would accommodate scores falling within three standard deviations on either side of the mean. In order to locate the mean nearer the middle of the range of points, it might be desirable to

<table>
<thead>
<tr>
<th>Grade</th>
<th>Boys and Girls Mean</th>
<th>S.D.</th>
<th>Boys Mean</th>
<th>S.D.</th>
<th>Girls Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.067</td>
<td>2.99</td>
<td>11.704</td>
<td>3.33</td>
<td>10.545</td>
<td>2.62</td>
</tr>
<tr>
<td>2</td>
<td>13.050</td>
<td>2.94</td>
<td>14.031</td>
<td>3.34</td>
<td>11.929</td>
<td>1.88</td>
</tr>
<tr>
<td>3</td>
<td>15.069</td>
<td>4.42</td>
<td>15.862</td>
<td>3.81</td>
<td>14.379</td>
<td>4.85</td>
</tr>
<tr>
<td>1, 2, 3</td>
<td>13.039</td>
<td>3.84</td>
<td>13.886</td>
<td>3.85</td>
<td>12.211</td>
<td>3.68</td>
</tr>
</tbody>
</table>
change the time limit from fifteen to twenty seconds per trial.

Table 3 presents information concerning the differences between group means on Test 3, Block Maze. It may be seen that the trend toward improvement in performance from grade one through grade three was statistically significant at the .01 level of confidence. Also, the mean of the boys was significantly greater than the mean of the girls in the sample.

The standard deviations (Table 5) for the composite groups of boys and girls suggested that the variability among scores for first grade subjects was like that for second grade subjects. The scores of third grade subjects were more widely dispersed than those of the younger children. The same pattern was evident in reference to boys only from grade one through grade three. An exception to the pattern existed at second grade level for girls only. In this sub-sample, the scores were grouped more closely about the mean than were the scores for any other sample group. The scores of boys were more variable than the scores of girls at every grade level except third grade.

Reliability estimates for Test 4, Log Roll, are presented in Table 1. The coefficient for the entire sample was .619, with coefficients of .728, .330, and .659 respectively for grades one, two, and three. It was predicted by means of the Spearman-Brown formula that ten trials would be needed to achieve an overall reliability of .80, and twenty-two trials would be needed to achieve a reliability of .89. In this task, the subject rolled a distance of ten feet. Four trials were given, two with the right side next to the starting line, and two with
the left side next to the starting line. An alternative to increasing the number of trials might be to increase the duration of each trial by lengthening the grid upon which the subjects rolled.

Table 6 gives the mean and standard deviation for each group on Test 4, Log Roll. In this test, a perfect score consisted of zero deviations from the center zone, and the worst score possible was eighty. The mean number of rolling deviations for the entire sample was 11.629, with a standard deviation of 6.65. This distribution would not be able to accommodate scores between two and three standard deviations above the mean.

**TABLE 6**

**MEAN AND STANDARD DEVIATION FOR LOG ROLL**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Boys and Girls Mean</th>
<th>S.D.</th>
<th>Boys Mean</th>
<th>S.D.</th>
<th>Girls Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.967</td>
<td>7.65</td>
<td>11.926</td>
<td>6.88</td>
<td>13.818</td>
<td>8.24</td>
</tr>
<tr>
<td>2</td>
<td>10.933</td>
<td>5.46</td>
<td>9.562</td>
<td>5.48</td>
<td>12.500</td>
<td>5.09</td>
</tr>
<tr>
<td>3</td>
<td>10.966</td>
<td>6.62</td>
<td>11.759</td>
<td>7.25</td>
<td>10.586</td>
<td>5.77</td>
</tr>
<tr>
<td>1, 2, 3</td>
<td>11.629</td>
<td>6.65</td>
<td>10.875</td>
<td>6.62</td>
<td>12.367</td>
<td>6.68</td>
</tr>
</tbody>
</table>

Inspection of Table 3 reveals the fact that none of the mean differences between sub-groups was significant at the .05 level of confidence.

There was no clear pattern in regard to the variability of performance (Table 6) among the groups. In general, the scores of first grade subjects were more variable than the scores of second and third grade subjects,
an exception being the standard deviation of first grade boys. Standard deviations of second grade subjects were smaller than those of first and third grade subjects.

Reliability estimates for Test 5, Bowl Between Pins, are listed in Table 1. The coefficient for the entire sample was .544, with coefficients of .486, .473, and .537, for grades one, two, and three respectively. These were considered to be consistently lower than desired. By utilizing the Spearman-Brown formula, it was predicted that thirty-four trials would be needed to achieve a coefficient of .80, and eighty trials would be required to obtain a coefficient of .90.

Table 7 presents the mean and standard deviation for each group on Test 5, Bowl Between Pins. The maximum score was ten. The mean score for the entire sample was 4.707, with a standard deviation of 2.21, indicating an adequate distribution of scores.

**TABLE 7**

**MEAN AND STANDARD DEVIATION FOR BOWL BETWEEN PINS**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Boys and Girls Mean</th>
<th>S.D.</th>
<th>Boys Mean</th>
<th>S.D.</th>
<th>Girls Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.750</td>
<td>2.05</td>
<td>4.481</td>
<td>2.06</td>
<td>3.152</td>
<td>1.86</td>
</tr>
<tr>
<td>2</td>
<td>4.983</td>
<td>2.09</td>
<td>5.750</td>
<td>1.85</td>
<td>4.107</td>
<td>2.02</td>
</tr>
<tr>
<td>3</td>
<td>5.414</td>
<td>2.19</td>
<td>5.793</td>
<td>1.91</td>
<td>5.034</td>
<td>2.41</td>
</tr>
<tr>
<td>1, 2, 3</td>
<td>4.707</td>
<td>2.21</td>
<td>5.375</td>
<td>2.01</td>
<td>4.056</td>
<td>2.22</td>
</tr>
</tbody>
</table>
Table 3 shows the differences between the means of the sub-samples on Test 5, Bowl Between Pins. The mean of grade two subjects was significantly greater at the .01 level than the mean of the first grade subjects. The comparison between the means of second and third grade subjects showed no statistically significant difference. In comparing the mean score of boys with the mean score of girls in the entire sample, it was found that the boys' mean was significantly greater than the girls' mean at the .01 level of confidence.

In the composite groups of boys and girls (Table 7), the standard deviations increased from grade one through grade three, indicating that the scores of the older subjects were more widely distributed than were those of the younger subjects. The trend toward increased variability with increasing age was also evident in reference to girls only. In considering the standard deviations of the boys' groups, however, the greatest variability was shown to be at the first grade level.

The reliability estimates for Test 6, Balloon Tapping, are presented in Table 1. The coefficient for the entire sample was .856, with coefficients of .858, .887, and .751, for grades one through three respectively. These reliabilities were considered excellent. In order to achieve a coefficient of .89, it was predicted by means of the Spearman-Brown formula that six trials would be needed. In this test, four trials were given, two with the right hand and two with the left hand. It would probably be wise to administer two additional trials.

Table 8 lists the mean and standard deviation for each group on Test 6, Balloon Tapping. The mean for the entire sample was 38.949,
with a standard deviation of 8.5. The maximum score was sixty. The location of the mean near the midpoint of the scoring range with this standard deviation would permit a normal range of scores.

**TABLE 8**

**MEAN AND STANDARD DEVIATION FOR BALLOON TAPPING**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Boys and Girls Mean</th>
<th>Boys Mean</th>
<th>Girls Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36.050</td>
<td>39.185</td>
<td>33.485</td>
</tr>
<tr>
<td>2</td>
<td>39.183</td>
<td>42.531</td>
<td>35.357</td>
</tr>
<tr>
<td>3</td>
<td>41.707</td>
<td>41.966</td>
<td>41.655</td>
</tr>
<tr>
<td>1, 2, 3</td>
<td>38.949</td>
<td>41.250</td>
<td>36.700</td>
</tr>
</tbody>
</table>

It was observed that the mean scores tended to increase from grade one through grade three. The differences between means of the grade level groups approached but did not attain significance at the .05 level of confidence, as shown in Table 3. The t ratio for the first grade and second grade means was 1.9380; for the second grade and third grade means the t ratio was 1.7518. A ratio of 1.979 was required to demonstrate significance at the .05 level of confidence. The mean score for boys was significantly greater at the .01 level of confidence than the mean score for girls.

For composite groups of boys and girls (Table 8), the standard deviation decreased from grade one through grade three, indicating that there was less variability among the scores of older children than among
the scores of younger children. Similarly, the trend toward less variability with increasing age was observed with regard to girls only. There was no clear pattern for boys only. The sizes of the standard deviations indicated that the boys' scores were less variable than the girls' scores at each grade level.

The intercorrelations for the experimental tests are given in Table 9. These intercorrelations were established by using the entire sample of 178 boys and girls. With 177 degrees of freedom, a correlation of .148 is statistically significant at the .05 level of confidence, of .193 at the .01 level. The coefficients are all low, indicating that each of the tests was measuring a different ability. Inasmuch as each task was

<table>
<thead>
<tr>
<th></th>
<th>Hopping Over Lines</th>
<th>Block Maze</th>
<th>Log Roll</th>
<th>Bowling</th>
<th>Balloon Tapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle Board</td>
<td>.119</td>
<td>.328</td>
<td>-.211</td>
<td>.388</td>
<td>.252</td>
</tr>
<tr>
<td>Hopping Over Lines</td>
<td>.250</td>
<td>-.023</td>
<td>.242</td>
<td>.196</td>
<td></td>
</tr>
<tr>
<td>Block Maze</td>
<td>-.036</td>
<td>.324</td>
<td>.246</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log Roll</td>
<td></td>
<td>-.221</td>
<td>-.119</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bowl Between Pins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.239</td>
</tr>
</tbody>
</table>
selected to represent different facets of perceptual-motor performance, this finding was not surprising. In assembling a battery of perceptual-motor tests, it would be highly desirable to utilize such unrelated measures. The negative coefficients for Test 4, Log Roll, resulted from the manner in which this test was scored. A high numerical score indicated poor performance, and a low numerical score indicated good performance. The highest correlation (.388) was between Test 5, Bowl Between Pins, and Test 1, Angle Board. Both tasks involved rolling a softball underhand, but one task was designed to test perception of distance from subject to object, while the other was designed to test perception of distance between two objects.

The following summary is based upon material presented in Table 1, which gives the reliability coefficients obtained on all six tests. The size of these coefficients was of major concern in evaluating the experimental tests. According to Scott:

no arbitrary size can be set as a minimum but generalizations can be made... Lower coefficients can be expected in tests of physical abilities than in tests of mental capacities, perhaps due to more fluctuation in the former. Tests given to girls usually yield lower reliabilities than when given to boys, probably due to the greater difficulty of motivating girls to put forth their best efforts. The performance of inexperienced players is usually less reliable than that of highly skilled ones... With all of the above points in mind, a generalization can be made on the qualitative interpretations of numerical coefficients. Anything above .85 is considered excellent... From .75 to .85 is considered adequate for many purposes. As reliability coefficients drop below .75, they indicate an inconsistent and poor measuring instrument.²

The overall reliability coefficient for Test 6, Balloon Tapping, (.856) was considered excellent. The coefficients for grade one (.858), grade two (.887), and grade three (.751), indicated that this test could be used with all three grade levels.

The reliability for Test 2, Hopping Over Lines (.785), was considered to be acceptable. It would probably be profitable, however, to experiment with additional trials. The reliabilities for the grade level groups were: grade one (.720); grade two (.752); and grade three (.799). These coefficients could have been influenced by the number of opportunities children have had to experience activities similar to the test situation in the three grade level groups. Activities such as hopscotch and rope jumping are commonly engaged in by children in the primary grades.

In reference to the entire sample, reliabilities for Test 3, Block Maze (.693) and Test 4, Log Roll (.619) rendered these tests of limited value unless the number of trials could be increased or the tasks re-designed. It was predicted that six trials would be needed to attain a reliability of .81 for Block Maze. This would be double the number of trials administered to the sample. The ten trials needed to achieve a reliability of .80 on Log Roll seemed to be prohibitive in terms of time and fatigue factors. Block Maze was more reliable with reference to the third grade population (.737). It might be desirable to include this task for third grade testing, but eliminate it from tests given to first and second grade children. The reliability for Log Roll in reference to first grade children was .728. It proved to be highly inconsistent with the
second grade sample (.330), and of limited value with the third grade sample (.659).

The two tasks chosen to represent the ability to project objects accurately toward targets in space - Test 1, Angle Board, and Test 5, Bowl Between Pins - reflected considerable inconsistency in measurement. Coefficients obtained for the entire sample for Angle Board and Bowl Between Pins were .511 and .544 respectively. These coefficients indicate that both tests are relatively undependable, for use with individuals, and could only be used in circumstances which will be discussed later in this chapter. It was predicted by the Spearman-Brown formula that forty trials would be needed to obtain a reliability of .80 for Angle Board, and thirty-four trials would be needed to obtain a reliability of .80 for Bowl Between Pins. It would, perhaps, be preferable to re-design these tasks in some way to eliminate the necessity for scoring them on a pass-fail basis.

Ultimately, the consistency of measurement which one demands of a test instrument depends upon the purpose or purposes which one has for using the test. If the score which an individual makes is to be used in making an important decision about that person's life, now or in the future, then a relatively high reliability coefficient should be required. If, however, one wishes to draw accurate conclusions about groups, as in comparing the means of two or more groups, a test with a relatively low reliability can be useful.

Thorndike and Hagen\(^3\) demonstrate the fact that a correlation

coefficient of .80 indicates the probability that subsequent testing will reverse the relative position of two individuals one out of five times, and that a coefficient of .90 indicates the probability that positions will be reversed one out of twelve times. In comparing the means of groups of twenty-five subjects, however, the situation is different. When the reliability coefficient is .50, the chance of reversal in the relative positions among the groups is one in twenty. Coefficients of .60 and .70, indicate probabilities of one in one-hundred and one in one-thousand, respectively.

Of the six tests in this study, only two - Balloon Tapping (.856) and Hopping Over Lines (.785) - may be considered reliable enough as presently developed to use in reference to the performance of individuals. All six of the tests may be considered dependable for use in studying the performance of groups of twenty-five subjects or more.
CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to establish a practical and valid method of determining perceptual-motor achievement among elementary school children, in tasks which have particular relevance to physical education, in order to gain more information about the learning process.

The writer defined the concept of perceptual-motor achievement as the ability to select, organize, and respond overtly to sensory cues: in maintaining orientation to gravity while moving about; in making and avoiding contact with stationary objects and persons while moving about in space; in making and avoiding contact with moving objects and persons; and in projecting objects accurately toward targets in space.

Various aspects of perceptual-motor achievement were described in behavioral terms and analyzed for perceptual content and motor requirements. These descriptions provided ideas for the construction of gross-motor tasks which required the subject to recognize task demands and to take appropriate action.

At the conclusion of a period of informal testing and experimentation with testing equipment and administrative procedures, twenty tasks were selected for use in a pilot testing program. The subjects
were seventy-six boys and girls enrolled in first, second, and third grade classrooms of the Rose C. Swart Campus School, Wisconsin State University - Oshkosh. The tests were administered and scored by university students under the direction of the writer. The pilot testing program also served as the training period for test administrators who participated in the final testing program. Analysis was made of the data derived from the pilot testing program, and administrative procedures and scoring techniques were refined. Six tests, classified according to the aspects of perceptual-motor achievement which they represented, were selected for experimental use. The tests were as follows.

Test 1, Angle Board, required the subject to roll a softball up an inclined plane with force sufficient to reach a target box, placed twelve inches away from the top of the incline. Processes required of the subject included: releasing the ball at an optimal moment in the underhand throwing pattern; making judgments concerning the amount of force needed to attain the goal; and monitoring visual and kinesthetic feedback during each succeeding trial. The test was selected as an example of perceptual-motor behavior in which the individual must project objects accurately toward targets in space. It was held that the dimension of space with which this task was most clearly related was the depth dimension. Ten trials were given with the preferred hand, each trial being recorded on a pass-fail basis. The score was the number of successes in reaching the target.

Test 2, Hopping Over Lines, consisted of three tasks performed first on the right leg, then on the left leg. The subject hopped side-to-
side, forward-backward, and in a square pattern, in relation to two masking tape lines on the floor. The lines were at right angles, each bisecting the other. In general the tasks represented the ability to maintain orientation to gravity while moving about in space - a test of dynamic balance. Processes required of the subject were: making continuous postural adjustments in reference to planes within the body; differentiating and integrating the movements of various body parts; and maintaining rhythmic locomotion while controlling the direction of the body movement. The task provided an opportunity to exercise motor planning in making concurrent adjustments in relation to direction, continuity of action, and floor pattern demands. Twelve hops were performed, using each leg once, for each of the three sub-tasks. The score was the number of hops made without fault.

Test 3, Block Maze, required the subject to push a block of wood through a configuration composed of straight lines and angles. The implement was a wooden wand. The object of the task was to push the block as far as possible within a fifteen-second time limit. The problem posed by this task required the ability to make and to avoid making contact with stationary objects and persons while moving about in space. Processes required of the subject included: coordination of the visual and motor systems; adapting to tactual and visual cues; and making decisions in relation to the use of force and time in moving through space. The subject had to accommodate to demands for speed as well as accuracy. Three trials were taken with the preferred hand. The score was the distance covered minus line violations.
Test 4, Log Roll, required the subject to lie on the floor with body extended, and roll in a straight line. A grid was drawn on a strip of plastic material to make the recording of deviations from a center zone possible. The task was classified as an activity which required the ability to make and to avoid making contact with objects and persons while moving about in space. Processes required of the subject included: maintaining orientation in space by utilizing visual, tactual, and kinesthetic cues; synthesizing the thrusting movements of body parts; and directing the movement in reference to the long axis of the body. The subject had to maintain a rhythmic alternation of the effort of the top and bottom halves of the body in order to solve the directional problem. Two trials were given with the right side next to the starting line, and two trials with the left side next to the starting line. The score was the sum of deviations from the center zone.

Test 5, Bowl Between Pins, required the subject to roll a soft ball between two plastic pins set twelve inches apart. The subject stood behind a restraining line eight feet away. The task was selected as an example of activity which required the ability to project objects accurately toward targets in space. Processes involved included: focusing visually on a near target; perceiving the distance between two objects; and timing the release of the ball in such a way that it would travel the desired path. In contrast to Angle Board, this test focused on the horizontal dimension of space. Ten trials were taken with the preferred hand, and recorded on the basis of pass or fail. The score was the sum of successful rolls.
Test 6, Balloon Tapping, required the subject to tap a balloon with a wooden kitchen spoon, attempting to keep it in the air. This task was selected as an example of activity which required the ability to make and to avoid making contact with moving objects and persons. Processes required were: tracking the moving balloon with the eyes; sequencing the movements of the body in striking the balloon with the spoon; and utilizing tactual as well as visual cues in regulating the amount of force needed to maintain control of the balloon. Acting and responding in relation to a moving object required concentration, and facility in adapting to changing situations. Two trials, consisting of fifteen attempts each, were taken with the right hand and two trials with the left hand. The score was the sum of successful taps.

The testing program took place on May 22 and May 23, 1969, at Franklin Elementary School, Oshkosh, Wisconsin. Subjects were 178 boys and girls, enrolled in grades one, two, and three. The testing team was composed of twenty-two university students trained in the administration and scoring of the experimental tests.

For the purpose of analyzing the test data, sub-groups within the sample were identified according to grade level and sex. The mean and standard deviation were computed for the entire sample as well as for each sub-group on each of the six tests. Reliability estimates were obtained by means of the intraclass correlation method. In order to determine the extent to which tests appeared to be measuring the same abilities, intercorrelations were computed.
Intercorrelations among the six tests were all low. The highest correlation coefficient (.388) was between Test 1, Angle Board, and Test 5, Bowl Between Pins. If, through further experimentation, the reliabilities of some of the tests can be increased, it would be desirable to incorporate such unrelated tests into a battery.

For use with individuals in grades one, two, and three, the reliability for Test 6, Balloon Tapping, (.856) was considered to be excellent. The reliability for Test 2, Hopping Over Lines, (.785) was considered to be acceptable. None of the other four tests were considered to be sufficiently reliable to use in making important decisions about individuals without revision and additional experimentation. Suggestions were made concerning changes which might produce improvements.

In reference to the comparative study of group means when twenty-five or more subjects are included, all of the six tests were considered to be reliable.

In reference to the problem stated in this study, the following conclusions were drawn.

1. A definition of perceptual-motor achievement which could serve as a framework for the development of valid test items was described in behavioral terms.

2. Two tests constructed on the basis of content validity yielded reasonably reliable results with a sample of elementary school children. The two tests were reliable across grade levels one, two, and three, and were considered dependable for use with individuals.
3. All of the tests were found to be reliable to use in studying the differences between the means of groups of twenty-five or more individuals.

Much more effort is needed to realize the objective of constructing a battery of valid and reliable tests to use in assessing perceptual-motor achievement of elementary school boys and girls. Recommendations for further study follow.

1. Tests which yielded relatively low reliabilities with this sample should be refined and subjected to further experimentation.

2. Tests which were found to have acceptable reliabilities with this sample should be administered to other samples within the first, second, and third grade population in order to check these results.

3. Tests which were found to have acceptable reliabilities with this sample should be administered to additional samples within the elementary school population (e.g. kindergarten, grade four, grade five, and grade six).

4. Tests found to be reliable with this sample should be administered to a large representative sample in order to establish norms for use in educational and research programs.

5. Additional tasks, representative of the various facets of perceptual-motor achievement described in this study, should be designed and subjected to the recommended procedures for test development.
APPENDIX
Task: ANGLE BOARD - Station 1

<table>
<thead>
<tr>
<th>Identification Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Item</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>-----</td>
<td>---------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>Side-To-Side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forward-Back</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Square</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Side-To-Side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forward-Back</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Square</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Task: BLOCK MAZE - Station 3

<table>
<thead>
<tr>
<th>Identification Number</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Task: LOG ROLL - Station 4

<table>
<thead>
<tr>
<th>No</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></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>

Deviations R
Deviations L
Total Score
Task: BOWL BETWEEN PINS - Station 5

<table>
<thead>
<tr>
<th>Identification Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></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>
Task: BALLOON TAPPING - Station 6

<table>
<thead>
<tr>
<th>Identification Number</th>
<th>Trial One R</th>
<th>Trial Two R</th>
<th>Trial One L</th>
<th>Trial Two L</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STATISTICAL FORMULAS

Intraclass Reliability Coefficient

\[ r_k = 1 - \frac{MS_{\text{between people}}}{MS_{\text{w. people}}} \]

Single Measure Reliability Coefficient

\[ r_1 = \frac{MS_{\text{between people}} - MS_{\text{w. people}}}{MS_{\text{between people}} + (k - 1) MS_{\text{w. people}}} \]

Spearman - Brown Prediction Formula

\[ r_k = \frac{kr}{1 + (k - 1) r_1} \]

---

1 Winer, p. 126.
2 Ibid., p. 126.
3 Ibid., p. 127.
BIBLIOGRAPHY
BIBLIOGRAPHY

Books


Articles and Periodicals


Gutteridge, Mary V. "A Study of Motor Achievements of Young Children," Archives of Psychology, XXXIV, No. 244 (1939), 5-178.


Reports


Unpublished Material


Kiphard, Ernst J., and Schilling, Friedhelm. "Hammer Geschicklichkeitstest: In Der Modifizierung Nach F. Schilling (Marburg)." Wisconsin State University - Oshkosh: Lectures Sponsored by the Departments of Special Education and Women's Physical Education, March 17, 1969. (Mimeographed.)

Other Sources