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LEARNING DIFFICULTIES OF FIRST GRADE CHILDREN DIAGNOSED BY THE FROSTIG VISUAL PERCEPTUAL TESTS: A FACTOR ANALYTIC STUDY

by

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A DISSERTATION

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PREFACE

The writer wishes to express sincere appreciation to her Advisory Committee for their valuable advice and assistance. For the writer's major Adviser, Dr. William Reitz, words of thanks are quite inadequate. He guided the writer through every phase of the doctoral project with sympathy and patience. Without his guidance and inspiration this study would never have reached completion.

No work of this kind is ever completed without the help of many people. A deep and sincere indebtedness is acknowledged to the Superintendent and School Administration for permission to carry on the investigation in the school system that was the setting for this study; to the teachers and principals of the different participating schools, who during their busy schedules, helped by planning and arranging for student testing; and to the first grade children who helped immeasurably by their wholehearted cooperation.

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CHAPTER I

INTRODUCTION

Perception in Relation to Early School Learning

The perplexing problems of reading disability and the particular difficulties of the young school child, in learning to read, have prompted this investigation of the efficacy of a newly available group of tests of visual perception. The purpose, particularly, is to assess the predictive value of this group of tests for reading achievement in the first grade school child, since perceptual skill or ability appears to play an important role in early school learning.

Why some children encounter great difficulty in learning to read and how the school can anticipate or predict the children who will require special help to work out these problems of learning, have been concerns of long standing for educators. Perhaps no area in the field of education has been the subject of more concentrated study and investigation, from the turn of the century down to the present day, than has reading, in an effort to answer these and related problems. Teaching children to read was one of the initial educational studies considered in earliest investigations and remains a matter of major concern; with the difference that in today's schools one of the chief emphases of elementary education is on "reading to learn" rather than on "learning to read."[1] The importance of reading as a tool for further learning is in-

[1] William S. Gray, Reading, Encyclopedia of Educational Research, The Macmillan Co., 1941, pp. 891-93.

dicated in the close relationship found between proficiency in reading and school success in other subjects.

On the basis of experimental studies, it has been concluded that a large number of factors may be associated with reading difficulties. For example, Malmquist[1] found this true at the first grade level, Robinson's report notes this at other age levels as well.[2] Intensive study of possible causes has ranged widely, from methods of teaching, age and mental maturity, physical deficiencies, poor diet, visual and auditory defects, problems of dominance and numerous others. Also various techniques have been used to try to predict the children who will or will not be able to achieve reading skills in the first grade, e.g., teacher evaluations, reading readiness tests, tests of intelligence and the like. However, in spite of exhaustive investigations and experiments in methods and techniques for improvement, many problems remain; the high percentage of failure at the first grade level and the difficulty of prediction of which children will be able to achieve in reading by the end of their first year. Numerous studies can be cited to demonstrate the extent of these problems.[3-8] McDaid's (1950) study in the Detroit school

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[1]Eve Malmquist, "Factors Related to Reading Disabilities in the First Grade of the Elementary School," Almqvist and Wiksell, Stockholm, 1958.

[2]Helen M. Robinson, "Why Pupils Fail in Reading" (Chicago: University of Chicago Press, 1946).

[3]Marion Monroe, "Children Who Cannot Read" (Chicago: University of Chicago Press, 1932).

[4]Helen M. Robinson, op. cit.

[5]A. Traxler, "Research in Reading In The United States," Journal of Educational Research, 42, pp. 481-99.

[6]A. Traxler and A. Townsend, "Eight More Years of Research in

system explored these problems extensively.[1]

Recently, some interest has turned to the role, perception, particularly visual perception, plays in the beginning learning of the young school child. The relationship between visual perception and reading ability has been studied by many investigators. The results of some research workers suggest that the role of perception may be particularly critical at the pre-reading and early reading level, indicating that difficulties in perceiving may contribute to reading difficulties at the very outset of learning. However, information is still limited and the subject seems to merit further investigation.

Review of Studies of Perception in Early School Learning

A number of the earlier studies, as: of Gates (1922 and 1926);[2,3] Sister Mary of the Visitation (1929);[4] Fendrick (1935);[5] Sister Mary B.

Reading, Summary and Bibliography," Ed. Rec. Bulletin, 64, N. Y.

[7]M. D. Vernon, "Backwardness in Reading, A Study of Its Nature and Origin (Cambridge: Cambridge University Press, 1957).

[8]P. Witty, "Factors Associated with the Etiology of Reading Disability," Journal of Educational Research, 29, pp. 449-59.

[1]Elmer William McDaid, "A Study of an Experimental Reading Readiness Program in a Large City School System" (unpublished Doctoral dissertation, Wayne State University, 1950).

[2]Arthur I. Gates, "The Psychology of Reading and Spelling" (Teachers College Contributions to Education, No. 129); (New York, Teachers College, Columbia University, 1922).

[3]_____. "A Study of the Role of Visual Perception, Intelligence and Certain Associative Processes in Reading and Spelling," Journal of Educational Psych., XVII (October, 1926), pp. 433-45.

[4]Sister Mary of the Visitation, "Visual Perception in Reading and Spelling: A Statistical Analysis" (Catholic University of America Educational Research Bulletin), Vol. IV, No. 1 (Washington: Catholic Education Press, 1929).

[5]Paul Fendrick, "Visual Characteristics of Poor Readers" (Teach-

Phelan (1940)[1] and others explored the function and importance of visual perception in reading and spelling, using later elementary school children as their subjects. The majority of the tests used were paper and pencil tests requiring matching of words and letters, discrimination of differences in words and letter patterns and the like. A few non-verbal tests were used but because their correlations were low it was assumed that they were of little value in defining the function of perceptual abilities involved in reading. However, there did appear to be some functional similarity between both types of tests. It was pointed out by Stroud (1945)[2] in a review of these studies that the differential practice effect of long familiarity with reading materials would have contributed to the higher correlations obtained with test materials of a verbal nature. He surmised, that for this reason, these test materials would give little added insight into the nature of basic perceptual differences.

Several more recent studies have been concerned with visual perception in the learning of the beginning school child, most of them using non-verbal materials; Potter (1949)[3] studied relationships between

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ers College Contributions to Education, No. 658); (New York: Teachers College, Columbia University, 1935).

[1]Sister Mary B. Phelan, "Visual Perception in Relation to Variance in Reading and Spelling" (Catholic University of America Educational Research Monographs), Vol. XII, No. 3 (Washington: Catholic Education Press, 1940).

[2]J. B. Stroud, "Role of Visual Perception As A Factor in Rate of Reading," Journal Educational Psych., XXXVI (November, 1945), pp. 495-

[3]Muriel Catherine Potter, "Perception of Symbol Orientation and Early Success in Reading (Teachers College Contributions to Education) No. 939; Bureau of Publications, Teachers College (Columbia, New York, 1948), p. 54.

perceptual tests; as symbol orientation, and shape matching, with a group of 176 first graders and found these had the highest correlation with reading achievement. However, she found low correlations between directional drawing and reading achievement and she suggested this might be interpreted as indicating that writing readiness may be somewhat slower to develop than reading readiness.

Malmquist (1958)[1] was of the opinion that visual perception constituted important factors in the elementary reading process. He carried on a very comprehensive investigation with 400 first grade children in Swedish schools. He developed the perceptual tests used in his study. Because of the difference in response to different test materials he concluded that perception is not a unitary function or capacity which operates uniformly for all kinds of data. Instead, he writes: "We are inclined to assume that visual perceptual ability is, to a great extent, specialized and varies with different types of material."

Goins (1958)[2] was interested in visual perception as a primary mental ability in line with Thurstone's[3,4] studies in this area. Her investigation was concerned with the problems at the first grade level for a number of reasons: (1) it is generally conceded that accurate perception is more important when learning to read; (2) at this level the practice differential pointed out by some reviewers would not be present;

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[1]Malmquist, op. cit., p. 277.

[2]Jean Turner Goins, "Visual Perceptual Abilities and Early Reading Progress," (University of Chicago Press Supplementary Educational Monographs), No. 87, February, 1958, Chicago.

[3]L. L. Thurstone, "Primary Mental Abilities" (Psychometric Monographs), No. 1; (Chicago: University of Chicago Press, 1938), p. 411.

[4]_____. "A Factorial Study of Perception" (Psychometric Monographs), No. 4; (Chicago: University of Chicago Press, 1944), pp. 125-30.

and (3) it has been postulated that there is a possibility of difference of organization of mental traits at this developmental level. Goins tested 120 first grade children with several standard tests and some unpublished perceptual tests developed by Dr. Thelma Gwinn Thurstone. Goins noted that the scores on pattern copying and reversals of the readiness test and the combined perceptual scores correlated most highly with reading achievement and she felt could be used as predictors of later success in reading. Factor analysis was used to determine common factors underlying the correlations. She reported that there was a wide range of perceptual abilities and varying degrees of competence in perception as noted in her study group.

Simpson (1960)[1] studied the test data on 448 first grade children and found Matching, Numbers, and Copying subtests of the Metropolitan Readiness Test and the Quantitative and Space subtests of the Primary Mental Abilities Test correlated most highly with reading achievement. Simpson developed a program of visual and kinesthetic training which she used with one of two groups of children she selected from the large group tested. The children selected appeared not to be progressing as well in learning as their peers. Their scores on reading readiness subtests were average or above but scores in the Matching, Numbers, and Copying subtests were low. At the end of the training period she found that the experimental group showed a statistically significant gain in learning over the control group, confirming her hypothesis that training could improve perceptual function.

In each of these studies, reviewed here, the investigators dem-

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[1]Dorothy Margaret Simpson, "Perceptual Readiness and Beginning Reading" (unpublished Doctoral dissertation, Purdue University, 1960).

onstrated the importance of visual perception for the beginning reader and they indicated also that the subtests of the commonly used readiness tests that are presumed to test reading readiness appear not to be the best indicators of later reading achievement. A recent study by Karlin (1955)[1] may be cited here. In the course of his study of physical growth and success in undertaking beginning reading with first graders he carried out a correlation study of scores attained by children in the Metropolitan Readiness Test and later reading achievement with the Gates Primary Reading Test No. 3. He concluded that it was virtually impossible to predict from the reading readiness test how well any child would do on the reading test. He suggested that there is need for development of valid instruments which schools can use to evaluate the readiness levels that have been achieved by their pupils. In support of the effectiveness of the Readiness Test, Traxler's[2,3] studies should be considered. He found that results in use of the test varied greatly with the group, bringing to mind again the fact that has been confirmed in numerous investigations, that there are a number of factors involved in reading readiness, or in reading disability.

A further scrutiny of these studies of learning at the early elementary school level suggests some other problems that merit consideration for further investigation, The perceptual tests used in the studies

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[1]Robert Karlin, "Physical Growth and Success in Undertaking Beginning Reading" (Doctoral dissertation, School of Education, New York University, 1955).

[2]Arthur E. Traxler, "Research in Reading in the U. S.," Journal of Educational Research, 42, pp. 481-99.

[3]Arthur E. Traxler and A. Townsend, "Eight More Years of Research in Reading," Summary and Bibliography, Ed. Rec. Bull., 64, N. Y.

cited here, included reversals, matching items, identifying items, copying, completing designs, speed of perception and a number of others. The perceptual tests prepared by Dr. Thelma Gwinn Thurstone had been developed for use with five and six year olds. Age norms or standardization were not mentioned for the other perceptual materials used, some of them specially prepared for their studies. In conjunction with this some other points might be considered:

1. There appears to be very little base-line data on the normal growth of perceptual ability in the young child and there are few tests of perception with normative data and no simple group tests suitable for use with the young school child.

2. Testing instruments do not differentiate among the various perceptual abilities.

3. In the studies reviewed, no attempt, for purposes of learning, has been made to differentiate between aspects of visual perception.

4. Little or no emphasis has been given, in these studies, to what the implications for education may be for the child who has some visual perceptual dysfunction in one or more aspects.

Underlying these problems, of course, is the rather limited knowledge available, at present, concerning the various aspects of perception that appear to contribute to the young school child's learning.

A visual perception test that appears to meet some of these problems has been developed recently by Dr. Marianne Frostig[1] and presently is being evaluated by further research. Dr. Frostig, as she comments in her publications, states that during the course of considerable time working with children with a variety of learning problems, she observed that difficulties in perception were not infrequent. She became

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[1]Marianne Frostig, D. Welty Lefever and John R. B. Whittlesey, "A Developmental Test of Visual Perception for Evaluating Normal and Neurologically Handicapped Children," Perceptual and Motor Skills, 1961, 12, pp. 383-94.

convinced that a number of areas could be identified and that they developed independently of each other. She noted that perceptual difficulties became most apparent during the beginning school years, in kindergarten, first and second grades, which she suspected was the period when development of certain perceptual abilities were at their maximum. She surmised that some disturbance in these perceptual functions were factors contributing to learning difficulties. She was persuaded that different aspects of perception could be disturbed independently of each other in normal children as in children with some degree of recognized neurological dysfunction.

She found some support for her observations from the studies of Cruickshank, Wedell, and others. The inference made earlier by Strauss and his co-workers that impairment of figure-ground discrimination was the underlying cause of all perceptual impairment in brain-injured children was studied by Cruickshank, Bice and Wallen (1957).[1] Their studies indicated that a notion of general impairment was not supported by their findings. The perceptual functions in individual cerebral palsy children were disturbed in varying degrees; figure-ground perception was not necessarily impaired. Wedell (1959 and 1960),[2,3] a British Psychologist, studied several groups of cerebral palsy children with different types of involvement and a control group of non-brain-injured children. His

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[1] William M. Cruickshank, Harry V. Bice, and Norman E. Wallen, "Perception and Cerebral Palsy"; (Syracuse: Syracuse University Press, 1957.

[2] K. Wedell, "The Visual Perceptions of Cerebral Palsy Children," Journal of Child Psychology and Psychiatry, Vol. 1, No. 3, 1960, pp. 215-27.

[3] _____. "Variations in Perceptual Ability Among Types of Cerebral Palsy," Cerebral Palsy Bulletin, Vol. 2, No. 3, 1960.

findings were similar to those of Cruickshank; no specific type of perdeptual impairment was found to characterize cerebral palsy subjects.

Frostig[1,2] reports that convinced of this theory and concerned with effective remedial training for children with learning problems, she began working on the development of a simple group test for use with young children. Her present test is in its third revision and is available for research purposes only. In her judgment, it will permit differential screening of perceptual functions at an early age. She selected the aspects: eye-motor, figure-ground, form constancy, position-in-space, and space relations, as the perceptual functions most essential at beginning school level. She describes her reasons:

> These five visual perceptual abilities were chosen for a number of reasons. They are critical for the acquisition of school learning. They affect the total organism to a much greater degree than some functions, such as color discrimination and pure tone discrimination. They develop relatively early in life. They are frequently disturbed in children diagnosed as neurologically handicapped. They are suitable for group testing and we have observed that training in these areas is very frequently successful.[3]

Frostig[4] observed that in the five areas of visual perception tested, a clear evidence of age progression was found from three years up to about seven and one-half years but with little development shown

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[1] Marianne Frostig, D. Welty Lefever and John R. B. Whittlesey, "A Developmental Test of Visual Perception for Evaluating Normal and Neurologically Handicapped Children," Perceptual and Motor Skills, 1961, 12, pp. 383-94.

[2] _____. "Disturbances in Visual Perception," accepted for publication in the Journal of Educational Research.

[3] _____. "Visual Perception in the Brain-Injured Child," submitted for publication to the American Journal of Orthopsychiatry.

[4] _____. "Perceptual Ability and School Adjustment in Kindergarten and Primary Grades," presented at the December, 1961 California State Psych. Assn.

after that age. This finding, she noted, is in accord with that of Piaget[1] who found that at about seven years of age the cognitive (i.e., intellectual) functions become predominant. For this reason, she feels, the test is more indicative of perceptual learning problems when used at the kindergarten or first grade level, though it may be effectively used with older children.

Interest in the possibilities promised by this test prompted this study to evaluate the Frostig Visual Perceptual Tests as a possible predictor of the early learning of the elementary school child.

Specific Statement of the Problem

Discriminating use of the Frostig Visual Perceptual Tests would imply some understanding of the perceptual abilities Frostig has included in her tests. It would imply, also, some knowledge of the role each of these perceptual abilities plays in the early learning of the young school child. Aside from Frostig's own limited publications on this subject, the literature on the developing role of perception in the young child is rather widely scattered. For this reason it seemed appropriate to precede the proposed investigation by a review of literature on the contribution of visual perception to the beginning learning skills of the young child. Thus this study, as planned, divided itself into two main tasks: Part 1, a review of literature on the function of visual perception in the young child; and Part 2, investigation of the Frostig Visual Perceptual Tests as a possible predictor of reading achievement in a group of first grade children.

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[1]Jean Piaget, "The Origins of Intelligence in Children," The International Universities Press, Inc., Transl., Margaret Cook, 1952.

Part 1. Review of Literature in Visual Perception Related to the Learning of the Young School Child

The review of literature endeavored to bring together and to try to synthesize the information available on the five aspects of perceptual abilities Frostig postulates as essential for early school learning. During the review, references were scanned for any information about the implications for learning in the presence of any dysfunction of these perceptual abilities. Perhaps a restatement of Frostig's[1] analysis of the five aspects of perception she considers important for the child may indicate something of the scope of the review. The five abilities are: eye-motor, figure-ground, form constancy, position-in-space, and space relations. These she describes in terms of the types of problems a young child encounters in pre-reading and early reading.

Subtest Eye-Motor

Eye-motor coordination is a test of motor skill and requires the ability to coordinate vision with movements of the body or parts of the body. Controlled eye movements are necessary for reading. Eye-hand coordination is necessary for writing skills.

Subtest Figure-Ground

Frostig[2] describes figure-ground ability in this fashion:

> The figure is that part of the field of perception which is the center of the observer's attention. When the observer shifts his attention to something else, the new focus of attention becomes the 'figure' and the previous 'figure' recedes in to the 'ground.'

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[1] Marianne Frostig, D. Welty Lefever, and John R. B. Whitlesey, "A Developmental Test of Visual Perception for Evaluating Normal and Neurologically Handicapped Children," Perceptual and Motor Skills, 1961, 12, pp. 383-94.

[2] _____. "Disturbance in Visual Perception," accepted for publication in the Journal of Educational Research.

She maintains that an object cannot be accurately perceived unless it is perceived in relation to its "ground." Unless the child can learn to focus on the "figure" he has difficulty keeping and finding his place and tends to respond to any stimuli rather than the appropriate one, causing difficulties in analysis of words, phrases, etc., as well as keeping his place.

Subtest Form Constancy

Perceptual constancy refers to the fact that an object is perceived as having invariant properties, such as shape, brightness, etc. Frostig[1] believes that perception of constancy of form develops out of perception of shape itself. A child must be familiar with a shape before he can recognize it when it is presented differently. She conjectures that:

> A child with poorly developed constancy is not only likely to be made anxious by the general unreliability of appearances in his world; he will have major difficulties in academic learning. Although he may learn to recognize a number, letter, or word when he sees it in a particular form or context, he may be quite unable to recognize the same symbol when it is presented differently. He appears to have forgotten what he had learned.

Subtest Position-In-Space

This ability may be described as the perception of an object in relation to the observer; a person is always the center of his own world and experiences objects as being behind, before, beside, or above himself. The child having difficulty with position-in-space perception is likely to have problems with reversals or rotations of letters, numbers or words; with mirror writing and problems of a like nature, making learning difficult for him.

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[1]Marianne Frostig, D. Welty Lefever, and John R. B. Whittlesey, op. cit.

Subtest Space Relations

Frostig[1] defines spatial relationships as a complicated process; it includes the perception of the position of objects in relation to the observer as well as to each other. It has some similarity to figure-ground perception in that both abilities involve perception of relationships. In Figure-ground the visual field is divided into two parts, a prominent and a recessive part. Whereas, in space relations any number of different parts may be seen in relation to each other. All the elements of pattern vision are involved in perception of space relations, as visualization, visual memory, sequence, order and the like. Difficulties for the young child, in this area, may lead to problems of perceiving, as the sequence of letters or words, or in relation of parts to the whole, as in model building, etc.

The second part of this study dealt with the investigation of the use of the Frostig Visual Perceptual Tests as a predictor of later reading achievement in the young child.

Part 2. A Study of the Frostig Visual Perceptual Tests As a Predictor of Reading Achievement in a Group of First Grade Children

This second part of the study proposed to explore, through correlational analysis, the basic relations between measures of perceptual and achieved learning in a random sample of 100 school children at the first grade level. The measures to be used were the Frostig Visual Perceptual Tests and as criteria, the Metropolitan Readiness Test and a Reading Achievement Test, Teacher Evaluation Ratings in School Adjustment and Learning and Kindergarten and First Grade Draw-A-Figure tests.

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[1] Ibid.

To aid in interpreting the correlation analysis findings a factor analysis was planned to discover in the data the functional unities and their nature.

Based on the assumption that the Frostig Visual Perception Tests and the criteria tests (as noted) were valid for their purposes, hypotheses were set up to serve as a means of critical evaluation of results observed and as a possible guide in further investigation.[1] Specifically, the hypotheses were formulated to test the predictive value of the Frostig Visual Perception Tests as a measure of perceptual and later reading achievement.

The Hypotheses to be Tested

The hypotheses postulated were considered for the findings of the correlation analysis and the factor analysis.

A. The Hypotheses for the Correlation Analysis

The hypotheses for the correlation analysis were tested against corresponding statistical null hypotheses. It was postulated that:

1. The Frostig Visual Perceptual tests scores will show significant relationships with the Metropolitan Readiness Test confirming the importance of visual perception in beginning reading.

2. The Frostig Visual Perceptual Tests scores will show significant correlations with later success in reading as evidenced by significant relationships with the Reading Achievement Test.

3. The Frostig Visual Perception Tests scores will show significant correlations with the Teacher Evaluation Ratings in School adjustment and Learning confirming the hypothesis that visual perceptual skill is important in school adjustment and learning.

4. The Frostig Visual Perceptual Tests scores will show significant correlations with the Draw-a-Figure Tests for kindergar-

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[1]C. V. Good, "Introduction to Educational Research" (New York: Appleton, Century, Crofts, Inc.), 1959, p. 138.

ten and first grade levels, confirming the hypothesis that visual perception is important in predicting the child's mental maturity and readiness for learning.

B. The Hypotheses for the Factor Analysis

It was anticipated that the findings of the factor analysis would aid in summarizing and interpreting the findings of the correlation analysis by indicating the underlying unities present in the 22 test variables. For this reason it was hypothesized that:

1. The factor analysis would result in fewer factors than 22, the number of test variables.

2. The factor analysis would indicate one or more unique factors in the Frostig Visual Perceptual Tests.

3. The factor analysis would find one or more factorial relationships common between the Frostig Visual Perceptual Tests and the criteria tests, the Metropolitan Readiness and Reading Achievement Tests, the Teacher Evaluation Ratings and the Draw-a-Figure Tests.

Methodology of the Study

This investigation, as planned, was divided into two main tasks, Part 1, the review of literature on aspects of perception as used in the Frostig Visual Perceptual Tests, and Part 2, a study of the value of the Frostig Visual Perceptual Tests as a predictor of reading achievement with a group of first grade children.

Part 1. Procedures Followed in the Review of Literature

A tentative survey of literature was undertaken, initially, to provide a working frame of reference for the five aspects of visual perception Frostig uses in her tests. At the very outset it became evident that this would be no simple task for a number of reasons, e.g.:

1. Reference materials were very widely scattered in the literature of many disciplines.

2. Some research appeared inconclusive or contributed little to the problem being considered.

3. Not infrequently references did not differentiate between the various aspects of perception, all perception was lumped together.

Other factors also contributed to the difficulties of selecting out materials relevant to the problem. A great deal of the research in perception has been done with adults and is of a non-veridical nature. Research on the function of perception in the learning in early childhood has been quite limited.

Another difficulty that increased the problem of evaluating reference material was the rather vague concept or definition of perception that appears not uncommonly in the literature. Ammons[1] commented on this problem. He noted that:

> A survey of the literature showed that although the concept of 'perception' is widely used in psychology and supposedly refers to something important; it has many different meanings, often overlapping and confused.

Fifteen different general meanings were identified and illustrated by quotations from current literature. Ammons' study was in psychological literature, the same may well be true in the literature of education, though no study similar to Ammons' for education was found.

At the outset, the search for reference materials attempted to follow a pattern of review of periodicals, year by year. However, this appeared to be an unproductive use of time and attention was turned to study of other sources of information. Good[2] and numerous other authors writing on research procedures give suggestions for documentary research.

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[1]R. B. Ammons, "Experiential Factors in Visual Form Perception: A Review and Formulation of Problems," Journal of Genetic Psychology, 1954, 84, pp. 3-25.

[2]C. V. Good, "Introduction to Educational Research" (New York: Appleton, Century, Crofts, Inc., 1959), Chap. 5.

With the tremendous increase in numbers of periodicals, reference to the various guides becomes almost imperative. The Educational Guide, Psychological Abstracts and Annual Review of Psychology, Encyclopedia of Educational Research, Review of Educational Research, Dissertation Abstracts, listings of dissertations in the Phi Delta Kappan and others were carefully scanned for subjects related to perception in children. A considerable number of items were obtained through inter-library loan service, and were reviewed.

In many instances one useful article, book or dissertation gave references to others of a similar kind. Thus, eventually, a large body of notes was collected. Then began the task of further screening out the references, particularly relevant for this investigation, limiting and differentiating materials related to the five aspects of visual perception under study. No claim is made that this is an exhaustive review of literature but it is hoped that it may be considered a setting or frame of reference for this investigation of Frostig Visual Perceptual tests. Perhaps, it might be categorized as a dimension of one domain of the taxonomy of educational objectives.[1]

One fact that is quite striking is the almost complete lack of reference in the literature to the problems of learning and the implications for education in the presence of some perceptual dysfunction. Frostig's publications are among the very few references found that make any effort to recognize and deal with these problems, with the exception of the rather extensive work with children diagnosed as brain-injured. This would appear to be an area in need of considerable research.

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[1]Benjamin S. Bloom, ed., "Taxonomy of Educational Objectives" (New York: Longmans, Green, & Co., 1956).

Part 2. Procedures Followed in the Investigation of the Frostig Visual Perceptual Tests as a Predictor of Reading Achievement with a Group of First Grade Children

The city selected for the study was one that was readily accessible for study which aided in the collection of data which had to be done over a period of a few weeks.

A. The Sample

It was felt that an unselected sample, fairly representative but not necessarily of any special grouping, as socio-economic status, intelligence or other characteristic would provide a suitable study group. It was felt that the random selection would tend to provide a range of reading ability as well as a range in perceptual competence.

The group for the study were from the 250 children in grade IA in one school system selected on as random a basis as possible. One hundred eleven children on whom complete data were compiled, made up the final study group. Table 1 indicates the age, sex, and race characteristics of the study group.

Initially, the examiner tested a small group of children (32) at the beginning first grade level. A part of the group were IB Juniors, i.e., they had been retained at the beginning first grade level because of low performance on the readiness test. The final number after complete data were collected was only 21. With a view to combining the two groups, "t" tests and "F" tests were calculated and intercorrelations were inspected for the two groups, but it became evident that the two groups were too unlike to be considered of the same population. For this reason their data have been set aside and will not be considered further in this study.

TABLE 1

AGE, SEX, AND RACE OF STUDY GROUP (N=111)

Age Range in Years & Months	Male				Female			
	White		Non-White		White		Non-White	
	N	Per cent	N	Per cent	N	Per cent	N	Per cent
6-6 to 6-8	4	3.6	1	0.9	7	6.3	4	3.6
6-9 to 6-11	11	9.9	7	6.3	6	5.4	9	8.1
7-0 to 7-2	6	5.4	5	4.5	5	4.5	9	8.1
7-3 to 7-5	4	3.6	6	5.4	4	3.6	5	4.5
7-6 to 7-8	..	....	5	4.5	2	1.8	1	.9
7-9 to 7-11	..	....	1	.9	2	1.8	..	....
8-0 +	2	1.8	..	....	1	0.9	4	3.6
Sub-Total	27	24.3	25	22.5	27	24.3	32	28.8
Total	52				59			
Per cent	46.8				53.1			
Grand Total	111							

B. The Setting of the Study

The setting of the study was an industrial suburb in a large mid-west metropolitan area. The 1960 census population figures for the suburb were 17,328. Approximately two-thirds of the population were white and one-third were non-white; 7.5 per cent were foreign-born. Median income was $5,479 with 10.8 per cent over $10,000 income and 18.8 per cent under $3,000 income and 10.3 per cent unemployed. Twenty-eight per cent moved into their present housing after 1958.

C. Tests Used in the Study

1. Description of the Frostig Visual Perceptual Tests:[1]

The Frostig Visual Perceptual Tests are a short paper and pencil

[1]Marianne Frostig, D. Welty Lefever, and John R. B. Whitlesey, op. cit.

group test that can be given by a teacher; no equipment is required except the test booklet and some colored crayons or pencils. The tests purport to differentiate between five different kinds of visual perception, which Frostig believes are essential for early learning, and to measure the degree of competence in each aspect as compared with the perceptual age norms developed by Frostig and her colleagues.

In the test the child is required to attempt graded tasks in five areas of visual perception. The first of these areas is eye-hand coordination, in which the child's task is to draw straight and curved lines between increasingly narrow boundaries. The second function tested is figure-ground perception in which the child is asked to discriminate between intersecting figures. The third function is the perception of form constancy, in which the child is to detect squares and circles among other shapes on the page. Position-in-space is tested by requiring the child to detect a reversed or rotated figure in a sequence. The last subtest explores the perceptual relationships. The task is to copy patterns by linking dots.

Frostig and her colleagues have established age norms for these five aspects of visual perception indicating the age progression from three years of age up to seven and one-half years. (Age-Equivalent Table, Appendix C)

2. Description of Criteria Tests:

The criteria tests used in the study were the Metropolitan Readiness Test, Reading Achievement Test, Teacher Education Ratings of School Adjustment and Learning, and the Draw-a-Figure Test at

the end of Kindergarten and again at the end of First Grade. The Metropolitan Readiness Test,[1] developed by G. Hildreth and H. Griffiths (1933 and 1948) and standardized on 15,000 children, is a general readiness test. The first four sub-tests, word-meaning, sentences, information, and matching are considered diagnostic for reading readiness. The sub-test numbers indicate readiness for number work and the sub-test copying indicates the child's visual perception and motor control required for writing.

The Reading Achievement Test[2] prepared by Marion Monroe for Scott, Foresman and Company and standardized on a large sample of children is designed to be used as a diagnostic tool to measure the extent to which pupils have progressed in the various aspects emphasized by the New Basic Reading Program. There are seven sub-tests.

The two Teacher Evaluation Ratings describe the characteristics of school adjustment and learning described by Frostig[3] in her studies. She postulates that the child with learning difficulties reflects his difficulties in his behavior and a teacher evaluation of his adjustment in the classroom will indicate his comparative rating with others in his class. A similar evaluation is made for the child's learning.

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[1]Metropolitan Readiness Test (New York: World Book Co.), 1948.

[2]Marion Monroe, "New Basic Reading Tests (New York: Scott, Foresman & Co., 1954).

[3]Marianne Frostig, "Perceptual Ability and School Adjustment in Kindergarten and Primary Grades," presented at California State Psychological Meeting, December, 1961.

The Draw-a-Figure test is the Goodenough test and is assumed to give an approximate measure of a child's mental age and ability.

D. Data Gathering

1. Instruments for Data Gathering:

Instruments for Data Gathering were the Data Gathering Sheet, Teacher Evaluation Rating for School Adjustment and for Learning and the Frostig Data Gathering Sheet. (Appendix A 1, 2, 3, and 4)

The Data Gathering Sheet included all data that the Cumulative School Record outlines and also information about handedness, hearing, vision, etc., and the test results of all the tests except the Frostig.

The two Teacher Evaluation Rating Sheets described characteristics to be observed in the pupils and requested the teacher to select the poorest and the best from her class in this respect and place them at the bottom and the top of the space provided, to proceed in this fashion until the names of the class members had all been transcribed in this forced-choice type of procedure. The children of the lowest quartile were rated low, in the upper quartile were rated high and the two middle quartiles were in the average group, in accord with Frostig's[1] notes on school adjustment and learning.

The Frostig Data Sheet provided the scores on the five tests, the age-equivalent scores and the perceptual scores.

2. Data Gathering Procedures:

The data were all gathered near the close of the school year

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[1] Ibid.

1961-1962, in April and May. The Frostig Visual Perceptual Tests were given to small groups of children. Following the test the children were requested to draw a person, the best person they could draw. After this the children were tested for eyed-ness by having them look through a kaleidoscope and by sighting an object on the floor through a cardboard cylinder held about eight to ten inches from the face. They were tested for handedness by noting the hand used to write with and the hand used in cutting. Footedness was noted by the foot used in kicking a football.

Data from each child's Cumulative School Record were transferred to the data sheet. In the school system under study, the children are routinely tested for vision and hearing and a referral is made if there is any question. The hearing and vision were considered within normal range unless a referral had been made.

3. Data Processing Techniques:

The data were tabulated, a code manual containing all data was prepared and a frequency count was run by the IBM Computer and recorded on the code manual. A copy is included in the Appendix.

E. <u>Statistical Techniques Used in the Study</u>

The statistical techniques used were of two kinds:

1. Product-Moment Coefficients of Correlation:

Coefficients of correlation by the product moment method were computed. The correlation analysis was studied to discover the significant relationships between variables, and a matrix was prepared for factor analysis.

2. Factor Analysis:

Factor analysis was used to find the underlying unities present in the correlation between variables and to aid in interpretation of the nature of the factors extracted.

Factor analysis was calculated by the principal axes method[1,2]--communalities were computed and rotation was accomplished by the Kaiser[3] Varimax criterion.

The data were programmed and processed by the Wayne State University Computing Center under the auspices of the National Science Foundation. The factor analysis was completed through the courtesy of the General Motors Technical Center, because of a long continued mal-function in the IBM Computer at Wayne State University Computing Center.

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[1] Harry H. Harmon, Modern Factor Analysis (Chicago: The University of Chicago Press, 1960), pp. 289-90.

[2] J. P. Guilford, Psychometric Methods (New York: McGraw-Hill Book Co., Inc., 1954), p. 478.

[3] Henry F. Kaiser, "The Varimax Criterion for Analytical Rotation in Factor Analysis," Psychometrika, No. 3, Vol. 23 (September, 1958), pp. 187-200.

CHAPTER II

REPORT OF STUDY

The report of the study includes first, Part 1, a review of literature on the five aspects of visual perception and the implications for learning in the presence of dysfunction in visual perception, and Part 2, the evaluation of the Frostig Visual Perceptual Tests as a predictor of reading achievement in first grade children.

Part 1. Review of Literature on Aspects of Visual Perception

Gibson and Olum (1960)[1] reviewing experimental research in the study of perception in children, comment that:

> For the most part research (in this area) lacks a truly developmental approach. Many studies appear to have just happened to be done with children because they were available; methods, in such cases, were not tools for the solution of a problem of development. Often, in a given area of research there are many facts and interesting methods but they add up to a motley, rather hit-or-miss collection.

Solly and Murphy (1960)[2] cite only one research study (Rush, 1931) on the perceptual development of children. Vernon (1957)[3] re-

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[1]Eleanor Gibson and Vivian Olum, "Experimental Methods of Studying Perception in Children," Handbook of Research Methods in Child Development, Chap. 8, Paul Mussen ed. (New York: John Wiley & Sons, Inc., 1960).

[2]Charles M. Solley and Gardner Murphy, Development of the Perceptual World, Chap. 2; (New York: Basic Books, Inc., 1960).

[3]M. D. Vernon, "Further Study of Visual Perception"; (Cambridge: Cambridge University Press, 1957).

viewed the field of visual perception research; one section is devoted to studies on the development of perception in children. However, many studies reviewed seemed not to have relevance for the purposes of this study. Most of the studies do not attempt to distinguish between the different aspects of visual perception and perception in general. These and other factors made the search for suitable reference material seem an apparently never-ending one. Of necessity, there is no claim that this is a complete review of the literature in the field, but, simply, an attempt to provide a frame of reference to aid in considering and evaluating the perceptual tests used in this study.

A brief mention of some of the theories about the infant and young child's beginning learning may be apropos here. The development of perception in the child has been the subject of considerable interest in European laboratories for many years; Piaget's[1] continuing investigations in this area are an example. E. Gibson and Olum's[2] recent survey of research in the development of perception in the child indicates that until fairly recently American psychologists have been more interested in a normative approach. They note:

> In our mental tests are many tasks that could be classified as perceptual: form boards, matching pictures, copying figures, and so on. By inspecting the test norms, it is possible to compare performances at different ages of these tests and gain some rough notion of perceptual development. . . . However present day interest in effects of early experience has stimulated interest in the developmental course of perceptual functions as such.

The beginnings of perception in the infant are postulated some-

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[1]Piaget, J., "The Child's Conception of the World; (New York: Harcourt, Brace, 1929).

[2]E. Gibson and V. Olum, op. cit., p. 311.

what differently by different investigators, e.g., Solley and Murphy[1] assert that before any perceptual learning takes place, an infant can perceive. An infant can certainly differentiate figure from ground, can discriminate between certain colors, tastes, odors, and other sense data; and can attend to parts of his environment. The basic aspects of perceiving are present in the infant's terms, although the infant's perceptual world is certainly not as rich or complex as the adult's. They maintain that the infant does not experience what William James called a "blooming, buzzing confusion" nor is his perception as completely vague as Piaget, Werner, or Vernon, among others would have us believe. In the sense that veridical meanings are attached to things, perception is incomplete. Thus, perception is not completely innate, nor is it completely dependent upon learning. They point out that perceptual learning is dependent upon the level of maturation achieved by the child and conversely, the full achievement of maturational potentialities can be facilitated or inhibited by the occurrence or non-occurrence of specific learning experiences, neither maturation nor learning can fully unfold independently.

Hebb[2] postulates that the course of learning in man is gradual, proceeding from a dominance of color through a period of separate attention to each part of a figure, to a gradually arrived at identification of the whole as a whole, a serial apprehension though apparently simultaneous. He considers it possible that the human infant goes through this same process and that we are able to see a square as such in a single

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[1]Charles M. Solley and Gardner Murphy, op. cit., Chap. 2.

[2]D. O. Hebb, "Organization of Behavior" (New York: John Wiley & Sons, Inc., 1949).

glance only as the result of complex learning. He notes that each object is seen by the eyes' focus on successive parts of the whole. Perception of a form thus becomes an additive process of the proprioceptive impulses with the motor cortex helping to integrate the sensation into perception when visualizing an object. The performance consists usually of "seeing" the parts in succession, moving the eyes or imagining the movement of the eyes which would accompany the actual observations. He states that perception is affected by past experience, what is learned is in terms of what is perceived, what is not perceived can hardly be remembered, and conceptual development is a basis for learning.

Perceptual learning, in this sense, is similar to Symonds[1] statement: "Learning is Reacting, the child learns the acts performed, the thoughts and feelings experienced, i.e., we learn what we do."

A number of writers on this subject stress the motor aspects of the beginning learning the child experiences. Seigel[2] proposes the theory as does Hebb, that there are stages of perceptual learning. Seigel stresses the role of eye movements in the development of perception and suggests that this motor involvement be broadened to include other sensory components, e.g., that a tactual, motor kinesthetic stage of perceptual learning may precede the appraisal of visual dominance that characterizes adult perceptual learning.

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[1]Percival M. Symonds, "What Education Has to Learn from Psychology," V, Learning is Reacting, Teachers College Record, Vol. 59, 1957-1958, pp. 89-100.

[2]A. J. Seigel, "A Motor Hypothesis of Perceptual Development," American Journal of Psychology (1953), 66, pp. 301-04.

This theory is in line with Werner[1] and Wapner's Sensory-Tonic theory of perception; also with the observations of Gesell in his longitudinal studies of infants; also with psychiatrists, as Bender, Schilder and others; and with educators, as Cruickshank, Kephart, Fernald, and others.

Little is known about the neural mechanism by which the child builds up his background of knowledge, how he develops his categorial information or schema, or of the methods of organization or integration. Workers in this field are far from agreement on many of the facets of perceptual learning, many controversies are in progress on topics, as, perceptual readiness, set, sensory deprivation, perceptual defense, etc. Of the schema recognized perhaps figure-ground is considered most basic.

A. Aspects of Visual Perception

1. Figure-Ground Perception:

Solley and Murphy[2] note that the child, in infancy, has the basic ingredients of the perceptual act but relatively vague and undifferentiated percepts. Following his first vague awareness of something there, the infant appears to be able to recognize a "figure," e.g., the mother, from the surrounding background, i.e., with his innate organization of figure and ground, now by learning he becomes aware of what is figure and what is ground. Werner and Strauss[3] term the figure-ground schema as the frame of

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[1] H. Werner and S. Wapner, "Toward a General Theory of Perception," Psychological Review, 59 (1952), pp. 324-38.

[2] Charles Solley and Gardiner Murphy, op. cit., p. 134.

[3] H. Werner and A. A. Strauss, "Pathology of Figure-Background Relation in the Child," Journal of Abnormal and Social Psychology, Vol. 36 (1941), pp. 236-48.

reference by which the human organism is able to organize a given field in an adequate manner. Goldstein[1] conceives of the figure-background function as the basic principle of organization. This principle cannot be further reduced and special schemata are products of this basic function. Witkin,[2] in studies of perception of embedded figures found that there were dafinite individual characteristics in this and people differed markedly in this type of perception. Meister[3] made a comparative study of the ability of pre-school children and adults to note figure-ground and found that the child's perception resembled that of the adult for ground but the child's perception of figure seemed more diffuse, more poorly articulated, less cohesive. Frostig[4] stresses that an object cannot be accurately perceived unless it is perceived in relation to its ground. Those things are perceived most clearly that become the center of attention; i.e., for the moment other stimuli are "out out" and are perceived only dimly as ground. She points out that the ability to differentiate figure from ground is necessary for the analysis and synthesis of words, phrases and paragraphs, without which it is impossible to read.

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[1]Kurt Goldstein, "The Organism," 109 (New York: American Book Co., 1939).

[2]H. A. Witkin, "Individual Differences in Ease of Perception of Embedded Figures," Journal of Personality, Vol. 19, (1950), pp. 1-16.

[3]David Meister, "A Comparative Study of Figure-Ground Discrimination in Pre-School Children and Adults," Journal of Genetic Psychology (1949), 74, pp. 311-23.

[4]Marianne Frostig, "Resource Material for Training Visual Perception."

2. Form Constancy:

Constancy refers to the fact that an object is perceived as possessing invariant properties, such as, shape, position, size, etc., writes Frostig.[1] This means that where constancy of shape is concerned two and three dimensional forms are recognized as belonging to certain categories of shapes, whatever their size, color, texture, mode of presentation or angle from the perceiver. There are three other aspects of objects which may be visually perceived as constant, besides shape: they are, color, size, and brightness. The perception of constancy of shape develops out of the perception of shape itself, a child must be familiar with a shape before he can recognize it when it is differently presented.

Studies by Skeel (1933)[2] and by Ling (1941)[3] indicated that children learned to discriminate form as young as 16 months. The Stevenson and McBee study (1958)[4] found that four to six year olds perceived the three dimensional objects more readily than two dimensional. Welch's[5] study of a group of children one to five years of age tested at intervals over a year's period found

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[1] Ibid.

[2] H. M. Skeels, "The Use of Conditioning Techniques in the Study of Form Discrimination of Young Children," Journal of Experimental Education, 2 (1933), pp. 127-37.

[3] B. C. Ling, "Form Discrimination as a Learning Cue in Infants," Comparative Psychology, Monograph, 17, No. 2 (1941).

[4] Harold W. Stevenson and George McBee, "The Learning of Object and Pattern Discrimination by Children," Journal of Comparative and Physiological Psychology, Vol. 51 (1958).

[5] Livingston Welch, "The Development of Discrimination of Form and Area," Journal of Psychology, 7 (1939), pp. 37-54.

that the children learned to discriminate between sizes of objects; the wide differences of form were learned first; recognition of middlesizedness came later.

Perceptions of color may take precedence over form at certain ages, e.g., in a study by Brian and Goodenough (1929)[1] with children from one to six years, elementary school children and adults, they found the younger group's response indicated that under two and one-half years children's matching choices were largely based on form similarity. Over two and one-half years there was a steady increase in matching choices based on color, with a peak at four and one-half years. After this period there was decline in color matching and an increase in form matching.

Werner[2] cites similar studies in Europe and calls this a "primitive" abstraction which is a mental process allied to sensory organization, or a type of categorial organization.

Hebb[3] points out this problem of identifying figures and color, as noted by Senden (1932), as patterns of learning. Senden's studies of congenitally blind persons who received sight following cataract operations indicate how these newly sighted persons appeared to have to learn constancy of size, shape, and form.

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[1]C. A. Brian and Florence Goodenough, "The Relative Potency of Color and Form Perception at Various Ages," Journal Experimental Psychology, 12 (1929), pp. 197-213.

[2]Heinz Werner, "Comparative Psychology of Mental Development," rev. ed. (New York: International Universities Press, Inc., 1957).

[3]D. O. Hebb, op. cit., pp. 32-33.

Senden[1] noted that color was found to dominate form persistently in the first vision of these patients. Such patients, when learning had proceeded far enough, manifested the characteristic generalization of the normal person, so the initial difficulties are not to be put down to structural defects of the sensory apparatus, as Hebb points out.

Gibson and Olum[2] comment:

> A review of Senden's studies indicates the extraordinary extent to which we have to learn to see. In a sense this is obvious enough from the slow progress made by normal children but study of them alone does not, of course, tell us how much of their development is due to maturation under the influence of heredity. The cases described by Senden constitute a controlled experiment on this question and they tell us that it is only by use and experience that the visual system develops its power.

A point of controversy of long standing that has been the subject of considerable study is whether children perceive globally, that is, the whole at the expense of the part; or analytically, the parts at the expense of the whole. In some situations children seem unable to differentiate the parts of a perceptual whole. Gibson and Olum (1960 and Vernon (1957)[3] cite a number of studies that seem to indicate this ability develops as the child matures. Townsend (1951)[4] made a study of the intercorre-

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[1]M. von Senden, "Space and Sight: The Perception of Space and Shape in Congenitally Blind Before and After Operation," transl. Peter Heath, The Free Press, Glencoe, Ill. (1960), (first published in German, 1932).

[2]E. Gibson and V. Olum, op. cit.

[3]M. D. Vernon, "A Further Study of Visual Perception," op. cit.

[4]Edward Arthur Townsend, "A Study of Copying Ability in Children," Genetic Psychology, Monograph, 1951, 43, p. 3057 (Doctoral dissertation), Teachers College, Columbia University, 1949.

lations between perceptual measures of form perception, motor abilities, and copying and the relation of these to chronological and mental age for groups of children in the first three grades of elementary school. He demonstrated that form perception was more influential in copying ability than hand-eye coordination and found a steady increase in recognition of form up to the age of seven years.

3. Spatial Perception:

Spatial perception is essentially relationships, e.g., (1) relationships of the individual to his surroundings, to the objects around him, and (2), of objects in relation to other objects. Piaget[1] implies this in his description of the two factors essential in the construction of a notion of space: (1) comprehension of the individual's own shifts of position, and (2), comprehension of the spatial relations between objects.

Spatial perception is extremely complex, as Stern[2] noted some years back:

> Nowhere is sensory-motor association so sharply marked as in relation to space. . . . The spatial concept is so manifold in its categories—extent in line, surface, depth, form, size, direction, position, distance—that the power of its inward comprehension could not possibly be innate in its full perception—much must be learned.

Gooddy and Reinhold[3] postulate that man orients himself in space

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[1]J. Piaget, op. cit. "The Child's Conception of the World (New York: Harcourt, Brace, 1929).

[2]William Stern, Psychology of Early Childhood, transl. from 3rd ed., revised and enlarged, by Anna Barwell (New York: Henry Holt & Co., 1924).

[3]William Gooddy and Margaret Reinhold, "Some Aspects of Human Orientation in Space," Brain, Vol. 76, Part 3 (1953), pp. 337-63.

by means of his knowledge of one-half of the body in relation to the other, of the position of one portion of a limb in relation to the other parts. Perception involves the active appreciation of change or motion sense. They note:

> Sensations are actively endowed with spatial properties by the individual who perceives them. They are also perceived as possessing temporal properties on account of their serial nature. Because they are endowed with spatial qualities and because they are in motion, stimuli are perceived as possessing attributes of direction. The sense of direction is necessary for spatial orientation and for such performances as reading, writing, calculation and drawing. Sensations, notions of space and time and abstract thinking are attributes of mind. Orientation in space, therefore, depends upon dynamic motion patterns organized by the nervous system and upon active mental performance.

There are a number of investigations that add some information on the development of space perception in the young child. Johnson and Beck (1939)[1] found that children as young as two years had well developed stereoscopic vision and that ocular convergence probably is an important and perfected cue for the judgment of size by pre-school children.

Walk and Gibson (1959)[2] tested visual depth discrimination in infants six and one-half to 14 months, by a technique called "visual cliff" and concluded that by the time locomotion is possible infants can discriminate a "drop-off" visually.

It is quite commonly assumed that the problem of reversals of the confusing letters as b and d is related to immaturity. Stud-

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[1]Beth Johnson and L. F. Beck, "The Development of Space Perception: I Stereoscopic Vision in Pre-School Children," Journal of Genetic Psychology, Vol. 58 (1941), pp. 247-54.

[2]R. D. Walk and E. Gibson, "Perception of 'Visual Cliff' by Infants," in Gibson and Olum, op. cit.

ies by Krise[1] and by Wechsler and Pagnatelli (1937)[2] and others relate this to spatial perception. Krise suggests that letters as n and u may be axial rotations as d and b are reversals. Davidson (1935)[3] studied the discrimination of the letter shapes b and d and p and q in the kindergarten and first grade by a matching method. He found four stages of discrimination, beginning with confusion in all four letters and gradual lessening with age. In Rice's (1930)[4] and in Newhall's (1937)[5] studies in the orientation of forms they concluded that the ability to discriminate the change of orientation was a function of age. Jones (1925)[6] study seemed to indicate that in general children's judgment of differences develops sooner than that of similarities. Bender[7] suggested that the reason for the child's confusion with shapes which look alike but face in different directions is that as an infant the child learns that an object up-

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[1]E. Morely Krise, "Reversals in Reading: A Problem in Space Perception," Elementary School Journal, Vol. 49, Sept.-June, 1948-1949.

[2]D. Wechsler and M. L. Pagnatelli, "Reversal Error in Reading: Phenomenon of Axial Rotation," Journal of Educational Psychology, 28, 1937.

[3]H. P. Davidson, "A Study of the Confusing Letters, b, d, p, and q," Journal of Genetic Psychology, 47, 1935, pp. 458-68.

[4]C. Rice, "The Orientation of Plane Figures As a Factor in Their Perception By Children," Child Development, 1, 1930, pp. 111-43.

[5]S. M. Newhall, "Identification By Young Children of Differently Oriented Visual Forms," Child Development, 8, 1937, pp. 105-11.

[6]Vernon A. Jones, "A Study of Children's Ability to Note Similarities and Differences," Journal of Educational Psychology, 1925, 16, pp. 253-60.

[7]L. Bender, "Visual Motor Gestalt Test and Its Clinical Uses," Research, Monograph, No. 3, American Orthopsychiatry Ass'n, New York, 1952.

side down is still the same object and often can recognize pictures, even words, upside down and since remembering is harder than perceiving, may not see the differences in reversal letters and pictures, etc. until later.

a) Position-in-space:

Vernon,[1] Frostig,[2] Kephart[3] and others relate this problem of reversals, rotation of figures, etc. to the relationship of the individual to the objects around him or in Frostig's terms position-in-space. Kephart (1960) describes the beginning of this sense as "laterality." Initially the infant is bilaterally symmetrical and only gradually develops an internal awareness of the two sides of the body and their difference.

This development that permits him to keep things straight between b and d is one of laterality. Once he has developed this awareness he is ready to project these concepts into space, i.e., "directionality."

Gesell (1949)[4] describes "directionality" as a functional trait allied to laterality and indirectly related to it. It concerns the preference which the organism exhibits in the direction of its limb-body movements and its eye movements.

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[1]M. D. Vernon, "Backwardness in Reading"; (Cambridge: England, University Press, 1957).

[2]Marianne Frostig, op. cit., "Disturbance in Visual Perception," accepted for publication in the Journal of Educational Research.

[3]N. C. Kephart, "The Slow Learner in the Class Room," Charles E. Merrill Books, Inc., Columbus, Ohio, 1960.

[4]A. Gesell, Frances Ilg, and Glenna Bullis, "Vision, Its Development in Infant and Child," Paul B. Hoeber, Inc., New York, 1949.

Benton[1] points out that these concepts of right and left develop rather slowly and relatively late as a part of the intellectual equipment of the child. Early genetic studies showed that while distinction between up and down, before and behind are adequately mastered in pre-school years by the normal child, he begins to discriminate between right and left only in early school childhood, a perceptual skill that develops as a function of learning.

b) Space Relations:

Frostig[2] notes that the perception of spatial relationships has some similarity to figure-ground perception in that both abilities involve the perception of relationships. In the figure-ground perception the field is divided in two parts, one the center of attention. In spatial perception any number of different parts may be seen in relation to each other and all of them approximately equal in attention though perceived in a temporal sequence and integrated step by step into a total picture, termed pattern vision. She points out that in development of pattern vision a degree of memory function is involved since visualization and visual memory play an important part. Thus, spatial relations come later in the developmental hierarchy.

4. Eye-Motor Perception:

The child appears to go through a sequence in developing eye-mo-

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[1]Arthur L. Benton, "Right, Left Discrimination and Finger Localization: Development and Pathology"; (New York: Hoeber-Harper, 1959).

[2]Marianne Frostig, "Resource Material for Training Visual Perception."

tor control as part of his visual-motor development that encompasses the different visual perceptual learnings. Schaefer-Simmern[1] points out that Koffka was one of the first to suggest that the structural order of children's drawings follow definite laws of perception. He indicates that eye-motor control, form, figure-ground, space relations can all be identified through progression from their initial beginnings to well-defined percepts. Thus an essential aspect of the child's development appears to be in the coordination of his visual-motor skills.

The child's first eye-motor coordination appears after a period of play, sometimes with scribbles and lines, often scarcely observed as he makes them, with full arm swing and complete body involvement; his beginnings undifferentiated and uncontrolled. Later, with age, motor coordination begins to appear, with preference for vertical, then horizontal lines, then circles and much later oblique lines begin to enter his pictures. Rush[2] noted this progression, also Gesell[3] in extensive observations. As the child acquires control for stopping and starting, he begins to show more imagination, form begins to appear, his pictures begin to show relationships, sometimes rather bizarre at first. His increasing eye-motor control goes hand-in-hand with his general growth. He has gained progressive control of his body, he

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[1]Schaefer-Simmern, Henry, "The Unfolding of Artistic Ability," University of California Press, Berkely, and L. A. (1948).

[2]Grace Rush, "Visual Grouping in Relation to Age," Archives of Psychology, 31, No. 217 (1937-1938), p. 95.

[3]A. Gesell, op. cit.

can steer his way around objects while running, his motor behavior shows more patterning of response, as Biber[1] points out. Lowenfeld[2] surmised that visual perception only starts when the child discovers he can control his motions; from then on he follows his motions with his eyes.

Well-directed eye-movements are a pre-requisite for reading and most other school work and good coordination of hand and eye is necessary for writing.

The evidence from studies and investigations in these areas of perception seems to indicate that while some degree of perception may be innate, as in figure-ground, much of the perceptual ability of the individual is learned; if learned--then it can be taught. This poses the urgent need for a better understanding of what the implications for learning may be for the child who has some dysfunction in one or more of the visual perceptual areas.

B. Perceptual Dysfunction and Its Implications for Learning

The role or function of perception in the early learning of the child is still incompletely comprehended and the implications perceptual dysfunction may have for this learning are even less completely understood. The inter-relatedness of perceptual disturbance with the child's patterns of reaction to stress, to health, visual and auditory acuity, his experiential background, home environment and many

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[1]Barbara Biber, "Children's Drawings: From Lines to Pictures," No. 6, The Cooperative School Pamphlets, Bureau of Ed. Experiments, 69 Bank St., New York (1956).

[2]Viktor Lowenfeld, "Creative and Mental Growth"; (New York: Macmillan Co. (1954).

other factors may considerably complicate the problem of recognition. Disturbance in more than one area of perception may further confuse the problem of diagnosis.

An understanding of just what problems dysfunction in a specific area places on a child in his early learning may aid teachers in developing teaching aids and materials. There is little of such material readily available, designated for these specific purposes. Frostig has prepared some training materials which are under revision and in use only in study projects, as yet.

1. Figure-Ground Perceptual Dysfunction:

   Solley and Murphy and Goldstein, as noted earlier, stress that figure-ground perception is extremely fundamental. Strauss and Kephart[1] point out that there is a constant conflict between figure and ground in normal perception and they point out that the individual must learn to select that pattern which he will treat as figure and hold it against a tendency for some other pattern to become figure. This is particularly true when the contrast between figure and ground is limited. For example, Silver and Hagin[2] reported that 92 per cent of their reading disability cases had some difficulty with the marble board test using the gray background and black marbles. If red marbles were used instead of the black, intensifying the contrast between figure and ground, much of the difficulty disappeared.

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[1]A. A. Strauss and N. C. Kephart, "Psychopathology and Education of the Brain-Injured Child," (New York: Grune & Stratton, 1955).

[2]A. Silver, and R. Hagin, "Specific Reading Disability: Delineation of the Syndrome," Comparative Psychology, Vol. 1, April (1960), pp. 126-34.

From his extensive studies with adults who had experienced some type of brain damage, Goldstein[1] wrote about the effect of figure-ground disturbance:

> Defective figure-ground formation can manifest itself in various ways: in the leveling of the difference between figure and ground; . . . in an impaired preciseness of the figure; . . . in the formation of the simpler figures with impoverishment of content; in the instability of the figure and therefore in a tendency to inversion of figure and ground. . . . In the visual field differentiation shows itself in a simplification of the organized units, in the loss of characteristic pecularities, and in the appearance of simpler patterns, as when a patient sees two parallel lines instead of a triangle. . . . It is nothing but a change in the functional evaluation of stimuli.

Goldstein points out abnormal distractibility and abnormal stimulus-bond or "forced-responsiveness" may be an expression of defective figure-ground perception.

A number of writers indicate that this defective figure-ground perception may be evident in areas of functioning as thinking, emotional reactions, volition, etc. Examples may be found in assignment of values or importance, minor details may overshadow significant meanings. Problems of this nature multiply as the child must deal with abstractions and more complex situations.

Frostig[2] indicates that the difficulty in transferring the focus of attention from one stimulus to another results in a difficulty in "scanning" . . . the child will appear to be careless in his work because he is unable to find his place on the page, skips sections, cannot find the word he is seeking in the dic-

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[1]Kurt Goldstein, "The Organism," Chap. 4, op. cit.

[2]Frostig, op. cit., "Resource Materials."

tionary and is unable to solve familiar problems if they are presented on crowded pages because he cannot pick out the relevant detail.

2. Form Constancy Perceptual Dysfunction:

Form perception serves to hold the whole together so the parts can be dealt with en masse and the details within the figure be observed for purposes of recognition and comparison. Kephart,[1] in his description of Form Constancy stresses that the conception of an integrated or constructive form is a learning task, and he believes that many children experience difficulty at the early stage of differentiating elements from the globular mass. Vernon[2] cites some studies supporting this conception. They either do not or cannot attend to the details of the mass; hence these details remain unrecognized. In addition to this initial problem with form perception, Kephart surmises that many more children break down at the higher level where the details, having been differentiated, must be re-integrated into a constructive form. He points out that if this integration fails to take place, the child is unable to deal with a coherent figure in the manner in which we are accustomed to deal with it. Instead he is left with a mere mass of elements which he can manipulate only one at a time or in very small groups. Since he cannot perceive an integrated form, he does not respond to the totality of the elements in a figure but responds to only one or a limited number. This may lead to a kind of detail awareness and the

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[1]N. C. Kephart, "The Slow Learner in the Class Room," op. cit.

[2]M. D. Vernon, "A Further Study of Visual Perception."

child may be described as distractible, impulsive, or uninhibited.

From her viewpoint Frostig[1] stresses instability and indicates that it is the lack of constancy that is disturbing to the child. She states that a child with poorly developed constancy is not only likely to be made anxious by the general unreliability of appearance in his world, but he will have major difficulties in academic learning. Although he may learn to recognize a number, letter or word when he sees it in a particular form or context, he may be quite unable to recognize the same symbol when it is presented differently. He is constantly being deceived by his senses; a word he knows well on one form or color or size or type of writing or in conjunction with certain other words, may appear quite new to him when he sees it in another form, color, size or context. Learning to read or to work with symbols is virtually impossible for such a child, she points out. Thus an instability of performance may be apparent; a thing learned yesterday is forgotten today.

3. Spatial Perceptual Dysfunction:

Spatial perception may be divided into position-in-space or the relationship of the individual to objects around him and space relations, the relationships of objects to other objects.

a) Position-in-space:

Frostig maintains that the perception of position-in-space must precede the perception of spatial relationships. She indicates that the child with poor position-in-space percep-

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[1]Marianne Frostig, ibid., "Resource Training Materials."

tion will be handicapped in many ways. His visual world will be distorted, he will be clumsy and hesitant in his movements and he will have difficulty in understanding what is meant by words designating spatial position, as, in, out, up, down, before, behind, right, and left. His difficulties will become most apparent when he is faced with his first academic tasks, for letters, words, phrases, numbers and pictures will appear to him distorted and confusing. He will encounter the "reversal" problem.

Frostig also relates some of the difficulties a child may encounter with position-in-space perception to the child's concept of his own body-image, body concept and schema that he has developed. Upon these will depend his ability to coordinate eye-hand movements and to perceive position-in-space and space-relations.

b) Space Relations:

Frostig alleges that disabilities in the perception of spatial relationships leads inevitably to difficulties in academic learning. Incorrect spatial perception may make impossible the proper perception of the sequence of letters, or an arithmetic problem. Other tasks will be equally difficult, she points out, as model making, map reading, grouping phenomena, etc. All these require the elements of pattern vision, a degree of memory function and visualization.

4. Eye-Motor Perceptual Dysfunction:

Kephart[1] points out that in copying a square, the child has not

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[1] N. C. Kephart, op. cit.

only the problems of muscle coordination and the neurological innervation but also the problem of matching these motor skills to a visual input which is being generated as his pencil moves over the paper. He has to learn to stop the movement on cue. Such a process means that the child must have accurate control of the eyes, an accurate match between eye movements and the perceived visual stimulus and an adequate inter-relationship between the movements of the eyes and the movements of the other muscles of the body. The problem of ocular control and visual kinesthetic matching required in a "simple" task as copying a square is something the child must learn with practice. Kephart points out observation of how the six or seven year old grips his pencil and tends to dig into the paper indicates the effort it is for him.

Some studies have used the Draw-a-Figure test to evaluate this aspect of visual perception, but the studies appear inconclusive and insufficient verfication is given for the assertions. Without well-directed eye-movements reading is difficult and without coordination of hand-eye movements, writing is almost impossible.

Frostig[1] postulates that perception plays a very important role in the total development of the young child. If he has perceptual disabilities his total behavior is likely to be affected. An environment that appears unstable because of constantly changing figure-ground, form constancy and relationships-in-space make

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[1]Marianne Frostig, "Perceptual Ability and School Adjustment in Kindergarten and Primary Grades," December, 1961, California State Phychological Association Meeting.

learning and adjustment extremely difficult. As an approximate measure of a child's perceptual abilities Frostig has used a teacher evaluation of school adjustment and learning which in her studies appear to have a significant correlation with a child's learning as evidenced in reading achievement at the first grade level.

C. Discussion of Research Findings in Perception in Beginning Reading in Terms of the Review of Literature

The findings of other investigations in perception with young children in terms of some of the literature reviewed suggests a few points that appear to have some bearing on the two questions noted at the beginning of this study. The questions: Why do some children encounter great difficulty in learning to read, and how can the school anticipate or predict the children who will require help to work out these problems of learning.

These points may be considered under the headings (1), discussion of certain aspects of findings of research that indicate the importance of perception at the beginning reading level; and (2), consideration of clues in the readiness tests that appear to be possible indicators of later reading achievement.

1. Discussion of Certain Aspects of Findings of Other Studies of Perception in Young Children:

Reports of other investigations of perception in young school children are in agreement that perception appears closely related to learning in the young school child. Investigators in this area have tried various kinds of perceptual tests, mostly non-verbal in nature, in attempts to define more sharply the function of and significance of perception in learning to read. Assuming

that perceptual ability is a part of the developmental process it was postulated by some of the studies that there would be variations in perceptual responses that would suggest variations in competence; other studies stressed the need for training in form and mobility.

a) Individual Differences in Perceptual Competence:

Goins[1] and Siegler[2] reported considerable variation in individual differences in perceptual competence in the first graders tested in their studies. Siegler was particularly interested in the types of perceivers as discussed by Thurstone.[3] She hypothesized that children appeared to be different types of perceivers because some were more advanced in development than others and this would show up in the variation of perception.

Malmquist,[4] in his study of 400 first grade children, found this true with his perceptual tests, even though in Sweden, the setting of his study, children do not enter the first grade before they are seven years of age, giving them an added year of maturity. Malmquist was particularly interested in this aspect of the problem of learning to read and made a careful study of his group, using oral reading tests. He

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[1]Jean Turner Goins, op. cit.

[2]Hazel Gantt Siegler, "Visual Perceptual Patterns and Their Relation to Reading: A Study of 100 First Grade Children," unpublished Doctoral Dissertation, University of South Carolina, 1960.

[3]L. L. Thurstone, "A Factorial Study of Perception," Psychometric, Monograph, No. 4 (Chicago: University of Chicago Press, 1944).

[4]Eve Malmquist, op. cit., Chap. XX.

found that none of the errors in reading recorded was made by only one group of readers. Every type of error was found among poor, medium, and good readers. He concluded from this that the difference between poor, medium, and good readers with regard to errors in reading are rather of a quantitative than a qualitative character. This finding suggests that there is no hard and fast line of demarcation between children slow in learning to read and normal readers.

An earlier study by Frank[1] suggests that lack of maturity of the perceptual processes may be the cause of later reading disabilities.

Frank (1935) compared errors made by children aged seven to eleven and one-half years who had reading disabilities, with those made by children aged five to seven years who were just learning to read. She found remarkable similarities existed. The ability to discriminate between words of similar structure as well as the reversal of letters of similar shape, both as regards reading and spelling, indicated the older retarded reader was still at the same level of perception as the beginner in reading. Frank postulated that this signified that the retarded reader still remained at a stage where the ability to analyze and distinguish between minor details in wholes, which otherwise are structurally almost the same, has not been developed sufficiently.

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[1]H. Frank, "A Comparative Study of Children Who Are Backward in Reading and Beginners in Infant School," British Journal of Educational Psychology, 5 (1935), pp. 41-58.

b) Training in Form Perception:

Goins[1] in her study of first graders sought to test Renshaw's[2] claims for use of the tachistoscope as a technique for improving reading skills. She found that:

> Skill in perception through the tachistoscopic visual form training was achieved to any measurable extent only by the initially superior readers in the group. . . . No positive effect was produced by the tachistoscopic training on the skills of the group as a whole.

Townsend's[3] study indicated the child increased in recognition of form up to about seven years of age. Frostig emphasizes that a child must first be familiar with shapes before he can recognize them when differently presented. This may be the important point in Goin's study; the children already familiar with shapes could recognize them tachistoscopically. The others could not and hence did not benefit by training with the tachistoscope.

This is in accord with Simpson's[4] conclusions in a study mentioned earlier that present day readiness materials do not give enough emphasis to copying and reproducing form, assuming a level of motility that many children have not acquired.

c) Training in Motility:

A number of the research workers in the field of perception such as Hebb, Siegel, Solley and Murphy and others; investi-

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[1] Jean Turner Goins, op. cit.

[2] Samuel Renshaw, "The Visual Perception and Reproduction of Forms By Tachistoscopic Methods," Journal of Psychology, XX (October, 1945), pp. 217-32.

[3] Townsend, op. cit. [4] Simpson, op. cit.

gators in child development as Gesell; of educators as Cruickshank, Kephart and others stress the close relationship of the motor component with the perceptual in learning.

Solley and Murphy[1] postulate that probably there is no such clear functional separation as perceptual versus motor learning. They write:

> It is entirely possible that sense organs, centers, and motor systems are built as they are because the perceptual is that which makes contact with environmental requirements. The centers must receive and redirect the incoming energies in accordance with a dynamic of perpetual change in the light of experience, and the motor acts must redeploy themselves constantly in the light of fresh perceptual information, and fresh central reorganization.

In Siegel's[2] view, the motor aspects of learning are possibly of greater importance in the beginning stages of learning, than after skill has been acquired; as would be the case with the young child.

There are a number of special techniques receiving some publicity at present, that purport to aid in improving a child's perceptual skills or abilities through development of motor skills. Examples:

(1) Delacato's[3] work with children with reading disabilities follows some of the theories of Dr. Temple Fay, a well-known neurologist and stresses development of a progression of patterning of movements, beginning with the old brain patterns.

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[1]Charles M. Solley and Gardner Murphy, op. cit., pp. 324-25.

[2]Arthur Siegel, op. cit.

[3]Carl H. Delacato, "Treatment and Prevention of Reading Problems: The Neuro-Psychological Approach," Springfield, Ill., Thomas, 1959.

(2) Getman,[1] an optometrist, who worked with Gesell in vision research.

(3) Kephart,[2] an educational psychologist.

These last two recommend stress on development of early motor patterning. The theory back of these training methods appears to be that it is assumed that for some reason some children miss steps in the progression of motor patterning that are fundamental to their perceptual learning.

Some studies making use of kinesthetic training have reported improvement in learning but full data are not available, as the studies of Shedd[3] and Hind.[4]

Simpson's[5] study with young children at first grade level dealt with this problem. Simpson postulated that training in motor and perceptual skills could improve perceptual function.

Two other studies appear to have some bearing on Simpson's thesis. Townsend[6] (mentioned earlier) studied children in grades one to three in copying figures. He concluded that this combined activity of form perception, comprehension of that form and the motor skill required to reproduce the form

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[1]G. N. Getman, "How to Develop Your Child's Intelligence," 7th ed., Luverne, Minn.

[2]N. C. Kephart, "The Slow Learner in the Classroom," op. cit.

[3]Charles L. Shedd, "The Diagnosis and Treatment of Symbolic Confusion," International Reading Assoc. Conference Proceedings, Vol. 6, 1961.

[4]Lillian Hind, "Longitudinal Studies of Certain Visual Characteristics and Success in Reading," International Reading Assoc. Conference Proceedings, Vol. 4, 1959.

[5]Dorothy Margaret Simpson, op. cit. [6]Edward Townsend, op. cit.

was a better indicator of the child's mental maturity than his chronological age.

Russell[1] studied the visual-motor function in the young school child as compared to organismic growth as discussed by Olson.[2] Russell found that the visual-motor function matures independently of the rate of change in organismic age in children, ages six to seven years, as measured by the Bender Visual-Motor Gestalt Test. He found that this visual-motor development was a better indicator of reading readiness than the organismic age of the child. In both these studies the ability to comprehend and recognize form and the motor skill to copy it appeared to be better indicators of reading readiness than the so-called readiness tests themselves.

Simpson[3] noted that in many readiness materials emphasis on the level of motility is limited to left and right analysis of pictures, words, and symbols and she suggested that this is an extremely sophisticated level of visual development. She points out that unless the child already possesses the motility required, he will need more basic motility developmental experiences than most available readiness materials provide. She advocated that more stress should be placed on

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[1]Ivan Lee Russell, "The Visual-Motor Function as Related to Child Grow th and Reading Development," unpublished Doctoral dissertation, University of Michigan, 1955.

[2]Willard C. Olson, Child Development, 2nd Edition (Boston: Heath, [3]Dorothy

[3]Dorothy Margaret Simpson, op. cit.

these motor aspects of learning. Her experimental group given additional training in kinesthetic and perceptual activities performed significantly better on her final reading test than did her control group.

2. Consideration of Clues in the Readiness Test That Appear to be Possible Predictors of Reading Achievement:

A number of the studies reviewed here found that the so-called readiness subtests of the Readiness Tests were less accurate predictors of later reading achievement than were the subtests of a perceptual nature.

Simpson[1] and Siegler[2] found high correlations between Matching, Numbers and Copying subtests of the Metropolitan Readiness test and reading achievement. Goins[3] noted that the scores on Pattern Copying and Reversals of the readiness test she used correlated most highly with reading achievement. Potter[4] found Shape Matching and Symbol Orientation the highest in correlation with reading achievement.

It is noteworthy that in each of these studies, these perceptual tests which are quite similar in nature, should be found to be better indicators of later performance in reading than the reading readiness subtests. However, it would seem that before these particular tests are actually used as predictors further study should be made.

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[1] Ibid. [2] Hazel Gantt Siegler, op. cit.

[3] Jean Turner Goins, op. cit.

[4] Muriel Catherine Potter, op. cit.

Part 2. The Study of the Frostig Visual Perceptual Tests as a Predictor of Reading Achievement in First Grade

The second part of the study proposed to test the predictive value of the Frostig Visual Perceptual Tests as a measure of perceptual and later reading achievement, against the Metropolitan Readiness and Reading Achievement Tests as criteria.

The first procedure in this part of the investigation was a comparison of the study group scores with the standardized norms of each of the tests used in the investigation.

A. Comparison of Scores of the Study Group with the Norms of the Frostig Visual Perceptual Tests, the Metropolitan Readiness Test and Reading Achievement Test

The first comparison was made between the Frostig Visual Perceptual Tests norm and the scores of the study group.

1. Comparison of Frostig Visual Perceptual Tests Norm with the Study Group Scores:

Frostig and her colleagues[1] have recently completed a revised standardization of her test on over 1,800 children from nursery school, kindergarten, first and second grades; ages three through nine years. In the earlier standardization a perceptual age level was used with an age conversion scale. (Appendix C) The perceptual age is retained in this new standardization with use of scale scores and a perceptual quotient.

The perceptual quotient described in the revised standardization

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[1]Marianne Frostig and Colleagues, Pre-publication copy, "The Marianne Frostig Developmental Test of Visual Perception," 1962 standardization.

is a deviation score obtained from the sum of subtest scale scores after correcting for age variation. For each age group the perceptual quotient has a median of 100, a lower quartile of 90 and upper quartile of 110 and the other points consistent with the IQ values of the Wechsler Intelligence Score for Children.

Table 2 gives the percentile rank of the Frostig norm and the percentile quotient for each rank. The study group's perceptual quotients were computed, using the methods described by Frostig. Percentage totals of the study group are listed for each level indicating in each case the percentage of the study group that fall below this percentile rank.

Frostig points out that her sample of 1,800 children is not truly representative because these children were from communities largely middle and lower middle class, a very few Oriental and Mexican children were in the sample group, but no colored children.

According to the census figures for the city in which this present study was done, the children of this investigation were probably from middle and lower class homes, approximately one-half of the group were non-white. In comparison with the norm of Frostig's group the study group was a little low; 36 per cent of the study group were below the 25th percentile or first quartile. Fifty-six and seven-tenths (56.7) per cent of the study group fell below the 50th percentile; 73.8 per cent were below the 75th percentile or third quartile; leaving 26.1 per cent of the study group in the upper quartile. There appeared to be a fairly wide

TABLE 2

FROSTIG VISUAL PERCEPTUAL TESTS EQUIVALENT PERCENTILE RANK OF CORRECTED PERCEPTUAL QUOTIENT SCORES OF NORM COMPARED WITH THE STUDY GROUP PERCEPTUAL GROUP QUOTIENT SCORES

Percentile Rank of Frostig Norm	Perceptual Quotient of Frostig Norm	No. of Study Group in Perceptual Group	Percentage Below Each Level
95	125	5	99.9
90	119	10	95.4
80	113	14	86.4
75	110	1	73.8
70	108	9	72.8
60	104	9	64.8
50	100	11	56.7
40	96	6	46.8
30	92	6	41.4
25	90	3	36.0
20	87	9	33.3
10	81	15	25.2
5	75	5	11.7
3	72	5	7.2
1	65	3	2.7
Total	. .	111	. .

range of individual difference in perceptual competence within the group, with some concentrations at both the lower and upper ends of the scale.

Frostig[1] reports that in her observations children achieving a perceptual quotient of 90 or less usually have difficulty in learning to read. To study this possibility with the data of the study group Table 3 was prepared. The perceptual quotients of the Frostig Visual Perceptual Tests of all the records with scores of 90 or less were selected and the Metropolitan Readi-

[1] Ibid.

ness and Reading Achievement Tests totals were added to the Table. It is of interest to note that 40 or 36 per cent of the 111 children in the study group had scores of 90 or less on the perceptual quotient. Of these 12 or 30 per cent of the group (40) were below the average or midpoint on the Metropolitan Readiness Test and 28 or 70 per cent of the group (48) fell below the "average" or midpoint on the Reading Achievement Test. Tables 4 to 9 show the range of individual differences of the study group in each of the five subtests of the Frostig Visual Perceptual Tests. Information is not available by means of which the study group subtest range of perceptual competence could be compared with similar groups of children. However, the observation about children who achieve a perceptual quotient of 90 or less, showing later difficulty with reading would appear to be substantiated in the study group.

2. Comparison of Scores of the Study Group with Norms of the Metropolitan Readiness Test:

The Metropolitan Readiness Test was standardized on approximately 15,000 children of pre-reading level. Percentiles, only, were available for comparative purposes. Table 10 indicates that 80 per cent of the study group were at the midpoint or above in comparison with the percentile ratings given for the Metropolitan Readiness Test. This would suggest that the Study group rate is a little above the norm with only 19.8 per cent of the group who fall below the midpoint. If the readiness test is a good predictor of later achievement the group should show up well on the reading achievement at the end of their first grade year.

TABLE 3

SCORES OF CHILDREN IN STUDY GROUP ACHIEVING A PERCEPTUAL QUOTIENT OF 90 OR LESS, AND THEIR SCORES ON THE METROPOLITAN READINESS AND READING ACHIEVEMENT TESTS

Identification	P.Q.	Metropolitan Readiness Test	Reading Achievement Test
1. No. 5	86	80 High average	62 High average
2. No. 19	80	65 average	62 High average
3. No. 11	86	70 average	66 High average
4. No. 13	78	67 average	61 High average
5. No. 24	80	87 High normal	67 Very high
6. No. 26	72	78 average	64 High average
7. No. 28	78	72 average	21 Very low
8. No. 30	78	61 Low average	28 Very low
9. No. 36	76	58 Low normal	58 Low average
10. No. 41	76	50 Low normal	32 Very low
11. No. 44	84	77 average	50 Low
12. No. 46	88	73 average	55 Low average
13. No. 47	62	53 Low normal	41 Very low
14. No. 48	88	66 average	55 Low average
15. No. 54	86	66 average	45 Very low
16. No. 56	86	61 Low normal	59 Low average
17. No. 57	78	80 High normal	54 Low average
18. No. 61	50	62 Low normal	31 Very low
19. No. 62	90	44 Low normal	45 Very low
20. No. 64	84	87 High normal	52 Low
21. No. 67	84	78 average	60 average
22. No. 69	74	86 High normal	62 High average
23. No. 72	68	79 average	54 Low average
24. No. 75	78	92 superior	67 High
25. No. 79	78	74 average	56 Low average
26. No. 80	90	53 Low normal	57 Low average
27. No. 82	74	69 average	52 Low
28. No. 83	72	63 Low normal	60 average
29. No. 86	76	69 average	60 average
30. No. 92	84	61 Low normal	34 Very low
31. No. 96	90	67 average	30 Very low
32. No. 98	74	77 average	20 Very low
33. No. 99	86	65 average	28 Very low
34. No. 100	66	67 average	50 Low
35. No. 102	88	74 average	33 Very low
36. No. 104	80	67 average	61 High average
37. No. 108	78	43 Low normal	41 Very low
38. No. 109	86	69 average	52 Low average
39. No. 110	72	55 Low normal	31 Very low
40. No. 111	82	67 average	35 Very low
Total 40	..	12 Below "Average"	28 Below "Average"
.....	..	30 Per cent of Group (40)	70 Per cent of Group (40)
		8.1 Per cent of N = 111	25.2 Per cent of N = 111

TABLE 4

FREQUENCY TABLE OF FROSTIG VISUAL PERCEPTUAL TESTS TOTAL, RAW SCORE, RANGE 12-56, FOR STUDY GROUP (N = 111)

Code No.	Midpoint of Interval	Number in Interval
0	14	1
1	19	3
2	24	5
3	29	8
4	34	16
5	39	25
6	44	29
7	49	14
8	54	10
Total		111
Mean		40.36
Standard Deviation		8.74

TABLE 5

FREQUENCY TABLE OF FROSTIG EYE-MOTOR TEST, RAW SCORE, RANGE 5-26, FOR STUDY GROUP (N = 111)

Code No.	Midpoint of Interval	Number in Interval
0	6	6
1	9	9
2	12	18
3	15	24
4	18	33
5	21	15
6	24	5
7	26+	1
Total		111
Mean		15.74
Standard Deviation		3.52

TABLE 6

FREQUENCY TABLE FOR FROSTIG FIGURE-GROUND TEST, RAW SCORE (10) FOR STUDY GROUP (N = 111)

Code No.	Midpoint of Interval	Number in Interval
0	1	1
1	2	0
2	3	1
3	4	2
4	5	12
5	6	8
6	7	16
7	8	26
8	9	21
9	10	24
Total		111
Mean		7.82
Standard Deviation		1.79

TABLE 7

FREQUENCY TABLE FOR FROSTIG FORM CONSTANCY TEST, RAW SCORE (17),* RANGE 0-13, FOR STUDY GROUP (N = 111)

Code No.	Midpoint of Interval	Number in Interval
0	0	9
1	1-2	12
2	3-4	18
3	5-6	27
4	7-8	23
5	9-10	15
6	11-12	6
7	13+	1
Total		111
Mean		5.64
Standard Deviation		3.18

*Total possible Raw Score, Range of Group 0-13.

TABLE 8

FREQUENCY TABLE FOR FROSTIG POSITION-IN-SPACE TEST, RAW SCORE (8),* FOR STUDY GROUP (N = 111)

Code No.	Midpoint of Interval	Number in Interval
0	1	0
1	2	2
2	3	8
3	4	9
4	5	15
5	6	22
6	7	28
7	8	27
Total		111
Mean		6.16
Standard Deviation		1.58

*Total possible Raw Score (8).

TABLE 9

FREQUENCY TABLE FOR FROSTIG SPACE RELATIONS TEST, RAW SCORE (8),* FOR STUDY GROUP (N = 111)

Code No.	Midpoint of Interval	Number in Interval
0	0	7
1	1	4
2	2	7
3	3	13
4	4	12
5	5	15
6	6	27
7	7	22
8	8	4
Total		111
Mean		4.78
Standard Deviation		2.09

*Total possible raw Score (8).

TABLE 10

COMPARISON OF STUDY GROUP SCORES WITH THE METROPOLITAN READINESS TEST NORM SCORES

Metropolitan Readiness Test Norms			Study Group	
Rating	Score	Percentiles	Number in This Range	Percentage At This Range
Superior	90 - 100	95 - 100	15	13.5%
High normal	80 - 89	73 - 93	22	19.8%
Average	65 - 79	37 - 70	52	46.8%
Low normal	40 - 64	6 - 35	22	19.8%
Poor risk	0 - 39	1 - 5	0	0.0%
Total	. . . .	. . . .	111	99.9%

3. Comparison of Scores of the Study Group with Reading Achievement: Table 11 gives another picture, however. It shows that the study group scores, instead of clustering toward the upper end of the scale, are spread from the very high to the very low levels. More than half of the study group fall below the median, with 30 per cent in the low and very low ranges. This marked difference in achievement would suggest some lack in predictive power in the readiness test or that the two tests are not measuring the same skills. This, of course, is similar to the results of other studies. As Traxler's study, noted earlier, pointed out the results of the readiness test varied with the group, indicating that there were other factors that contribute to the results that are not included in the readiness test or the reading achievement test.

4. Summary of Comparison of Scores of Study Group with Frostig Visual Perceptual Tests, Metropolitan Readiness and Reading Achievement Tests:

The study group test scores were compared with the norms of the Frostig Visual Perceptual Tests, the Metropolitan Readiness Test and the Reading Achievement Test.

TABLE 11

COMPARISON OF STUDY GROUP SCORES WITH
READING ACHIEVEMENT TEST NORMS

Reading Achievement Test Norms			Study Group	
Rating	Score	Percentiles	No. of Group At This Level	Percentage At This Range
Very high	67 - 70	90 - 99	13	11.7%
High	64 - 66	75 - 89	19	17.1%
High average . .	61 - 63	51 - 74	15	13.5%
Average	60	50	7	6.3%
Low average . . .	53 - 59	25 - 49	24	21.6%
Low	46 - 52	10 - 24	13	11.7%
Very low	0 - 45	1 - 9	20	18.0%
Total . . .	. . . .	. . . .	111	99.9%

The Frostig Visual Perceptual Tests Norms have been newly standardized on children of middle and lower middle class white population. By contrast, the study group were approximately half non-white and according to the census figures the socio-economic level could be lower in range. These factors could contribute to the somewhat lower scores. Table 3, showing the children whose perceptual quotients were 90 or less, having problems in reading, were in accord with Frostig's observations.

The study group appeared to compare favorably with the Metropolitan Readiness Test norm suggesting a prediction of readiness for reading for a high percentage of the class. However, the comparison with the norm of the Reading Achievement Test indicated a group slightly below the average with more than half the group falling below the national median. (Tables 2 to 11 demonstrate these trends.) The comparison of the study group with the Reading Achievement are in accord with Table 3 of the children whose

scores were low on perceptual quotient.

B. Study of the Relationships Among Variables

A correlation matrix makes it possible to determine the similarities between one test and all the other tests in the table. Product moment coefficients of correlation are generally employed for testing relationships in this way. Tables 12 to 15 show the intercorrelations between the individual test measures.

The level of significance for a group N = 111 computed in accordance with the formula given by David[1] for small samples is: .01 significance level = ± .244; and .05 = ± .186.

1. The Study of the Correlations Between the Frostig Visual Perceptual Tests and Scores of the Metropolitan Readiness and Reading Achievement Test, with the Teacher Evaluation Ratings for School Adjustment and Learning and the Two Draw-a-Figure Tests:

The Frostig total score is considered first and then the individual subtests.

a) The correlations between the Frostig Total Score and other test scores:

The Frostig total score correlates significantly at .01 level with the Metropolitan Readiness Test total (.400) and with the subtests Word Meaning (.311), Information (.282), Matching (.338), Copying (.412). It correlates with subtests numbers (.227) at .05 level of significance. Correlation with subtest Sentences (.049) is negligible.

The Frostig Total score correlates significantly at .01 level with Reading Achievement Test total (.382) and with subtests Sentence Meaning (.304), Sensory Imagery (.421), Relation-

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[1]F. N. David, Tables of the Ordinates and Probability Interval of the Distribution of the Correlation Coefficient in Small Samples (Cambridge, Cambridge University Press, 1938).

ships (.344), Visual Scrutiny (.307), Phonetic Analysis (.283) and Structural Analysis (.287). Relationships with Emotional Reactions is negligible.

TABLE 12

INTERCORRELATIONS BETWEEN THE FROSTIG VISUAL PERCEPTUAL TESTS AND METROPOLITAN READINESS TEST FOR THE STUDY GROUP (N=111)[a,b]

Frostig Test	Metropolitan Readiness Test	Total	Word Meaning	Sentences	Information	Matching	Numbers	Copying
Total	. .	400*	311*	049	282*	338*	227+	412*
Eye-Motor	. .	135	085	-073	-027	135	082	137
Figure-Ground	. .	358*	264*	212+	244*	312*	233+	296*
Form Constancy . . .	. .	342*	264*	090	364*	229+	159	347*
Position-in-Space . .	. .	440*	295*	146	348*	364*	282*	479*
Space Relations . . .	. .	239+	282*	008	231+	245*	121	302*

[a]Decimal point omitted.

+= 5% Significance Level = ± 186.

*= 1% Significance Level = ± 244.

[b]
$$r = \frac{t}{t^2 + N - 2}$$

(N = df 111 -2) X 2 = .05; t = 1.99.

F. N. David, Tables of the Ordinates and Probability Interval of the Distribution of the Correlation Coefficient in Small Samples (Cambridge: Cambridge University Press, 1938).

TABLE 13

INTERCORRELATIONS BETWEEN THE FROSTIG VISUAL PERCEPTUAL TESTS AND READING ACHIEVEMENT TEST FOR STUDY GROUP (N=111)[a,b]

Frostig Test	Reading Achievement Total	Sentence Meaning	Sensory Imagery	Relationships	Emotional Reactions	Visual Scrutiny	Phonetic Analysis	
Total	382*	304*	421*	344*	147	307*	283*	287*
Eye-Motor	237+	166	326*	214+	094	174	213+	149
Figure-Ground	287*	140	278*	318*	202+	233+	167	181
Form Constancy . . .	347*	208+	282*	294*	270*	249*	268*	236+
Position-in-Space . .	344*	311*	327*	221+	070	374*	294*	293*
Space Relations . . .	116	154	212+	123	-109	097	143	150

[a,b]As in Table 12.

TABLE 14

INTERCORRELATIONS BETWEEN THE FROSTIG VISUAL PERCEPTUAL TESTS AND TEACHER EVALUATION AND DRAW-A-FIGURE TESTS WITH STUDY GROUP (N=111)[a,b]

Frostig Test	Teacher Evalua. School Adjust.	Teacher Evalua. Learning	Kindergarten Draw-a-Figure	Grade 1A Draw-a-Figure
Total	298*	420*	235+	272*
Eye-Motor	059	219+	-010	163
Figure-Ground	286*	261*	203+	176+
Form Constancy	354*	337*	257*	184+
Position-in-Space	236+	402*	243+	231+
Space Relations	246*	278*	178+	167+

[a,b]As in Table 12.

Frostig total score relates at .01 level with Teacher Evaluation Rating School Adjustment (.286) and Learning (.420) and with IA Draw-a-Figure test (.272), with the kindergarten Draw-a-Figure (.235) test at .05 level.

b) Correlation Between Frostig Eye-Motor and Other Test Scores:

The Frostig Eye-Motor test measures eye control of motor activity, as in writing. There are no correlations of any significance with the subtests of the Metropolitan Readiness Test. With the Reading Achievement Test, Eye-Motor subtest shows a relationship at .01 level of significance with only one subtest, Sensory Imagery (.326). There is relationship at .05 level with subtests Relationships (.214) and Phonetic Analysis (.213). Relationships with other subtests of the Reading Achievement test are all negligible.

Correlations with Teacher Evaluation Rating School Adjustment and both Draw-a-Figure tests are negligible. The significant relationship of the subtest Eye-Motor test suggests there must be a specific reason. Perhaps the reason is that Eye-Motor skill sufficient for these tests is acquired fairly early, as suggested by the Age-Conversion Table (Appendix C), and hence does not become or remain an important factor by the end of the first grade. Perhaps if this test were given at kindergarten level the results would be different.

c) Frostig Figure-Ground Test:

The Figure-Ground subtest purports to measure recognition of relationships, i.e., of the central focus of attention and

the surrounding ground. Figure-Ground may be constantly shifting, figure may become ground and ground become figure, making concentration on anything in the area of focus difficult for the child trying to learn to recognize letters, etc.

Relationships with the Metropolitan Readiness subtests Word Meaning (.264), Information (.244), Matching (.312), and Copying (.296), all at .01 level of significance. Subtests Sentences (.212) and Numbers (.233) relate with Figure-Ground test at .05 level.

Figure-Ground relationships with Reading Achievement subtests appear less important than at the earlier level. It correlates at .01 level of significance with two subtests, Sensory Imagery (.278) and Relationship (.318) and at .05 level with Emotional Reactions (.202) and Visual Scrutiny (.233). Correlations with other subtests were negligible.

Figure-Ground correlations with Teacher Evaluation Ratings are at .01 level, for School Adjustment (.286) and Learning (.261); and for the Draw-a-Figure tests (.203 and .176) at .05 level.

d) Frostig Form Constancy Test:

The ability to recognize form even when presented in different sizes, settings, orientations, etc., as ability to recognize letters or words in different sizes, colors, etc.--this is form constancy perception for the child.

Form Constancy shows a .01 level of significance relation-

ship with Metropolitan Readiness subtests Word meaning (.264), Information (.364) and Copying (.347), with only one subtest Matching (.229) at .05 level.

Form Constancy appears to gain more significance at reading achievement level. It correlates at .01 level with Reading Achievement sub-tests Emotional Reactions (.270), Visual Scrutiny (.249) and Phonetic Analysis (.268). It correlates at .05 level with Sentence Meaning (.208) and with Structural Analysis (.236).

Form Constancy relates at .01 level with Teacher Evaluation School Adjustment (.354) and Learning (.337), and with Kindergarten Draw-a-Figure test (.257). It relates at .05 level of significance with IA Draw-a-Figure (.184).

e) Frostig Position-in-Space:

According to Frostig, children showing difficulty with writing, as mirror writing, reversal of letters, etc. lack competence in Position-in-Space perception. This subtest rates significantly at .01 level with Metropolitan Readiness subtests Word Meaning (.295), Information (.348), Matching (.364), Numbers (.282) and Copying (.479). It shows negligible relationship with Sentences.

With Reading Achievement subtests, position-in-space test shows a correlation at .01 level with Sentence Meaning (.311), Sensory Imagery (.327), Visual Scrutiny (.374), Phonetic Analysis (.294), and Structural Analysis (.293). It relates at .05 level with subtests Relationships at .01 level.

Position-in-Space test correlates at .01 level with Teacher

Evaluation Rating Learning (.402) and at .05 level with Teacher Evaluation Rating School Adjustment (.236) and both Draw-a-Figure tests (.243 and .231).

f) Frostig Space Relations Test:

This perceptual ability is considered important for sequence, order, activities requiring visual memory, relationships between objects, etc. It may show up in a tendency to interchange the order of words or letters, etc.

This test relates at .01 level with Metropolitan Readiness subtests Word Meaning (.282), Matching (.245) and Copying (.302). It relates at .05 level with Information (.231). With Reading Achievement test, it correlates with only one subtest Sensory Imagery (.212) at .05 level; relationships with all other tests of Reading Achievement test are negligible. With Teacher Evaluation Rating School Adjustment and Learning (.246 and .278) at .01 level and with both Draw-a-Figure tests (.178 and .167) at .05 level of significance.

Frostig maintains that this aspect of perception is vitally essential for learning and that acquisition of Position-in-Space perception precedes it in the hierarchy of development. Perhaps this aspect of perception was present in sufficient degree in this study group and for this reason did not show up in the test scores, or conversely that this aspect of visual perception was not required to any significant degree in these tests, hence did not indicate any significant correlation.

g) Summary of the Study of Correlations Between Frostig Visual Perception Tests and Other Tests Used in the Study:

The Frostig Visual Perceptual Tests with the exception of subtest Eye-Motor relate significantly with all of the Metropolitan Readiness subtests except Sentences and Numbers.

The Frostig subtests Form Constancy and Position-in-Space relate significantly with almost all of the Reading Achievement subtests. This would suggest that these two subtests are particularly important at the first grade reading level.

2. Study of the Relationships Between the Metropolitan Readiness Test and Reading Achievement Test, Teacher Evaluation Ratings and Draw-a-Figure Tests.

a) Because of the tentative postulation that the Metropolitan Readiness test scores might provide some clues from which a prediction of reading achievement might be made, the Metropolitan Readiness test and other tests of the correlation table were studied. These relationships are shown in Tables 15 and 16.

Metropolitan Total scores relate at .01 level of significance with Reading Achievement subtests sentence Meaning (.399), Sensory Imagery (.320), Relationships (.372), Emotional Reactions (.302), Visual Scrutiny (.354), Phonetic Analysis (.413) and Structural Analysis (.385). This test total correlates at .01 level with both Teacher Evaluation Ratings (.396 and .496) and with kindergarten Draw-a-Figure (.272).

b) Metropolitan Subtest Word Meaning:

This test shows relationship of .01 level of significance

TABLE 15

INTERCORRELATIONS BETWEEN METROPOLITAN READINESS TEST, READING ACHIEVEMENT TEST AND TEACHER EVALUATIONS FOR STUDY GROUP (N=111)[a,b]

Metropolitan Readiness Test	Reading Achievement Total	Sentence Meaning	Sensory Imagery	Relationships	Emotional Reactions	Visual Scrutiny	Phonetic Analysis	Structural Analysis	Teacher Evaluation	School Adjustment	Learning
Total	476*	399*	320*	372*	302*	354*	413*	385*		396*	496*
Word Meaning	242+	113	077	228+	218+	126	269*	215+		290*	215+
Sentences	368*	309*	160	347*	306*	320*	270)	314*		319*	290*
Information	232+	114	168	236+	176	138	237+	110		235+	283*
Matching	236+	159	254*	118	182+	165	323*	110		156	400*
Numbers	384*	388*	220+	256*	177	347*	340*	381*		341*	399*
Copying	495*	544*	399*	284*	284*	458*	303*	411*		290*	408*
Teacher Evaluation											
School Adjustment	404*	270*	261*	330*	338*	280*	280*	361*			
Learning	616*	532*	537*	345*	567*	486*	486*	470*			

[a,b]As in Table 12.

TABLE 16

INTERCORRELATIONS BETWEEN THE DRAW-A-FIGURE TESTS AND METROPOLITAN READINESS AND READING ACHIEVEMENT TESTS FOR STUDY GROUP (N=111)[a,b]

Draw-a-Figure	Metropolitan Total	Word Meaning	Sentences	Information	Matching	Numbers	Copying	Reading Achievement Total	Sentence Meaning	Sentence Imagery	Relationships	Emotional Reactions	Visual Scrutiny	Phonetic Analysis	Structural Analysis
Kindergarten	272*	158	224+	123	133	261*	351*	398*	319*	290*	294*	222+	405*	259*	341*
1A	197+	101	133	115	095	205+	233+	310*	254*	323*	262*	121	308*	221+	275*

[a,b]As in Table 12.

only, with Reading Achievement subtest Phonetic Analysis (.269) and with Teacher Evaluation Rating for School Adjustment (.290). It relates at .05 level with Reading Achievement subtests Relationships (.228), Emotional Reactions (.218), Structural Analysis (.215) and with Teacher Evaluation Rating Learning (.215). Perhaps the skill required for this test is so fundamental for pre-reading level that it does not appear to contribute to relationships at the reading level.

c) Metropolitan Readiness Subtest Sentences:

This test correlates significantly at .01 level with nearly all the tests with Reading Achievement subtests Sentence Meaning (.309), Relationships (.347), Emotional Reactions (.306), Visual Scrutiny (.320), Phonetic Analysis (.270) and Structural Analysis (.314). It relates at .01 with Teacher Evalua-

tion Rating School Adjustment and Learning (.319 and .290) and with kindergarten Draw-a-Figure at .05 level.

d) Metropolitan Readiness Subtest Information:

This test correlates at .01 level with Teacher Evaluation Learning (.283). It shows relationships at .05 level with subtests Relationships (.236), Phonetic Analysis (.237) and with both Teacher Evaluation Rating School Adjustment (.235). Perhaps this skill is similar to Word Meaning, so basic that it does not appear to show any relationship with most of the test.

e) Metropolitan Readiness Subtest Matching:

This test correlates at .01 level of significance with subtest Sensory Imagery (.254), Phonetic Analysis (.323) and with Teacher Evaluation Rating Learning (.400).

f) Metropolitan Subtest Numbers:

This test shows high correlation at .01 level with Sentence Meaning (.388), Relationships (.256), Visual Scrutiny (.347), Phonetic Analysis (.340), Structural Analysis (.381), with both Teacher Evaluation Ratings (.341 and .399) and with the kindergarten Draw-a-Figure (.261). It shows relationship at .05 level with subtest Sentence Imagery (.220) and IA Draw-a-Figure (.205).

g) Metropolitan Readiness Subtest Copying:

This test shows a .01 level of significance correlation with all of the tests except IA Draw-a-Figure. Relationship with subtest Sentence Meaning (.544), Sensory Imagery (.399), Relationships (.284), Emotional Reactions (.284), Visual Scru-

tiny (.458), Phonetic Analysis (.303), Structural Analysis (.411), with both Teacher Evaluation Ratings (.290 and .408) and with kindergarten Draw-a-Figure Test (.351).

Teacher Evaluation Ratings show correlations at significant levels, with all of the Frostig Visual Perceptual Tests and with the other tests used in this study. The correlation with the Learning Rating was higher in each instance than the School Adjustment Rating, indicating probably that the teachers' judgments were more accurate in this area. Possibly the operational definition of School Adjustment as used by Frostig was not made sufficiently clear to them, or this evaluation tends to be more subjective.

h) Summary of the Study of Relationships Between Metropolitan Readiness Tests and Other Tests of the Study:

The subtests of the Metropolitan Readiness that show the highest correlations with the other tests used in the study were Copying, Sentences, and Numbers, in that order. If any investigation of possible indicators of learning difficulty should be studied, these three appear to give more promise than any others.

C. Factor Analytic Study of the Test Variables

The correlation matrix for the factor analysis of the Study Group is given in Appendix D.

The principal axes factor analysis was carried out on the 22 variable matrix. Six factors were extracted and their loadings are presented in Table 17. The factors were rotated to orthogonal simple structure using the Kaiser[1] Varimax criterion. The rotated factor matrix

[1]Henry Kaiser, Ibid.

is shown in Table 18. The sum of the squares of each row of this factorial table is the communality, h^2.

TABLE 17

FACTOR ANALYSIS BY PRINCIPAL AXES METHOD*
22 VARIABLES BEFORE ROTATION-STUDY
GROUP DATA (N=111)

Variables	I	II	III	IV	V	VI	Commu. h^2
1. Draw-a-Figure	458	087	-000	-217	-156	069	0.405
2. 1A. Draw-a-Figure	371	078	-141	-065	-100	127	0.324
3. Metro Word Meaning	462	-570	232	-037	-083	-079	0.640
4. Metro Sentences	443	-104	404	-047	-075	052	0.380
5. Metro Information	459	-601	212	043	-044	-003	0.640
6. Metro Matching	480	-470	032	083	289	184	0.527
7. Metro Numbers	570	-241	197	-191	190	182	0.527
8. Metro Copying	643	032	-234	-140	019	173	0.544
9. R. Ach. Sentence Meaning .	712	396	049	-150	158	-017	0.701
10. R. Ach. Sentence Imagery .	642	218	-264	159	009	205	0.578
11. R. Ach. Relationships . . .	621	178	030	116	-263	147	0.542
12. R. Ach. Emotional Reactions	520	218	335	237	-083	-101	0.501
13. R. Ach. Visual Scrutiny . .	766	406	062	-009	112	-043	0.701
14. R. Ach. Phonetic Analysis .	640	116	136	281	331	-213	0.677
15. R. Ach. Structual Analysis.	663	320	113	-305	-093	-085	0.690
16. Teach. Eval. School Adj. .	532	-063	096	-015	-274	-208	0.472
17. Teacher Eval. Learning . .	711	042	-046	086	116	-103	0.567
18. Frostig Eye-Motor	283	013	-398	303	-016	-001	0.342
19. Frostig Figure-Ground . . .	429	171	-112	203	-199	196	0.342
20. Frostig Constancy	470	147	-121	137	-227	-130	0.364
21. Frostig Position-in-Space .	554	241	-356	-167	099	-087	0.525
22. Frostig Space Relations . .	354	308	-505	-161	-004	-258	0.525
$\sum a^2$ = Common Factor Variance .	6.655	1.764	1.176	0.623	0.591	0.439	11.248
Per cent Ratio of Common Factor Variance	72.6	19.2	12.8	06.8	06.4	04.8	100.00

*Decimals omitted.

A number of points may be noted concerning the explanation of the factor analysis. In attempting to interpret the factors, Thur-

stone[1] suggests that:

> A projection is not considered as significant in naming a factor unless it is as large as .40. Other factor loadings of .40 or higher tend to aid in interpreting the nature of the factor. However, Cattell[2] is of the opinion that loadings as low as .20 to .25 are adequate for this purpose.

TABLE 18

FACTOR ANALYSIS BY PRINCIPAL AXES METHOD* WITH ROTATION BY THE KAISER VARIMAX CRITERION FOR STUDY GROUP (N=111)

Test Variables	Factor I	Factor II	Factor III	Factor IV	Factor V	Factor VI	Communalities h^2
1. Kind.Draw-a-Figure	426	152	122	232	111	088	294
2. 1A. Draw-a-Figure	306	068	151	126	240	008	194
3. Metro. Word Meaning	077	740	147	-007	-005	178	607
4. Metro. Sentences	347	457	-179	055	-004	131	381
5. Metro. Information	041	762	123	052	076	115	620
6. Metro. Matching	130	633	169	-170	173	-269	577
7. Metro. Numbers	396	566	066	073	021	-201	527
8. Metro. Copying	506	204	322	119	302	-115	520
9. Read.Ach.Sentence Mean.	834	054	089	-036	054	-053	713
10. Read.Ach.Sensory Imag.	541	044	192	-081	505	-071	597
11. Read.Ach.Relationships	522	169	-015	063	414	213	522
12. Read.Ach.Emo.Reactions	523	192	-225	221	125	280	504
13. Read.Ach.Vis.Scrutiny	850	069	057	-132	144	031	769
14. Read.Ach.Phonet.Analy.	579	248	048	-523	059	007	676
15. Read.Ach.Struc.Analy.	766	100	103	180	-028	155	664
16. Tchr.Eval.Rat.Sch.Adj.	370	302	151	015	084	396	415
17. Tchr.Eval.Rat.Learning	572	271	233	-225	181	049	541
18. Frostig Eye-Motor	102	-048	298	-234	417	030	331
19. Frostig Figure-Ground	146	297	112	004	461	102	345
20. Frostig Form Constancy	213	256	261	-078	263	299	344
21. Frostig Position-in-Sp.	293	297	585	-008	128	-069	537
22. Frostig Space Relations	071	169	725	-017	067	063	568
Σa^2 = Total Common Variance	6.655	1.764	1.176	0.623	0.597	0.439	11.248
Per cent Ratio of Common Factor Variance	59.2	15.6	10.4	05.5	05.2	03.9	100.0

*Decimals omitted.

[1]L. L. Thurstone, Primary Mental Abilities (Chicago: University of Chicago Press, 1938), chap. 5.

[2]Raymond B. Cattell, Factor Analysis (New York: Harper Bros., 1952).

Fruchter[1] observes: Factor loadings of .2 or less are usually regarded as insignificant; loadings of .2-.3 as low; .3-.5 as moderate; .5-.7 as high and above .7 as very high.

Since factor loadings tend to diminish in magnitude progressively, the factor loadings after Factor I were considered on a relative basis, i.e., the highest loadings in each column were considered in the interpretation of the nature of the factor. In general, factor loadings were considered significant if they were above $\pm .3$.

For purposes of prediction and scientific identification of fundamental traits, Fruchter[2] notes that primary interest is in the common factor variances, since a variable will predict only to the extent to which it correlates with some criterion or factor.

Many of the test coefficients or factor loadings in all the factors except Factor I were negative in sign. However these negative signs were disregarded since a positive correlation coefficient represents a pair of test vectors with acute angular separation and a negative correlation represents a pair of vectors with obtuse angular separation.

Fruchter[3] observes that in dealing with temperament and traits, etc., both positive and negative loadings occur and the restriction of positive manifold does not apply. In that case bi-polar factors frequently occur, but the criteria for simple structure can still be applied.

In the interpretations of the nature of the factors not only the high but the insignificant loadings were considered. The high loading inspected for interpretation of the nature of the factor were marked in

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[1]Benjamin Fruchter, Introduction to Factor Analysis (New York: D. Van Nostrand, Inc., 1954), p. 46.

[2]Fruchter, ibid., p. 151. Benjamin Fruchter, ibid., p. 111.

each table with an asterisk.

Factor I

In Factor I, tentatively named "Verbal Relations," the first column had 59.2 per cent ratio of the common variance, only six of the test variables were not involved in the variance of this factor and this factor did not enter negatively into any of the tests. The loadings are shown in Table 19.

The highest loadings in this factor were subtests from the Reading Achievement Test, Visual Scrutiny, with factor loading .850, Sentence Meaning .830, and Structural Analysis .766, all very high loadings. Each of these tests requires comprehension of sentence meanings, as well as words. Subtest Sentence Meaning requires recognition of pronoun references within the sentence, Visual Scrutiny requires discrimination between similar word forms, Structural Analysis measures ability to attack word forms; as compound words formed from two known words, or words formed by adding s or 's of possession.

Four tests have near zero loadings, Metropolitan subtest Word Meaning (079), Matching (130), and three Frostig Subtests, Eye-Motor with factor loading 102, Figure-Ground 146.

The very high loadings of the three subtests of this Factor I, all requiring considerable verbal comprehension, would suggest that the nature of this factor may be a simple version of Thurstone's[1] primary mental ability, that he termed "verbal relations."

Factor II

Factor II was tentatively named "Verbal-Pictures Discrimination." The second column loadings are shown in Table 20. Twelve of the 22 test

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[1] L. L. Thurstone, Primary Mental Abilities, p. 84.

variables contribute to the common variance of this factor. The three highest loadings are subtests of the Metropolitan Readiness Test, Information with a factor loading .762, Word Meaning .740, and Matching .633. The first two tests with the high loadings require general information and comprehension of word meanings, as recognized in pictures. The third test requires discrimination to match identical pictures.

TABLE 19

FACTOR I - "VERBAL RELATIONS"

Test No.	Test Name	Loading*
13	Reading Achievement, Visual Scrutiny	.850*
9	Reading Achievement, Sentence Meaning	.834*
15	Reading Achievement, Struct. Analysis	.766*
14	Reading Achievement, Phonetic Analysis	.579
17	Teacher Evaluation Rating, Learning	.572
10	Reading Achievement, Sensory Imagery	.541
12	Reading Achievement, Emo. Reactions	.523
11	Reading Achievement, Relationships	.522
8	Metropolitan Readiness, Copying	.506
1	Kindergarten, Draw-a-Figure	.426
7	Metropolitan Readiness, Numbers	.396
16	Teacher Evaluation, School Adjustment	.370
4	Metropolitan Readiness, Sentences	.347
2	IA Draw-a-Figure	.306
21	Frostig Position-in-Space	.293
20	Frostig Form Constancy	.213
Common Variance of Factor		6.655
Per cent Ratio of Common Factor Variance		59.2

*Highest loadings.

Three of the Frostig subtests contribute a small amount to the common variance of this factor; Figure-Ground .297, Position-in-Space .297, and Form Constance .256, all fairly low loadings.

Variables with near zero loadings are IA Draw-a-Figure +.068;

Reading Achievement subtests Sensory Imagery +.044; Visual Scrutiny +.069; and Structural Analysis +.100, as well as Frostig Eye-Motor .048. The Draw-a-Figure Test and Frostig Eye-Motor involve some measure of control of eye movements. The other three subtests appear to require some degree of discrimination. These appear not to be involved in the common variance of this factor.

TABLE 20

FACTOR II - "VERBAL-PICTURES DISCRIMINATION"

Test No.	Test Name		Loadings
5	Metropolitan subtest	Information	.762*
3	Metropolitan subtest	Word Meaning	.740*
6	Metropolitan subtest	Matching	.633*
7	Metropolitan subtest	Numbers	.566
4	Metropolitan subtest	Sentences	.457
16	Teacher Evaluation	School Adjustment	.302
19	Frostig subtest	Figure-Ground	.297
21	Frostig subtest	Position-in-Space	.297
17	Teacher Evaluation	Learning	.271
20	Frostig subtest	Form Constance	.256
14	Reading Achievement	Phonetic Analysis	.248
8	Metropolitan subtest	Copying	.204
Common Variance of Factor			1.764
Per cent ratio of common Factor variance			15.6

*Highest loadings.

The nature of this factor possibly "verbal-picture discrimination" would appear to be similar to the nature of Factor I, in that it is word and information comprehension; however, all these high tests involve recognition of pictures, picture details, and the like, which apparently requires a different kind of discrimination than the high vari-

ables of Factor I. As an indication of this these sets of test variables are sufficiently unlike that they take opposite positions in the two factors. In the first factor, Visual Scrutiny, Sentence Meaning, and Structural Analysis have high loadings and near zero loadings in Factor II. The converse of this is true of subtests Information, Word Meaning, and Matching.

Three of the Frostig subtests are present with low loadings in this factor. However, it is not clear what contribution they make to the nature of the factor, if any.

Factor III

Factor III was called the "Space Perception" factor. Table 21 shows the test variables that contribute to the common variance of Factor III. Only seven of the 22 variables have loadings greater than .2.

The three highest factor loadings are Frostig Space Relations with loading of +.725; Position-in-Space +.585, and Metropolitan Readiness subtest Copying +.298. The subtest Space Relations test requires the duplication of patterns by linking dots. The Frostig Position-in-Space tests discrimination of like and unlike objects. The subtest Copying requires the recognition of a form, apprehension of it and eye-hand coordination to reproduce it.

The near zero loadings are the Metropolitan subtest Numbers +.066; Reading Achievement subtest Sentence Meaning +.089; Relationships .015; Visual Scrutiny +.057; Phonetic Analysis +.048. The numbers test involves understanding of numbers, to count objects, etc. Sentence Meaning, Relationships and Visual Scrutiny each require a degree of comprehension of sentence meaning. Phonetic Analysis requires association of sounds with initial consonant letters in words. None of these appear to

contribute anything to the common variance of this factor.

TABLE 21

FACTOR III - "SPACE PERCEPTION"

Test No.	Test Name		Loadings
22	Frostig subtest	Space Relations	.725*
21	Frostig subtest	Position-in-Space	.585*
8	Metropolitan subtest	Copying	.322*
18	Frostig subtest	Eye-Motor	.298
20	Frostig subtest	Form Constancy	.261
17	Teacher evaluation	Learning	.233
12	Reading Achievement	Emotional Reactions	.225
Common variance of factor			1.176
Per cent ratio of common Factor variance			10.4

*Highest loadings

This factor would appear to be perceptual in nature, each of these test variables requiring somewhat similar skills, i.e., a facility in spatial and visual imagery. This factor appears to share some of the characteristics of Thurstone's[1,2] Space Perceptual factor, noted in his primary mental abilities studies and factorial studies in perception.

Factor IV

This factor was designated "Auditory Perception." Table 22 indicates the test variables that contribute to the common variance of this factor. Only five variables have loadings above .2.

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[1]L. L. Thurstone, Primary Mental Abilities, pp. 79-80.

[2]L. L. Thurstone, "A Factorial Study of Perception," Psychometric Monographs, No. 4 (Chicago: University of Chicago Press, 1947), pp. 125-30.

TABLE 22

FACTOR IV - "AUDITORY PERCEPTION"

Test No.	Test Name		Loadings
14	Reading Achievement	Phonetic Analysis	-.523*
18	Frostig subtest	Eye-motor	-.234*
1	Kindergarten	Draw-a-Figure	.232*
17	Teacher Evaluation	School Adjustment	-.225
12	Reading Achievement	Emotional Reactions	-.221
Common variance of factor			0.623
Per cent ratio of common Factor variance			05.5

*Highest loadings.

The three test variables with highest loadings are Reading Achievement subtest Phonetic Analysis, with a loading .523; and Frostig subtest Eye-Motor .234 and kindergarten Draw-a-Figure .232. Subtest Phonetic Analysis requires ability to associate sounds with initial consonant letters and recognize the word represented by a picture. The Frostig Eye-Motor requires the child to draw straight and curved lines within increasingly narrow boundaries, a task requiring some degree of eye-hand coordination. The Draw-a-Figure test involves drawing a figure as best he is able, again a task involving coordination. The last two tests appear to have something in common. The skill necessary for Phonetic Analysis seems more in the nature of a possible auditory perception. There were no other tests of this nature in the battery, which may be the reason there are no others of a similar loading. One test is scarcely enough for the naming of a factor, so the suggestion that this is auditory perceptual in nature can be only tentative only.

The near zero loadings are many, including practically all the test variables not contributing to the variance. This suggests that the nature of this factor is possibly unique.

Factor V

Factor V was named "Discrimination of Embedded Figures." Table 23 gives the test variables that contribute to this factor. Seven test variables show factor loadings above .2. The four variables with highest loadings for this factor are Reading Achievement subtest Sentence Imagery with a loading of +.505, Frostig Figure-Ground +.461, and Frostig Eye-Motor +.417. Reading Achievement subtest Relationships +.414 has almost as high a loading as Frostig Eye-Motor, for this reason it was included with other high loadings.

Reading Achievement subtest Sensory Imagery requires the child to associate sensory images with both oral and printed language. In the Frostig subtest Figure-Ground the child discriminates between intersecting figures, an embedded figures test. Frostig subtest Eye-Motor requires the child to draw straight and curved lines between increasingly narrow boundaries, involving a degree of eye-hand control. Reading Achievement subtest Relationships tests the child's ability to anticipate outcomes on the basis of logical relationships.

The near zero loadings are chiefly variables involved in word and sentence comprehension; Metropolitan subtests Word Meaning .005; Sentences .004; Information +.076; Numbers +.021; Reading Achievement subtests Sentence Meaning .054; Phonetic Analysis +.059; Structural Analysis .028. In addition to these low loadings were Teacher Evaluation Rating School Adjustment +.084 and Frostig subtest Space Relations +.067. None of these appear to enter into the common variance of this factor.

TABLE 23

FACTOR V - "DISCRIMINATION OF EMBEDDED FIGURES"

Test No.	Test Name		Loadings
10	Reading Achievement subtest	Sensory Imagery	.505*
19	Frostig subtest	Figure-Ground	.461*
18	Frostig subtest	Eye-Motor	.417*
11	Reading Achievement subtest	Relationships	.414*
8	Metropolitan subtest	Copying	.302
20	Frostig subtest	Form Constancy	.263
2	IA	Draw-a-Figure	.240
Common variance of factor			0.597
Per cent ratio of common Factor variance			05.2

*Highest loadings.

There seem to be some common elements in these test variables, as association of sensory imagery with oral and printed language, discrimination of embedded figures, logical relationships. These all suggest a possible perceptual factor here. Perhaps a somewhat elementary version similar to the perceptual factor Thurstone[1] called C[2], strength of closure, which facilitates the retention of a figure in a distracting field.

Factor VI

Factor VI's naming is quite tentative but it suggests "Discrimination of Form." Table 24 shows the factor loadings on the six test variables that contribute to the common variance of this factor; none of them are high. Possibly the extraction of factors could have been ter-

[1]L. L. Thurstone, Mechanical Aptitudes III, Analysis of Group Tests, Psychometric Monograph, No. 55 (Chicago: University of Chicago Press, 1949), p. 47.

minated with five factors, since Factor VI has only .439 of the common factor variance, or a per cent ratio of 03.9.

TABLE 24

FACTOR VI - "DISCRIMINATION OF FORM" (TENTATIVE)

Test No.	Test Name		Loadings
16	Teacher Evaluation	School adjustment	.396*
20	Frostig subtest	Form Constancy	.299*
12	Reading Achieve. subtest	Emo. Reactions	.280*
6	Metropolitan subtest	Matching	-.269*
11	Reading Achieve. subtest	Relationships	.213
7	Met. Readiness subtest	Numbers	-.201
Common variance of factor			0.439
Per cent ratio of common factor variance			03.9

*Highest loadings.

The four variables with highest loadings are Teacher Evaluation Rating for School Adjustment +.396; Frostig Form Constancy +.299; Reading Achievement subtest Emotional Reactions +.280; and Metropolitan subtest Matching .296. None of these loadings are very high to be considered more than tentatively for naming the factor. However, there do appear to be some common elements. The Teacher Evaluation Rating School Adjustment is a measure used by the teacher of a child's ability to cooperate and adjust to classroom routines. Just what aspect of this variable contributes to this factor is not clear. In Frostig subtest Form Constancy the child is required to recognize squares and circles among other shapes on the page. Reading Achievement subtest Emotional Reactions tests the child's ability to identify the emotional reactions of story characters on the basis of the printed text

alone. Metropolitan Subtest Matching requires the child to recognize like objects. The last three tests appear to require recognition of form and to identify the pictured response of the story figures. It is not quite clear how the Teacher Evaluation Rating School Adjustment could be interpreted with this group. There are, no doubt, many aspects of this test variable that are not clearly defined. A tentative suggestion for naming this factor would be that it could be a third perceptual factor, possibly discrimination of form. Further experimentation with other tests of a similar type might be able to verify this.

Summary of Findings of Factor Analysis

Six factors were extracted in the principal axes factor analysis of the 22 test variable matrix. The factor that showed up most clearly was Factor I, which seemed to be a verbal comprehension factor, possibly similar to Thurstone's[1] "Verbal Relations." Sixteen of the 22 test variables contributed to the common variance of this factor.

The second factor with fewer loadings appeared to be verbal in nature, though apparently quite different from the nature of Factor I. This, seemingly, was because of the different type of discrimination required. The tests with high loadings in Factor II require discrimination of information gained from pictures, whereas the high variables of Factor I required comprehension of the printed text.

Factor III appears to be spatial perceptual in nature, involving the Frostig subtest Space Relations and Position-in-Space.

Factor IV had only one variable with a factor loading high enough to be considered significant. This one test appeared to be auditory perceptual in nature. There were no other tests in the battery that appear

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[1] L. L. Thurstone, Primary Mental Abilities, pp. 79-80.

to be similar in requirements. Perhaps further experimental study with auditory perceptual tests might verify this.

The fifth factor appeared to be a second perceptual factor, involving discrimination of embedded figures, or possibly a somewhat elementary version of Thurstone's[1] C[2] "Strength of Closure" factor which facilitates the retention of a figure in a distracting field.

The sixth factor had no factor loadings above .40 and the common factor variance was only .439, suggesting that the factor analysis might have been terminated with the fifth factor. However, there appeared to be some unity of elements in the loadings high for the factor, that suggested that this might be a third perceptual factor, possibly of the nature of form discrimination.

In each of these factors, one or more of the Frostig Visual Perceptual tests were involved in the common variance of the factor, in the tests, other than the perceptual ones, though their loadings were low. It is not clear if there is any significance to this fact. Possibly grouped together they might be considered as a group factor or perhaps they have some significance in terms of validity. Cronbach[2] has pointed out the importance of this type of contribution to the design of testing programs.

No unique or specific factors were discovered in the Frostig Visual Perceptual Tests. Other test variables contributed to the common factor variance in conjunction with the Frostig subtests. Two perceptual

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[1]L. L. Thurstone, "Factorial Study of Perception," Psychometric Monograph, No. 4; (Chicago: University of Chicago Press, 1947), pp. 125-30.

[2]Lee J. Cronbach, Essentials of Psychological Testing, 2nd ed. (New York: Harper & Bros., 1960).

factors, one of space perception and one of strength of closure or embedded figures were tentatively identified. It was tentatively speculated that a third factor, form discrimination, might be identified with further testing.

One other factorial study of the Frostig Visual Perceptual Tests has been reported recently. Corah and Powell[1] studied a group of 40 nursery school children. The Full Range Picture Vocabulary test was used as a measure of intelligence; Ghent Overlapping Geometric Figure as a measure of form discrimination and a form constancy test by Ardis and Fraser was given. The Frostig Visual Perceptual Tests were also administered. Age in months and sex were additional test variables. As they reported the results of their factor analysis, two major factors appeared to account for most of the variance; general intelligence with moderate loadings on Frostig subtests Position-in-Space and Space Relations; and a second factor that indicated developmental changes in perception, with moderate loadings on the other three Frostig subtests.

They considered that the range of scores was quite restricted in the age range of their study (50-76 months with a mean age of 63.2 months) and surmised that the intersubtest correlations of the Frostig Visual Perceptual Tests were probably lower than they should have been.

Frostig and colleagues,[2] in their recent standardization of tests used with children, ages three to nine years, pointed out that they did not give data on nursery school children in their intersubtest correla-

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[1]Norman L. Corah and Barbara J. Powell, "A Factor Analytic Study of the Frostig Developmental Test of Visual Perception," Perceptual and Motor Skills, 1963, 16, pp. 59-63.

[2]Marianne Frostig, Phyllis Maslow, D. Welty Lefever, and John R. B. Whittlesey, Developmental Test of Visual Perception, 1962 Standardisation, pre-publication copy.

lation tables of different age groups. They considered sample sizes for these age levels were too small and were possibly biased since they represented only children attending nursery school.

Tables 25 and 26 compare the Corah and Powell study (N=40) with Frostig's[1] kindergarten group (N=385) and the present study group (N=111) with Frostig's first grade group (N=334). Frostig noted that the general size of intersubtest correlations tended to diminish with advancing age. These tables appear to bear this out. The average intersubtest correlation with the Frostig Visual Perceptual Tests on the nursery school group was .43, for the kindergarten group .29, for the two first grade groups the average intercorrelation was .33 and .28 respectively.

Frostig suggests that this downward trend is probably due to progressive differentiation of perceptual ability. This might account for the difference in factor analysis results, e.g., high intersubtest correlations at the lower age level would indicate fewer factors. More factors would become evident as the intercorrelation decreased.

This present study with first graders revealed two perceptual factors and a speculative third, with additional low loadings of visual perceptual test variables on all the factors. The Corah and Powell[2] study with only 40 nursery school children named only one perceptual factor with other perceptual variables as a part of the common variance of the general intelligence factor. Frostig's comments about a nursery school group would appear to apply to this small and special group. Another contributing element in the nature of the factors discovered might

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[1] Ibid.

[2] Norman L. Corah and Barbara J. Powell, op. cit.

TABLE 25

INTERCORRELATIONS WITHIN THE FROSTIG VISUAL PERCEPTUAL TESTS IN DIFFERENT AGE GROUPS POPULATIONS

(Mean Age 63.2, N=40, Nursery School Children)
Corah and Powell Data

Subtest	I	II	III	IV	V
Subtest I	. .	.50	.18	.51	.53
II	. .	. .	.49	.31	.53
III	. .	. .	. .	.34	.34
IV	. .	. .	. .	. .	.57
V	. .	. .	. .	. .	. .

Total of intercorrelations = 430

Average of intercorrelations = .43

(Mean Age 67.9, N=385, Kindergarten)
Frostig Data

Subtest	I	II	III	IV	V
Subtest I	. .	.26	.17	.16	.26
II	. .	. .	.42	.33	.37
III	. .	. .	. .	.39	.31
IV	. .	. .	. .	. .	.48
V	. .	. .	. .	. .	. .

Total of intercorrelations = 295

Average of intercorrelations = .29

TABLE 26

INTERCORRELATIONS WITHIN THE FROSTIG VISUAL PERCEPTUAL TESTS IN TWO FIRST GRADE GROUPS

(No Mean Age Available, N=334, First Grade)
Frostig Data

Subtest	I	II	III	IV	V
Subtest I	. .	.26	.28	.36	.28
II	. .	. .	.41	.30	.34
III	. .	. .	. .	.31	.35
IV	. .	. .	. .	. .	.41
V	. .	. .	. .	. .	. .

Total of intercorrelations = 330

Average of intercorrelations = .33

(Mean Age 85.2 Mo., N=111, First Grade)
Study Group Data

Subtest	I	II	III	IV	V
Subtest I	. .	.34	.21	.20	.32
II	. .	. .	.24	.29	.13
III	. .	. .	. .	.30	.24
IV	. .	. .	. .	. .	.52
V	. .	. .	. .	. .	. .

Total of intercorrelations = 2797

Average of intercorrelations = .280

possibly be a function of the kinds of tests used, several of which appear to be perceptual in nature, as the Ghent Overlapping Figures and the Form Constancy test.

The reported research on the Frostig Visual Perceptual Tests is still quite limited. As the tests become more widely used and further research, including factor analysis, is carried out, no doubt comparative studies of the Tests will provide useful information about the Tests.

CHAPTER III

FINDINGS AND CONCLUSIONS

The purpose of this study was twofold: Part 1. To prepare from a review of literature, a synthesis of information that is available through research and other sources, concerning the five aspects of visual perception considered by Frostig as important for early school learning, and Part 2, to evaluate the Frostig Visual Perceptual Tests as a predictor of reading achievement in first grade children.

Previous studies of the role of perception in the beginning learning of the young school child have indicated that certain aspects of perception contribute to learning to read. The purpose of this study was to evaluate a new group of visual perceptual tests that can be used in the classroom by the teacher. This instrument, the Frostig Visual Perceptual Tests, is reported to measure the competence of the child in perceptual skills and evaluate his need for remedial teaching in specific aspects of perception. In terms of the perplexing problems of failure in first grade reading and the problems of prediction of which children will or will not achieve reading skills in the first grade, an evaluation of this test seemed to merit investigation.

Summary of the Investigation

Part 1 of the investigation was a collation of the relevant research reviewed, on the development of visual perception in the young school age child. This was done, after a fairly extensive study of the

literature, to provide a background for the aspects of visual perception used by Frostig in her tests. This collation of research data is not claimed to be an exhaustive review of literature but rather may be categorized as a dimension of one domain of the taxonomy of educational objectives; a dimension of visual perception.

A number of studies that were examined, explored the role or function of visual perception in the learning at late elementary and at early elementary school level. The studies of the function of visual perception in first grade children appeared to indicate the substantial importance of visual perception in the beginning learning at this age level.

One aspect in the literature examined, striking by reason of its absence, was the lack of information about problems of dysfunction in any area of visual perception, or of implications for learning in the presence of dysfunction. The studies, reviewed, appeared to indicate that there may be a wide range of individual variation in visual perception in "normal" children. However, aside from the teaching aids Frostig has developed, there appears to be quite limited research or of materials prepared for use in this area, except for the extensive studies with brain-injured children, as, eg., the work of Strauss and co-workers.

Part 2 of the investigation was a study of the value of the Frostig Visual Perceptual Tests as a predictor of perceptual and reading achievement.

The study group was selected from grade IA, in one school system. The children were given the Frostig Visual Perceptual Tests and a Draw-a-Person Test near the end of the spring school session. Scores of

the Metropolitan Readiness and Reading Achievement Tests and other data were obtained from each child's Cumulative School Record Form. Complete data were obtained on 111 children who were designated the study group.

Coefficients of correlation were obtained between the scores on all the data, and intercorrelations were studied to discover what common bonds existed among the tests themselves.

A factor analysis was computed on the test variables that showed significant relationships. This was done to determine the underlying functional unities or common factors present in this group of test variables. These were studied and interpreted subjectively in terms of this present study.

Specific Findings

The specific findings of this study were the hypotheses to be tested. They were in two groups - (1) those concerned with the findings in the study of the relationships of test variables, and (2), those in relation to the factor analytic study.

Hypotheses Related to the Correlation Between Test Variables

These research hypotheses were tested against corresponding statistical or null hypotheses and the high points of the alternative hypotheses then considered. A level of significance of at the least .05 was required for rejection of the null hypotheses.

1. Hypothesis: The Frostig Visual Perceptual Tests total score will show significant relationships with the Metropolitan Readiness Test confirming the importance of visual perception in beginning reading.

The null hypothesis, in this case, would be that the Frostig Visual Perceptual Tests total score will show zero or negligible relationship with the Metropolitan Readiness Test total score, indicating

that visual perception appears to be negligible in importance in beginning reading.

The null hypothesis may be rejected here because the Frostig Visual Perceptual Tests total score shows significant relationship at .01 level with the Metropolitan Readiness Test total score.

Hence the alternative hypothesis, as stated above, may be considered. With the exception of Frostig subtest Eye-Motor, the Frostig subtests correlated significantly at .01 level with all of the Metropolitan Readiness subtests except Sentences and Numbers subtests. Subtest Numbers correlated with Frostig subtest Position-in-Space at .01 level and at .05 level with subtest Figure-Ground. Subtest Sentences shows negligible relationships with all of the Frostig subtests except Figure-Ground subtest at .05 level.

The high correlations between most of these Frostig subtests and the Metropolitan subtests appears to confirm the alternative hypothesis that visual perception as measured by the Frostig Visual Perceptual Tests is important in beginning reading.

2. Hypothesis: The Frostig Visual Perceptual Tests total score will show significant relationship with the Reading Achievement Test, confirming the importance of visual perception in reading at the first grade level.

The null hypothesis, in this case, would be that the Frostig Visual Perceptual Tests will show zero or negligible relationship with the Reading Achievement Test, thus indicating that visual perception is of little significance in reading at the first grade level.

The Frostig Visual Perceptual Tests total score correlated significantly with the Reading Achievement total score at the .01 level, thus the null hypothesis may be rejected. The alternative hypothesis may be considered, as stated above.

The Frostig subtest Eye-Motor shows a .01 level of significance correlation with subtest Sensory Imagery and .05 level with subtests Relationships and Phonetic Analysis. Frostig subtest Space Relations shows a .05 level of significance with only one test Sensory Imagery. Frostig subtest Form Constancy and Position-in-Space relate significantly with most of the Reading Achievement subtests. Frostig Figure-Ground subtest shows significant correlation of .01 with two of the Reading subtests and at .05 level with two other subtests of the Reading Achievement Test.

The correlations of a significant level between the subtests of both the Frostig Visual Perceptual Tests and the Reading Achievement Test confirmed the importance of visual perception in first grade reading.

3. Hypothesis: The Frostig Visual Perceptual Tests total scores will show significant correlations with the Teacher Evaluation Ratings School Adjustment and Learning confirming the hypothesis that visual perceptual skill is important in school adjustment and learning.

The null hypothesis would be that correlations will show zero or negligible relationships between the Frostig Visual Perceptual Tests total score and the Teacher Evaluation Ratings. The Frostig total score correlates at .01 level of significance with the Teacher Evaluation ratings and thus the null hypothesis may be rejected.

The alternative hypothesis that the Frostig subtests will relate significantly with Teacher Evaluation Ratings is amply confirmed. With the exception of Frostig subtest Eye-Motor all the other Frostig subtests show a .01 level of significance with both of the Teacher Evaluation Ratings, exclusive of Frostig Position-in-Space, which correlates with Teacher Evaluation Rating School Adjustment at .05 level.

Frostig postulated that the young school child's school adjustment and learning would be directly related to competence in visual perception. This would appear to be confirmed by the almost uniformly high relationships evidenced here.

4. Hypothesis: The Frostig Visual Perceptual Tests total scores will show significant correlations with the Draw-a-Figure Tests for kindergarten and first grade, confirming the hypothesis that visual perception is important in this test of a child's mental maturity and readiness for reading.

The null hypothesis would be that the Frostig Visual Perceptual Tests total score will show zero or negligible relationship with the two Draw-a-Figure Tests. The null hypothesis may be rejected because the Frostig total score relates at .05 level of significance with the kindergarten Draw-a-Figure Test and at .01 level with the Draw-a-Figure Test for first grade.

The alternative hypothesis appears to be confirmed since, with the exception of Frostig Eye-Motor the other four Frostig subtests show a relationship of .05 level of significance in all but one instance with the Draw-a-Figure Tests. Frostig subtest Form Constancy shows a correlation of .01 level significance with the kindergarten Draw-a-Figure Test.

The significance level of the Frostig subtests with the Draw-a-Figure Tests is not as high as for many of the other tests but it is at the .05 level, which is high enough for rejection of the null hypothesis and confirms the importance of visual perception in the Draw-a-Figure Tests of a child's mental maturity.

Hypotheses Concerning the Factor Analytic Study

The study of the factor analysis confirmed in considerable measure the findings of the correlation analysis with some interesting differences.

1. Hypothesis: The factor analysis will result in fewer factors than the original 22 columns and rows.

This hypothesis was sustained since six factors were extracted.

2. Hypothesis: The factor analysis will indicate one or more unique factors in the Frostig Visual Perceptual Tests.

No unique factors were found in which the Frostig subtests contributed all or most of the common variance of the factor, hence this hypothesis cannot be sustained. The nearest to a unique factor was the "Space Perception" Factor III, in which the two highest loadings were Frostig Space Relations and Position-in-Space, the next highest loading was for Metrop litan subtest Copying.

3. Hypothesis: The factor analysis will indicate one or more factorial relationships common to one or more of the Frostig Visual Perceptual Tests and the subtests of the Metropolitan Readiness and the Reading Achievement Tests, the Teacher Evaluation Ratings or Draw-a-Figure Tests.

Factor III tentatively named "Space Perception" factor had significant loadings with Frostig subtests Position-in-Space and Space Relations and Metropolitan subtest Copying.

Factor V, "Discrimination of Embedded Figures" showed moderately high loadings with the Frostig subtests Figure-Ground and Eye-Motor and Reading Achievement subtests Sensory Imagery and Relationships, and Metropolitan subtest Copying. These all appeared to have some underlying unity or common element.

None of the loadings were high in Factor VI, which was considered as a possible third perceptual factor. The variables contributing to the common variance were: Teacher Evaluation for School Adjustment, Frostig subtest Form Constancy, Reading Achievement subtest Emotional Reactions. Thus, it is apparent that the hypothesis was sustained, that there would be one or more factorial relationships common to the Frostig subtest and

subtests of the other tests.

General Findings

A comparison was made between the standardized norms of the Frostig Visual Perceptual, the Metropolitan Readiness and Reading Achievement Tests and the scores of the study group to contrast their achievement with norms established with large groups of children. Some interesting results were apparent.

The study group compared quite favorably with the norm of the Metropolitan Readiness Test, suggesting that these children would do acceptably in later reading achievement. However, the results in the Reading Achievement Test showed that more than half the study group fell below the national median in their reading achievement.

The study group rated somewhat below the norms of the Frostig Visual Perceptual Tests; some factors of difference in population sample may have contributed to this difference. An examination was made of Frostig's observation that children who fall below 90 in Perceptual Quotient tend to encounter difficulty in reading. The Perceptual Quotients in the range of 90 or less of all children in the study group were contrasted with their scores on the Metropolitan Readiness and Reading Achievement Tests. It was found that of the group with Perceptual Quotient of 90 or less, 8.1 per cent of the group (40) fell below the "Average" on the Metropolitan Readiness Tests. Seventy per cent of the group (40) were below the "Average" on the Reading Achievement Test. These results suggest that Frostig's observation may have some foundation and would appear to merit further investigation. It also appears to be a further confirmation of the findings noted by a number of studies, reviewed earlier, that the present readiness tests do not adequate-

ly predict later reading achievement.

Intercorrelations between the Frostig Visual Perceptual Tests and the Metropolitan Readiness and Reading Achievement Tests, Teacher Evaluation Ratings and Draw-a-Figure Tests were significant, indicating that visual perception as measured by the Frostig Visual Perceptual Tests are important at both the pre-reading and reading level. Frostig subtests Eye-Motor correlated least significantly with the reading tests and interestingly enough, showed least relationship with the Draw-a-Figure Tests.

Intercorrelations of the Metropolitan Readiness and Reading Achievement Tests with the Teacher Evaluation Ratings in School Adjustment and Learning were significantly high, confirming Frostig's observation that a child's school adjustment and learning ability were closely related to his competence in perceptual skills as reflected in pre-reading and reading achievement.

Two factors that appeared to be visual perceptual in nature and one speculatively so designated, were revealed by factor analysis. One factor seemed to be related to "Space Perception" with high loadings for both Frostig subtests Position-in-Space and Space Relations. The second was named "Discrimination of Imbedded Figures." The third speculative factor was Factor VI with no loadings above .40. The three tests with highest loadings appeared to suggest that the nature of the factor might be "Discrimination of Form."

All six factors had some low loadings on one or more of the Frostig Visual Perceptual Tests, indicating that, to a certain degree, some elements of visual perception entered into the common variance of each of the factors.

The correlations of the Metropolitan Readiness Tests with the Reading Achievement Test, Teacher Evaluation Ratings, and Draw-a-Figure Tests were studied for possible clues that might be used as predictors of later learning difficulties. The three subtests showing highest intercorrelations with the Reading Achievement Test were subtests Copying, Sentences and Numbers, in that order. However, study of these test variables in the factor analysis indicated only one of these subtests, Copying, had significant loadings in the "perceptual" factors. Subtests Sentences and Numbers both had significant loadings on the "Verbal Relations" and "Verbal-Pictures discrimination factors. Without factor analysis, it might have been assumed that on the basis of intercorrelations, these three subtests might give further insight into the nature of the perceptual ability used in reading. Perhaps this is a matter that merits further study.

An item that the factor analysis appeared to point up was that the bulk of the test variables in the battery used in this investigation did not appear in the factors that were designated as visual perceptual in nature. This would suggest that these test variables probably evaluate visual perception to a quite limited degree. This would seem to be in agreement with the findings of other studies that the Readiness Test used in this study does not appear to measure "perceptual readiness" adequately.

Thurstone suggested that the various readiness subtests for young children might be examples of the factor P^1 that he found in his studies of Mental abilities. In this investigation, this would appear to be true to a very limited degree. Metropolitan Readiness subtest Copying is the only one that shows a significant loading (above .30) in

any of the factors tentatively designated as visual perceptual in nature.

Conclusions

Frostig postulated that certain aspects or elements of visual perception are essential for the young school child's learning and that these abilities developed at different rates. She observed that in some children who have learning problems there appeared to be a lack of proficiency in one or more of these abilities as compared with other children of comparable age. This led to the assumption that competence in perception may be disturbed or slow in developing in specific abilities in normal children, as well as in children with some brain-injury. Moreover, her experience indicated that these disturbances in perception could be corrected or improved by remedial training.

The findings in this study seem to bear out to some extent, Frostig's assumptions: e.g.:

1. There appears to be a wide range of individual variation in perceptual competence at the age level studied, end of the first grade. Two studies, reviewed earlier, suggested that this may be a matter of delay or immaturity of development.

2. A consensus of the literature reviewed appears to be that much of perceptual skill is learned; in part in the process of genetic development and in part by the experiences of life that the child encounters. A few studies bear this out, e.g., Townsend's study of children in grades one to three, indicated the progressive increase in recognition of form, comprehension of form and ability to reproduce form that occurred between ages five to seven (5-7) years. Frostig's Age-Equivalent Scale appears in agreement with this.

   If the child learns the greater part of his perceptual competence then it would seem only logical that teaching materials and techniques planned to improve or increase the skills in certain areas might add to his facility in learning. This apparently can be done as Simpson's study indicated. Frostig has reported that improvement can be made by remedial training, in each of the five perceptual aspects.

3. There seems to be some evidence that there is a "perceptual" readiness necessary for reading, which the Readiness Test used in this study did not adequately measure. This appears confirmed by other investigations previously reviewed.

4. Malmquist suggested another point that merits consideration. He studied his 400 first graders at the end of their fourth grade in school and found that those whose achievement had been low in their first grade tests were also uniformly still behind the level of reading skills attained by the rest of their classmates. This would suggest that without special help they had not been able to surmount their initial learning difficulties.

   Perhaps if these initial learnings are not achieved, the integration of these necessary beginning learnings can not take place. The process of perception in reading is extremely complex; it is possible that the stimulus of the visual form of the written word is a small but important or essential part of the total stimulus situation.

Thus, a part of an answer to the first question posed in this study, why do some young children encounter serious difficulty in learning to read, may be, that for some reason or reasons not specified, some children have not developed perceptually to a sufficient degree to be ready for learning.

The second question, how can the school anticipate or predict those children who will not achieve in learning to read and will require help to work out these problems of learning, also appears to have an answer of sorts. From this investigation and other studies reviewed here there seems to be some justification for the conclusion that a possible answer may be that more extensive use of tests of visual perception should be made. This might be done by adding other perceptual tests to the reading readiness tests now in use or by the use of a perceptual test, as the Frostig Visual Perceptual Tests. Since the individual perceptual test items as postulated by Frostig, appear to be related to specific aspects of learning, it would seem feasible that the Frostig Visual Perceptual Tests be experimented with in a school testing

program to ascertain the specific aspects of perceptual weakness in each child's learning. The assumption being that if the specific character of the child's perceptual difficulty can be discovered more appropriate remedial training can be instituted than has been the case in the past.

There appear to be a number of possible implications for education suggested by the findings of this and other studies of visual perception in the learning of young school children.

Implications for Education

1. Recognition of the need for a test that measures perceptual abilities in the young school child.

If the relation of perceptual competence to reading achievement is accepted it would appear to have important implications for designing readiness tests that more accurately predict the children with problems in learning.

An instrument for use with young school children that can identify the individual child's needs and problems would be of great value. Preferably the instrument should not only screen, but should also indicate the child's perceptual strengths and weaknesses. An instrument of this sort in the hands of the teacher would make it possible to place the emphasis upon prevention and early correction, rather than later remedial teaching after the child has experienced failure.

2. Recognition that perceptual skills are learned.

Perhaps the most important implication for education is, that to a considerable degree, perceptual skills and abilities appear to be learned as a part of the genetic process of development as well as through the learning experiences to which each individual is exposed. A number of the studies cited in the review of literature lend credence to this. Perhaps the most striking illustration is Senden's study of con-

genitally blind adults, newly-sighted following cataract operations. For example, only by extensive use and experience did these people appear to learn constancy of size and shape, judgment of distance, etc. Gibson and Olum referred to Senden's study as an indication of the slow cumulative process by which the individual's visual system develops its power.

If these abilities are learned, it would seem essential that the teaching of pre-reading and early reading skills take individual differences in perception into account and provide learning opportunities to supplement the apparent deficiencies.

Further Research

The whole field of perception and perception's place in education has changed radically in the past few years. Because of this fact and some of the research in children's learning there appears to be a wide range of areas in which more information is greatly needed in this expanding field of study. The present lack of developmental information about the young child in aspects of perception is one evidence of the problems awaiting investigation.

1. Studies on the implications for learning when there is dysfunction in aspects of perception.

More information, specific and explicit, is needed on the role of perception in early learning. Knowledge is limited about the symptoms and signs that are indicators of perceptual learning difficulties. It has long been recognized that reading problems may be of multiple causation. Perception would seem to be one of the causes but tests commonly used do not reveal the individual differences in perception. There are many questions in need of answers, e.g., how to differentiate between perceptual retardation and mental retardation; how does sensory deprivation of various kinds, or a poor self-image, etc. influence perceptual

learning in the young child.

2. A larger study on the order of the present study with an experimental group trained in perceptual skills with selected materials.

A study along the lines of this present study with carefully planned design, to explore added areas, might be of value. For example, an experimental group and control group of children might be selected from both the high and low achievers in the readiness test scores. Explorations of the children achieving perceptual scores below 90 might be included for further investigation. Use of training materials with the Experimental group might provide confirmation of this emphasis on "perceptual" teaching. A follow-up after three to four years would be of interest to confirm Malmquist's finding that early learning difficulties persist.

3. Development of teaching materials for specific perceptual problems.

There are many facets to this aspect of study. Development of teaching materials and teaching techniques might be explored in many ways. There is considerable material of a perceptual nature scattered among present prepared teaching aids. To the teacher who recognizes perceptual problems they could be adapted or strengthened to give emphasis in areas where needed.

The highly specific problems of perceptual and mental retardation, of emotionally disturbed children, children with visual and auditory perceptual disabilities, combined, etc., all are individual problems and require their own special materials. For example, Kephart reported that mentally retarded children appeared to require much more emphasis on form constancy, and that many more cues, guide lines and directions were required than for children without some perceptual problems.

4. A study of a comparison of unusual teaching techniques being experimented with, in this field, at the present time.

There are a number of rather unusual teaching methods being experimented with at the present time. These techniques are reported as being highly specific for children with perceptual learning problems. The basis for each of these is stress on the motor component of learning. Some study of these methods, as of Kephart, Getman, Delacato, and others may be of interest to determine what, if any, contribution they make to these problems of learning.

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APPENDIX A

DATA GATHERING SHEETS AND TEACHER EVALUATION RATINGS

Data Sheet for Information from C A 39 and Tests

Name _____ Sex ____ Age ____ B.D. _____

Education of Mother _____ National Descent _____

Education of Father _____ National Descent _____

Occupation of Mother _____

Occupation of Father _____

Birthplace of Mother _____

Birthplace of Father _____

Language in Home _____

Number of Children in Family _____ Number Older: Boys ____ Girls ____ ; Number Younger: Boys ____ Girls ____

Race: White ____ Negro ____ Other ____ Religion _____

*Snellen Eye Check _____ Hearing _____

*Handedness _____ Eye _____ Foot _____

Has Child been retained at any level _____ _____ _____

Metropolitan Readiness Test Data:

Goodenough Draw-a-Figure Age Level _____

Word Meaning _____

Sentences _____

Information _____

Matching _____

Numbers _____

Copying _____

Total _____

Rating _____

Achievement Test End of Grade 1 A (New Basic Reading Test, Scott Foresman):

Interpretation

Sentence Meaning _____

Sensory Imagery _____

Relationships _____

Emotional Reactions _____

Total _____

Word Perception

Visual Scrutiny _____

Phonetic Analysis _____

Structural Analysis-Meaning _____

Total _____

Total _____

Rating _____

Instructions.--Will you please appraise your IA children on the following items: Progress in Learning and Adjustment in the Classroom. In order to do this will you please select the child you feel is best in the area being considered, place his name at the top of the right-hand side of the page and cross off his name on the left-hand side. The child who is least able or adjusted place at the bottom of the right-hand side of the page and cross off his name at the right. Proceed in this fashion until you feel you can no longer discriminate any child from the "average" of the group.

I. By Progress in Learning, we mean the child who appears to be getting along very well, has little or no trouble in understanding the required work and does it easily, or, -- the child who seems unable to understand or do the work expected of the class, never able to keep up with the group, in short, who seems not to be learning.

II. By Adjustment in the Classroom, we mean the child who--though he may be very active--can cooperate, can participate in the class activities, can recognize limits set for the group, or, -- the child who seems always a behavior problem, rarely ever quite in tune with the class or group activities, often is hyperactive and distractible.

FROSTIG DATA GATHERING SHEET

Age Code Groups

0=3 - 3½ yrs.	6=6 - 6½ yrs.
1=3½- 4 yrs.	7=6½- 7 yrs.
2=4 - 4½ yrs.	8=7 - 7½ yrs.
3=4½- 5 yrs.	9=7½- 8 yrs.
4=5 - 5½ yrs.	10=8 - 8½ yrs.
5=5½- 6 yrs.	11=8½- 9 yrs.
	12=9 plus yrs.

Name Code = first three letters of last name followed by first two of first name.
i.e., John Smith = SMI - JO

1. Name.....
2. Name Code.....
3. Birth Date.....
4. Age.....
5. Age Code.....
6. I.Q.....
7. Social Adjustment.....
8. Reading Achievement.....
9. Medical Diagnosis if Available.....
   .....
10. Diagnosing Physician and Agency.....
    .....
X. .....

Subtests	I	II	III	IV	V	
Raw Scores						
Age Equivalents						Total
Scaled Scores						
		Perceptual Quotient				

I	II	III a	III b	IV	V
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9		9	9		
10		10	10		
11		11	11		
12		12	12		
13		13	13		
14		14	14		
15			15		
16			16		
			17		
			18		
I	II	III		IV	V
	Total				

APPENDIX B

CODE MANUAL

Code Manual

Col.	Code	Item: Identifica.	Study Group
(1)	001		
(2)	002		
(3)			
		Item: Pilot 21	
(4)	--0)		
	--1)	(Rest of subjects)	
		Item: Schools	
(5)	--0)	A	
	--1)	B	
	--2)	C	
	--3)	D	
	--4)	E	
	--5)	F	
	--6)	Pilot Group (21)	
		Item: Age of Child	
(6)	--0)	6-0 to 6-2	
	--1)	6-3 6-5	
	--2)	6-6 6-8	
	--3)	6-9 6-11	
	--4)	7-0 7-2	
	--5)	7-3 7-5	
	--6)	7-6 7-8	
	--7)	7-9 7-11	
	--8)	8-0 8-2	
	--9)	8-3	
		Item: Sex of Child	
(7)	--0)	Male	
	--1)	Female	
		Item: Race	
(8)	--0)	White	
	--1)	Negro	
		Item: Snellen Eye Test	
(9)	--0)	Within Normal Range	
	--1)	Referral	
		Item: Hearing	
(10)	--0)	Within Normal Range	
	--1)	Referral	
		Item: Handedness	
(11)	--0)	Right	
	--1)	Left	
	--2)	Mixed	

Col.	Code	Item: Eyedness	Study Group
(12)	--0)	Right	
	--1)	Left	
	--3)	Mixed	
		Item: Footedness	
(13)	--0)	Right	
	001)	Left	
		Item: Length of Time in School	
(14)	--0)	4 semesters	
	--1)	5 semesters	
	--2)	6 semesters	
	--3)	more than 6 semesters	
		Item: Draw-a-Fig., Raw Score, Kindergarten	
(15)	--0)	4-5	
	--1)	6-7	
	--2)	8-9	
	--3)	10-11	
	--4)	12-13	
	--5)	14-15	
	--6)	16-17	
	--7)	18	
		Item: Draw-a-Figure, Mental Age, Kinder.	
(16)	--0)	4-0 4-3	
	--1)	4-6 4-9	
	--2)	5-0 5-3	
	--3)	5-6 5-9	
	--4)	6-0 6-3	
	--5)	6-6 6-9	
	--6)	7-0 7-3	
	--7)	7-6	
		Item: Draw-a-Figure, Raw Score, Grade IA	
(17)	--0)	8-9	
	--1)	10-11	
	--2)	12-13	
	--3)	14-15	
	--4)	16-17	
	--5)	18-19	
	--6)	20-21	
	--7)	22-23	
	--8)	24-25	
	--9)	26	

Code Manual--Continued

Col.	Code	Item: Draw-a-Fig., Mental Age, Gr. IA	Study Group
(18)	--0)	5-0 to 5-3	
	--1)	5-6 5-9	
	--2)	6-0 6-3	
	--3)	6-6 6-9	
	--4)	7-0 7-3	
	--5)	7-6 7-9	
	--6)	8-0 8-3	
	--7)	8-6 8-9	
	--8)	9-0 9-3	
	--9)	9-6	

		Item: Metro. R.R. Test, Total (106)
(19)	--0)	40-46
	001)	47-53
	--2)	54-61
	--3)	62-68
	--4)	69-75
	--5)	76-82
	--6)	83-89
	--7)	90-97
	--8)	98

		Item: Metro. R.R. Test, Word Mean. (20)
(20)	--0)	6-7
	--1)	8-9
	--2)	10-11
	--3)	12-13
	--4)	14-15
	--5)	16-17
	--6)	18-19
	--7)	20

		Item: Mtro. R.R. Test, Sentences (14)
(21)	--0)	1-2
	--1)	3-4
	--2)	5-6
	--3)	7-8
	--4)	9-10
	--5)	11-12
	--6)	13-14

Col.	Code	Item: Metro. R.R. Test, Inf. (14)	Study Group
(22)	--0)	1-2	
	--1)	3-4	
	--2)	5-6	
	--3)	7-8	
	--4)	9-10	
	--5)	11-12	
	--6)	13-14	

		Item: Metro. R.R. Test, Match. (24)
(23)	--0)	1-3
	--1)	4-6
	--2)	7-9
	--3)	10-12
	--4)	13-15
	--5)	16-18
	--6)	19-21
	--7)	22-24

		Item: Metro. R.R. Test, Nums. (24)
(24)	--0)	1-3
	--1)	4-6
	--2)	7-9
	--3)	10-12
	--4)	13-15
	--5)	16-18
	--6)	19-21
	--7)	22-24

		Item: Metro. R.R. Test, Copy. (10)
(25)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8
	--8)	9
	--9)	10

Code Manual--Continued

Col.	Code	Item: Read.Achieve. Study Test, Total (70) Group
(26)	--0)	19-25
	--1)	26-32
	--2)	33-39
	--3)	40-46
	--4)	47-53
	--5)	54-59
	--6)	60-67
	--7)	68-75

Col.	Code	Item: Read.Achieve. Sen. Meaning (10)
(27)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8
	--8)	9
	--9)	10

Col.	Code	Item: Read.Achieve. Sen. Imagery (10)
(28)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8
	--8)	9
	--9)	10

Col.	Code	Item: Read.Achieve. Relationships (10)
(29)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8
	--8)	9
	--9)	10

Col.	Code	Item: Read.Ach., Study Emo. Reac. (10) Group
(30)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8
	--8)	9
	--9)	10

Col.	Code	Item: Read. Ach., Vis.Scrutiny (10)
(31)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8
	--8)	9
	--9)	10

Col.	Code	Item: Read. Ach., Phonetic Anal.(10)
(32)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8
	--8)	9
	--9)	10

Col.	Code	Item: Read. Ach., Struct.Analy. (10)
(33)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8
	--8)	9
	--9)	10

Code Manual--Continued

Col.	Code	Item: Tchr. Eval. School Adjustment Study Group
(34)	--0)	Low
	--1)	Medium
	--2)	High

Col.	Code	Item: Tchr. Eval. Learning
(35)	--0)	Low
	--1)	Medium
	--2)	High

Col.	Code	Item: Frostig, Tot. Raw Sc. (Range 12-56)
(36)	--0)	12-16
	--1)	17-21
	--2)	22-26
	--3)	27-31
	--4)	32-36
	--5)	37-41
	--6)	42-46
	--7)	47-51
	--8)	52-56

Col.	Code	Item: Frostig, Eye-Mot, Raw Sc. (30) (Range 5-26)
(37)	--0)	5-7
	--1)	8-10
	--2)	11-13
	--3)	14-16
	--4)	17-19
	--5)	20-22
	--6)	23-25
	--7)	26

Col.	Code	Item: Frostig, Fig.-Gr., Raw Sc. (10)
(38)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8
	--8)	9
	--9)	10

Col.	Code	Item: Frostig, Form Con. R.S. (17) (R.0-13) Study Group
(39)	--0)	0
	--1)	1-2
	--2)	3-4
	--3)	5-6
	--4)	7-8
	--5)	9-10
	--6)	11-12
	--7)	13

Col.	Code	Item: Fros. Po. in-Sp., Raw Sc. (8)
(40)	--0)	1
	--1)	2
	--2)	3
	--3)	4
	--4)	5
	--5)	6
	--6)	7
	--7)	8

Col.	Code	Item: Frostig, Sp. Rels. Raw Sc. (8)
(41)	--0)	0
	--1)	1
	--2)	2
	--3)	3
	--4)	4
	--5)	5
	--6)	6
	--7)	7
	--8)	8

Col.	Code	Item: Frostig, Eye-Mot, Age Equival.
(42)	--0)	4-0 to 4-3
	--1)	4-6 4-9
	--2)	5-0 5-3
	--3)	5-6 5-9
	--4)	6-3 6-6
	--5)	7-0 7-6
	--6)	8-0 8-6
	--7)	9-0 9-6
	--8)	10

Code Manual--Continued

Col.	Code	Item: Frostig,Fig.-grd., Age Equival. Study Group
(43)	--0)	3-0
	--1)	3-6
	--2)	4-9
	--3)	5-3
	--4)	5-6
	--5)	6-0
	--6)	6-9
	--7)	7-9
	--8)	9-9
	--9)	10

		Item: Form Const., Age Equivalent
(44)	--0)	2-9
	--1)	3-3 to 3-9
	--2)	4-3 4-9
	--3)	5-3 5-9
	--4)	6-3 7-9
	--5)	8-3 9-9
	--6)	10

		Item: Frostig, Poin-Sp., Age Equiv.
(45)	--0)	4-0
	--1)	4-6
	--2)	5-0
	--3)	5-6
	--4)	6-3
	--5)	7-9
	--6)	10

		Item: Frostig,Space Rela.,Age Equival.
(46)	--0)	4-0
	--1)	4-9
	--2)	5-3
	--3)	5-6
	--4)	6-0
	--5)	6-9
	--6)	7-6
	--7)	9-6
	--8)	10

APPENDIX C

FROSTIG AGE-EQUIVALENT CONVERSION SCALE

FOR CONVERTING RAW SCORES INTO AGE EQUIVALENTS

Second preliminary standardization of the Marianne Frostig Developmental Test of Visual Perception on 700 unselected school children at the nursery school, kindergarten, first, second, and third grade levels.

Raw Score	Sub Test I yr - mo.	Sub Test II yr - mo.	Sub Test III yr - mo.	Sub Test IV yr - mo.	Sub Test V yr - mo.	Raw Score
0	2 - 9	3 -	2 - 9	2 - 9	4 - 0	0
1	3 - 0	3 - 6	3 - 3	3 - 3	4 - 9	1
2	3 - 3	4 - 3	3 - 9	4 - 0	5 - 3	2
3	3 - 6	4 - 9	4 - 3	4 - 6	5 - 6	3
4	3 - 9	5 - 3	4 - 9	5 - 0	6 - 0	4
5	4 - 1	5 - 6	5 - 3	5 - 6	6 - 9	5
6	4 - 3	6 - 0	5 - 9	6 - 3	7 - 6	6
7	4 - 6	6 - 9	6 - 3	7 - 9	9 - 6	7
8	4 - 9	7 - 9	6 - 9	10 +	10+	8
9	5 - 0	9 - 9	7 - 3			9
10	5 - 3	10+	7 - 3			10
11	5 - 6		8 - 3			11
12	5 - 9		9 - 0			12
13	6 - 3		9 - 9			
14	6 - 6		10*			
15	7 - 0					
16	7 - 6					
17	8 - 0					
18	8 - 6					
19	9 - 0					
20	9 - 6					
21*	10+					

Note: Probable error in underlined equivalents is believed to be about three months.

Standardization: August, 1961.

APPENDIX D

CORRELATION MATRIX FOR FACTOR ANALYSIS

CORRELATION MATRIX FOR FACTOR ANALYSIS*

Variables	K.Draw-a-Figure	1A.Draw-a-Fig.	Metro.Word Mean.	Metro.Sentences	Metro.Informa.	Metro.Matching	Metro.Numbers	Metro.Copying	R.Ach.Sen.Mean.	R.Ach.Sen.Imag.	R.Ach.Relation.	R.Ach.Emo.Reac.	R.Ach.Vis.Scrut.	R.Ach.Pho.Anal.	R.Ach.Strut.Anal.	Tch.Eval.Sch.Ad.	Tch.Eval.Learn.	Frostig Eye-Mot.	Frostig Fig.Grd.	Frostig For.Con.	Frostig Po.-in-Sp.	Frostig Sp.Rela.
1. (K) Draw-a-Figure		251	158	223	123	132	260	353	319	289	294	222	404	259	340	252	214	-010	203	257	243	177
2. (1A) Draw-a-Figure			101	133	115	095	205	232	253	323	262	121	307	221	275	154	159	163	175	184	231	166
3. Metro.Word Meaning				335	640	397	476	205	112	077	228	218	126	269	216	290	214	084	263	264	295	281
4. Metro. Sentences					380	276	332	116	309	159	346	306	320	279	314	318	290	-073	211	089	145	008
5. Metro. Information						510	348	196	113	168	236	176	137	236	109	235	282	-027	244	363	348	231
6. Metro. Matching							527	338	158	253	118	181	164	322	110	156	400	135	312	229	364	244
7. Metro. Numbers								392	384	220	255	177	347	339	380	340	398	082	233	159	282	121
8. Metro. Copying									494	544	399	284	457	303	411	290	408	136	296	347	478	302
9. R.Ach.Sentence Mean.										517	490	427	701	519	689	270	532	165	140	208	310	154
10. R.Ach.Sentence Imag.											507	290	578	374	346	261	536	325	278	282	327	212
11. R.Ach.Relationships												375	542	310	403	330	430	213	317	294	221	122
12. R.Ach.Emo.Reactions													457	500	459	340	345	093	202	270	070	-108
13. R.Ach.Vis. Scrutiny														677	683	338	566	174	233	249	374	096
14. R.Ach.Phonetic Anal.															266	279	486	213	166	268	293	143
15. R.Ach.Struct.Anal.																361	470	149	181	236	293	150
16. Tchr.Eval.Sch.Adj.																	472	059	286	354	235	246
17. Tchr.Eval.Learning																		218	261	337	402	278
18. Frostig Eye-Motor																			341	208	201	314
19. Frostig Fig.-Ground																				246	294	132
20. Frostig Form Constan.																					297	237
21. Frostig Pos.-in-Space																						524
22. Frostig Space Rela.																						

*Decimals omitted.

AUTOBIOGRAPHICAL STATEMENT

Name: Ruth Hamilton Sprague.

Birth: September 9, 1900; Crete, Nebraska.

Education: High School, Lincoln, Nebraska, 1917; Registered Nurse, Green Gables Sanatorium, Lincoln, Nebraska, 1922; Bachelor of Science in Public Health Nursing, University of Minnesota, 1943; Physical Therapy, Graduate School, Harvard Medical School, 1944; Master of Public Health with Major in Public Health and Psychology, University of Minnesota, 1947; Master of Education in Vocational Counseling and Special Education, College of Education, Wayne State University, 1957.

Professional Experience: Taught in rural schools in Cherry County, Nebraska (grades 1-8), 1917-1919; Staff Nurse and Private Duty Nurse, eight months, 1922; Staff Nurse, Visiting Nurse Association, New Brunswick, New Jersey, 1923-1925; Director of Nurses Training Schools for 15 years, Mission Hospitals, Ambala and Fatehgarh, India, under the Presbyterian Board of Foreign Missions, 1925-1941; while on leave, four months at Spotted Island Summer Station of Grenfell Mission on the Labrador, 1935; Staff Nurse at Ganado Mission Hospital, Navajo Reservation, Presbyterian Board of Home Missions, Ganado, New Mexico, six months, 1935-1936; Orthopedic Nursing Consultant, Wayne County Health Department, Eloise, Michigan, eight years, 1947-1955; Physical Therapist in Special Education Programs, Ecorse and Allen Park, Michigan Public Schools, eight years, 1955 - present; Special Instructor, Special Education, Eastern Michigan University, Summer, 1958; Special Instructor in Special Education, Wayne State University, Spring, 1962 and Summer Session, 1963.

Military Service: Physical Therapist with U. S. Army General Hospitals in England and Occupation Germany, two and one-half years, 1944-1946.

Recognitions: Member of "Court of Honor" (for students in top tenth of class) and "With Honors" with Bachelor of Science degree, University of Minnesota, 1943; Scholarship from American Physical Therapy Association, 1944, given to students with high standing; listed in Womens' Who's Who, 1960.

Professional Membership: Fellow, American Public Health Association; Member, American Physical Therapy Association; Member, Council for Exceptional Children; Member, Michigan Education Association; Member, National Educational Association.