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THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE RELATIONSHIPS OF READING COMPREHENSION, CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT OF THIRD-GRADE PUPILS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

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ANITA HUTT KENT

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1973

THE RELATIONSHIPS OF READING COMPREHENSION, CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT OF THIRD-GRADE PUPILS

APPROVED BY

Robert L. Curry

O. J. Rupiper

Gene Shepherd

John W. Renner

Mary Clare Petty

DISSERTATION COMMITTEE

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THE RELATIONSHIPS OF READING COMPREHENSION, CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT OF THIRD-GRADE PUPILS

CHAPTER I

THE PROBLEM

Introduction

The question under investigation was: Do third-grade pupils classified by sex and reading comprehension levels, differ in conservation ability, auditory discrimination and visual-motor development? The variables that have been studied and separated high and low comprehension readers are manifold, including physical, emotional, perceptual, intellectual, instructional, and environmental factors.[1] In this study, the intellectual factors were approached through conservation tasks as characteristic of the concrete operational stage according to the Piagetian model of intellectual development.

As comprehension of printed symbols was the ultimate

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[1]Guy L. Bond and Miles A. Tinker, Reading Difficulties: Their Diagnosis and Correction (2nd ed.; New York: Appleton-Century-Crofts, 1967), pp. 100-147.

goal in reading instruction, the efficient reader differed from the disabled reader in comprehension ability. The efficient reader was reading on a level commensurate with his intellectual ability. Smith and Dechant stated that the disabled reader has poorer comprehension ability than the efficient reader.[2] The disabled reader was defined as one "who is not reading as well as could be expected for one of his intellectual and verbal ability."[3] The slow or intellectually retarded reader learns to read at a slower rate because of his intellectual ability. However, he may or may not be disabled depending on whether he is reading on a level equivalent to his capabilities.

Though comprehension may be defined as understanding, reading comprehension is difficult to define because of its many facets. Harris and Smith defined reading comprehension as the "process of deriving meaning from reading" including "four components: thinking skills, background experience, language skills, and purposes for reading."[4]

Edwards stated:

> . . . continuous development toward greater reading proficiency is a process with many phases, the goal of which is the comprehension of ideas. Success in the

---

[2]Henry P. Smith and Emerald V. Dechant, Psychology in Teaching Reading (Englewood Cliffs, New Jersey: Prentice-Hall, 1961), p. 235.

[3]Bond and Tinker, Reading Difficulties, p. 98.

[4]Larry A. Harris and Carl B. Smith, Reading Instruction Through Diagnostic Teaching (New York: Holt, Rinehart and Winston, Inc., 1972), p. 279.

> process depends on adequate motivation, a substantial background of concepts, word-perception skills, and the ability to reason one's way through smaller idea elements and to grasp, as a whole, the meaning of a larger unitary idea.[5]

Smith and Dechant likened the reading comprehension process to a cake which must have a certain number of ingredients (printed word) plus exposure to heat (exposure to the reader's active and thoughtful reaction).[6]

The following question concerning the relationship of variables evolved in formulating the research design: What has reading comprehension to do with conservation ability, auditory discrimination, and visual-motor development? First, decoding of the symbols, or mastery of the mechanics of the reading process must be achieved before reading comprehension can take place. Visual perception must necessarily precede mechanics involved in beginning reading.[7] Visual perception may be defined as the ability to recognize stimuli through the modality of sight. Frostig stated that the ability to recognize stimuli (through all the senses)

> includes not only the reception of sensory impressions from the outside world and from one's own body, but the capacity to interpret and identify the sensory impressions by correlating them with previous experiences. This recognition and integration of stimuli is a

---

[5]Thomas J. Edwards, "Oral Reading in the Total Reading Process," The Elementary School Journal, LVIII (October, 1957), p. 38.

[6]Smith and Dechant, Psychology of Reading, p. 213.

[7]Ned D. Marksheffel, Better Reading in the Secondary School (New York: The Ronald Press Company, 1966), p. 4.

> process that occurs in the brain, not in the receiving organ, such as the ear or the eye.[8]

If the last statement is accepted, visual perception problems may occur when no deficit in visual acuity is present.

Visual perception includes the ability to visually discriminate likenesses and differences in letters and words. Though visual discrimination is not reading, this ability is a necessary prerequisite. Visual perception problems may be detected by examining the pupil's visual-motor development. Visual-motor development can be defined as a developmental stage of motor functioning or output elicited by visual input. Motor functioning has revealed assets and deficits in the visual perception process.[9] The early detection of visual-motor deficits, followed by proper activities and instruction, may prevent or alleviate reading disability.

As the sequence of language development must proceed through listening, speaking, reading, and writing, the breakdown in the first of the hierarchy has been known to cause problems in auditory discrimination. Auditory discrimination, which has been defined as the ability to distinguish likenesses and differences of phonemes, is essential for the beginning reader before he can match the sound with its

---

[8]Marianne Frostig and David Horne, The Frostig Program for the Development of Visual Perception (Chicago: Follett Educational Corporation, 1964), p. 7.

[9]Marylow Ebersole, Newell C. Kephart, and James B. Ebersole, Steps to Achievement for the Slow Learner (Columbus, Ohio: Charles E. Merrill Publishing Company, 1968), p. 31.

visual counterpart. However, auditory discrimination difficulty is present in some disabled readers who have normal auditory acuity.[10] Van Riper and Irwin emphasized that defective auditory discrimination "can coexist with normal auditory acuity."[11] Wepman saw auditory discrimination as a developmental process and pointed out that auditory discrimination was positively correlated with age.[12]

Despite the fact that pages were devoted to concepts of reading and reading readiness activities, the possibility that children were being pushed into reading activities for which they were not ready, existed. Asking the child to learn letters of the alphabet may be beyond his intellectual level of functioning, according to Piaget's model of intellectual development.[13] Similar abilities may be involved in performance of conservation tasks and progress in beginning reading.[14]

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[10]Arthur W. Heilman, Principles and Practices of Teaching Reading (3rd ed.; Columbus, Ohio: Charles E. Merrill Publishing Company, 1972), p. 121.

[11]Charles Van Riper and John V. Irwin, Voice and Articulation (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958), p. 23.

[12]Joseph M. Wepman, Auditory Discrimination Test, Manual of Directions (Chicago: University of Chicago Press, 1958), p. 1.

[13]John W. Renner, Robert F. Bibens, and Gene D. Shepherd, Guiding Learning in the Secondary School (New York: Harper and Row, 1972), p. 89.

[14]Millie Almy, Young Children's Thinking (New York: Columbia University, Teacher's College Press, 1966), pp. 139-140.

Many apparent solutions to reading disability have been introduced, and a variety of methods have been tried. However, USOE First Grade Studies indicated the teacher was the most important variable in the learning situation as greater variation was shown between teachers within methods than between methods.[15]

The trend toward personalized individualized instruction was a welcomed one but had little value without adequate diagnosis of individual needs and use of the diagnosis as a "blueprint for instruction."[16] Awareness of the deficits that separate efficient readers from disabled readers can enable the classroom and clinic teacher to plan instruction according to the individual needs of each pupil in the groups.

Statement of the Problem

This study was designed to investigate whether relationships exist between measures of reading comprehension, conservation ability, auditory discrimination, and visual-motor development among third-grade pupils classified by sex and reading comprehension levels.

The purpose of this study was to investigate whether efficient readers differ from disabled readers in conservation ability, auditory discrimination, and visual-motor

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[15]Guy L. Bond and Robert Dykstra, "The Cooperative Research Program in First-Grade Reading Instruction," Reading Research Quarterly (Summer, 1967), 5-142.

[16]Heilman, Principles, p. 8.

development. This study was also concerned with investigation of the differences of boys and girls on those variables. A secondary purpose was to acquaint the educator with the relationships of reading comprehension to conservation ability, auditory discrimination, and visual-motor development so that instructional strategies may be planned to prevent and alleviate reading difficulties concerned with these factors.

Hypotheses

Investigation of the problem led to the formation of two general hypotheses:

1. There are no significant differences in measures of conservation ability, auditory discrimination, and visual-motor development among third-grade subjects classified by sex and reading comprehension levels.

2. There are no significant relationships between measures of reading comprehension and conservation ability, auditory discrimination, and visual-motor development among third-grade subjects classified by sex and reading comprehension levels.

Investigation of the first general hypothesis led to the establishment of six specific null hypotheses:

Ho_1: There are no statistically significant differences between the number of subjects in the high reading comprehension group and the number of subjects in the low reading comprehension group on two classifications of

measures of conservation ability, auditory discrimination, and visual-motor development.

Investigation of Ho_1 required the establishment of three sub-hypotheses:

Ho_1a: There is no statistically significant difference between the number of subjects in the high reading comprehension group and the number of subjects in the low reading comprehension group on high and medium-low classifications of conservation ability as measured by performance on six conservation tasks.

Ho_1b: There is no statistically significant difference between the number of subjects in the high reading comprehension group and the number of subjects in the low reading comprehension group on high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test.

Ho_1c: There is no statistically significant difference between the number of subjects in the high reading comprehension group and the number of subjects in the low reading comprehension group on high and low classifications of visual-motor development as measured by the Bender Gestalt Test, using the developmental Bender scoring system.

Ho_2: There are no statistically significant differences between the number of male subjects and the number of female subjects on two classifications of measures of conservation ability, auditory discrimination, and visual-motor development.

Investigation of Ho_2 required the establishment of three sub-hypotheses:

Ho_2a: There is no statistically significant difference between the number of male subjects and the number of female subjects in high and medium-low classifications of conservation ability as measured by performance on six conservation tasks.

Ho_2b: There is no statistically significant difference between the number of male subjects and the number of female subjects in high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test.

Ho_2c: There is no statistically significant difference between the number of male subjects and the number of female subjects in high and low classifications of visual-motor development as measured by the Bender Gestalt Test, using the developmental Bender scoring system.

Ho_3: There are no statistically significant differences between the number of male subjects in the high reading comprehension group and the number of female subjects in the high reading comprehension group on two classifications of measures of conservation ability, auditory discrimination, and visual-motor development.

Investigation of Ho_3 required the establishment of three sub-hypotheses:

Ho_3a: There is no statistically significant

difference between the number of male subjects in the high reading comprehension group and the number of female subjects in the high reading comprehension group in high and medium classifications of conservation ability as measured by performance on six conservation tasks.

Ho_3b: There is no statistically significant difference between the number of male subjects in the high reading comprehension group and the number of female subjects in the high reading comprehension group in high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test.

Ho_3c: There is no statistically significant difference between the number of male subjects in the high reading comprehension group in high and low classifications of visual-motor development as measured by the Bender Gestalt Test, using the developmental Bender scoring system.

Ho_4: There are no statistically significant differences between the number of male subjects in the low reading comprehension group and the number of female subjects in the low reading comprehension group on two classifications of measures of conservation ability, auditory discrimination, and visual-motor development.

Investigation of Ho_4 required the establishment of three sub-hypotheses:

Ho_4a: There is no statistically significant difference between the number of male subjects in the low reading

comprehension group and the number of female subjects in the low reading comprehension group in high and medium-low classifications of conservation ability as measured by performance of six conservation tasks.

Ho_4b: There is no statistically significant difference between the number of male subjects in the low reading comprehension group and the number of female subjects in the low reading comprehension group in high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test.

Ho_4c: There is no statistically significant difference between the number of male subjects in the low reading comprehension group and the number of female subjects in the low reading comprehension group in high and low classifications of visual-motor development as measured by the Bender Gestalt Test, using the developmental Bender scoring system.

Ho_5: There are no statistically significant differences between male subjects in the high reading comprehension group and male subjects in the low reading comprehension group on two classifications of measures of conservation ability, auditory discrimination, and visual-motor development.

Investigation of Ho_5 required the establishment of three sub-hypotheses:

Ho_5a: There is no statistically significant difference between male subjects in the high reading comprehension

group and male subjects in the low reading comprehension group on two classifications of measures of conservation ability, auditory discrimination, and visual-motor development.

Investigation of Ho_5 required the establishment of three sub-hypotheses:

Ho_5a: There is no statistically significant difference between male subjects in the high reading comprehension group and male subjects in the low reading comprehension group in high and medium-low classifications of conservation ability as measured by performance on six conservation tasks.

Ho_5b: There is no statistically significant difference between male subjects in the high reading comprehension group and male subjects in the low reading comprehension group in high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test.

Ho_5c: There is no statistically significant difference between male subjects in the high reading comprehension group and male subjects in the low reading comprehension group in high and low classifications of visual-motor development as measured by the Bender Gestalt Test, using the developmental Bender scoring system.

Ho_6: There are no statistically significant differences between number of female subjects in the high reading comprehension group and number of female subjects in the low reading comprehension group on two classifications of

measures of conservation ability, auditory discrimination, and visual-motor development.

Investigation of Ho_6 required the establishment of three sub-hypotheses:

Ho_6a: There is no statistically significant difference between female subjects in the high reading comprehension group and female subjects in the low reading comprehension group in high and medium-low classifications of conservation ability as measured by performance on six conservation tasks.

Ho_6b: There is no statistically significant difference between female subjects in the high reading comprehension group and female subjects in the low reading comprehension group in high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test.

Ho_6c: There is no statistically significant difference between female subjects in the high reading comprehension group and female subjects in the low reading comprehension group in high and low classifications of visual-motor development as measured by the Bender Gestalt Test, using the developmental Bender scoring system.

Investigation of the second general hypothesis led to the establishment of the following nine specific null hypotheses:

Ho_7: There are no statistically significant

relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male and female subjects in the high and low reading comprehension groups. Three specific sub-hypotheses required investigation.

Ho_7a: There is no statistically significant relationship between reading comprehension scores and conservation ability levels of male and female subjects in the high and low reading comprehension groups.

Ho_7b: There is no statistically significant relationship between reading comprehension scores and auditory discrimination scores of male and female subjects in the high and low reading comprehension group.

Ho_7c: There is no statistically significant relationship between reading comprehension scores and visual-motor development scores of male and female subjects in the high and low reading comprehension groups.

Ho_8: There are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of female subjects in the high reading comprehension group.

Investigation of Ho_8 requires the establishment of three sub-hypotheses:

Ho_8a: There is no statistically significant relationship between reading comprehension scores and conservation

ability levels of female subjects in the high reading comprehension group.

Ho_8b: There is no statistically significant relationship between reading comprehension scores and auditory discrimination levels of female subjects in the high reading comprehension group.

Ho_8c: There is no statistically significant relationship between reading comprehension scores and visual-motor development scores of female subjects in the high reading comprehension group.

Ho_9: There are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male subjects in the high reading comprehension group.

Ho_9a: There is no statistically significant relationship between reading comprehension scores and conservation ability levels of male subjects in the high reading comprehension group.

Ho_9b: There is no statistically significant relationship between reading comprehension scores and auditory discrimination scores of male subjects in the high reading comprehension group.

Ho_9c: There is no statistically significant relationship between reading comprehension scores and visual-motor development scores of male subjects in the high reading comprehension group.

Ho_{10}: There are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of female subjects in the low reading comprehension group.

$Ho_{10}a$: There is no statistically significant relationship between reading comprehension scores and conservation ability levels of female subjects in the low reading comprehension group.

$Ho_{10}b$: There is no statistically significant relationship between reading comprehension scores and auditory discrimination scores of female subjects in the low reading comprehension group.

$Ho_{10}c$: There is no statistically significant relationship between reading comprehension scores and visual-motor development scores of female subjects in the low reading comprehension group.

Ho_{11}: There are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male subjects in the low reading comprehension group.

Investigation of Ho_{11} required the establishment of three sub-hypotheses:

$Ho_{11}a$: There is no statistically significant relationship between reading comprehension scores and conservation

ability levels of male subjects in the low reading comprehension group.

$Ho_{11}b$: There is no statistically significant relationship between reading comprehension scores and auditory discrimination scores of male subjects in the low reading comprehension group.

$Ho_{11}c$: There is no statistically significant relationship between reading comprehension scores and visual-motor development scores of male subjects in the low reading comprehension group.

Ho_{12}: There are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male and female subjects in the high reading comprehension group.

$Ho_{12}a$: There is no statistically significant relationship between reading comprehension scores and conservation ability levels of male and female subjects in the high reading comprehension group.

$Ho_{12}b$: There is no statistically significant relationship between reading comprehension scores and auditory discrimination scores of male and female subjects in the high reading comprehension group.

$Ho_{12}c$: There is no statistically significant relationship between reading comprehension scores and visual-motor development scores of male and female subjects in the

high reading comprehension group.

Ho_{13}: There are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male and female subjects in the low reading comprehension group.

Investigation of Ho_{13} required the establishment of three sub-hypotheses:

$Ho_{13}a$: There is no statistically significant relationship between reading comprehension scores and conservation ability levels of male and female subjects in the low reading comprehension group.

$Ho_{13}b$: There is no statistically significant relationship between reading comprehension scores and auditory discrimination scores of male and female subjects in the low reading comprehension group.

$Ho_{13}c$: There is no statistically significant relationship between reading comprehension scores and visual-motor development scores of male and female subjects in the low reading comprehension group.

Ho_{14}: There are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of female subjects in the high and low reading comprehension groups.

$Ho_{14}a$: There is no statistically significant

relationship between reading comprehension scores and conservation ability levels of female subjects in the high and low reading comprehension groups.

$Ho_{14}b$: There is no statistically significant relationship between reading comprehension scores and auditory discrimination scores of female subjects in the high and low reading comprehension groups.

$Ho_{14}c$: There is no statistically significant relationship between reading comprehension scores and visual-motor development scores of female subjects in the high and low reading comprehension groups.

Ho_{15}: There are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male subjects in the high and low reading comprehension groups.

$Ho_{15}a$: There is no statistically significant relationship between reading comprehension scores and conservation ability levels of male subjects in the high and low reading comprehension groups.

$Ho_{15}b$: There is no statistically significant relationships between reading comprehension scores and auditory discrimination scores of male subjects in the high and low reading comprehension groups.

$Ho_{15}c$: There is no statistically significant relationship between reading comprehension scores and

visual-motor development scores of male subjects in the high and low reading comprehension groups.

Operational Definitions

1. The group with low reading comprehension level was that group on or below the scale score of 41, which was equivalent to a grade score of 1.9 and below on the comprehension subtest of the Gates-MacGinitie Reading Test, Primary C. This group fell on and below the 18th percentile.

2. The group with high reading comprehension was defined as that group reading on and above the scale score 60, which was equivalent to a grade score of 4.9 and above on the comprehension subtest of the Gates-MacGinitie Reading Test, Primary C.[17] This group fell on or above the 84th percentile.

3. Auditory discrimination ability was defined as the ability to distinguish likenesses and differences in the phonemes of English speech. Auditory discrimination was measured by the Wepman Auditory Discrimination Test, Form 1.[18] Subjects scoring 28 or above were considered discriminators while those scoring 27 and below were classified as non-discriminators.

4. Visual-motor development was that aspect of

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[17]Arthur I. Gates and Walter H. MacGinitie, Gates-MacGinitie Reading Tests (Teachers College, Columbia University, New York: Teachers College Press, 1965), pp. 1-12.

[18]Wepman, Auditory Discrimination Test, p. 1.

development determined by the subject's ability to reproduce nine figures on the Bender Motor Gestalt Test.[19] By using the developmental Bender scoring system, a visual-motor development score was established.[20] Subjects with scores of 3, 2, 1, 0 were classified as high in visual-motor development; subjects with scores of 4 or higher were classified as low in visual-motor development.

5. Conservation ability has been defined as the ability to "mentally retain the original image of an object,"[21] and has been considered characteristic of the child in the concrete stage of intellectual development according to the Piagetian model. As movement from the preoperational to the concrete stage has not occurred at a specific time, conservation abilities were measured by individual performance on each of the following tasks: 1) number, 2) solids, 3) liquid, 4) area, 5) length, and 6) weight.

6. The high conservation group was defined as that group that conserved on five or six conservation tasks.

7. The medium conservation group was defined as that group that conserved on three or four conservation tasks.

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[19]Lauretta Bender, Bender Motor Gestalt Test, Cards and Manual of Instructions (New York: The American Orthopsychiatric Association, Inc., 1946), Cards A, 1-8.

[20]Elizabeth M. Koppitz, The Bender Gestalt Test for Young Children (New York: Grune and Stratton, Inc., 1963), pp. 15-33, 188.

[21]Renner, Bibens, Shepherd, Guiding Learning, p. 94.

8. The low conservation group was defined as that group that conserved on none, one, or two conservation tasks.

Assumptions

1. Third-grade pupils in this study were unilingual; English being their language.

2. Third-grade pupils in the concrete stage of intellectual development were able to conserve.[22]

3. The separation into high, medium, and low conservation groups was arbitrarily determined. The equivalence of one conservation task to another had not been established by research at the time of this study.

4. Disabled readers fell in the low reading comprehension level and not in the high comprehension level. The disabled reader was actually defined as one reading below his intellectual potential.

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[22] Ibid., p. 105.

CHAPTER II

REVIEW OF THE SELECTED LITERATURE

Theoretical Models

Review of the literature on exactly how the human organism functions in performing the reading act revealed no absolute conclusions as to the process. Models of the reading process were enlightening in the revelation that reading is indeed a complex process. Four theoretical models were selected for review because of their relevance to this study.

Holmes stated:

> The Substrata-Factor Theory holds that, normally reading is an audio-visual verbal-processing-skill of symbolic reasoning, sustained by the interfacilitations of an intricate hierarchy of substrata factors that have been mobilized as a psychological working-system and pressed into service in accordance with the purpose of the reader.[1]

The substrata factors were neurological subsystems of brain cell assemblies, which contained various pieces of information such as memory for shapes, sounds, word meanings, word parts, concepts, memories of vicarious and experiential

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[1]Jack A. Holmes, "The Substrata-Factor Theory of Reading: Some Experimental Evidence," in Theoretical Models and Processes of Reading, ed. by Harry Singer and Robert B. Ruddell (Newark, Delaware: International Reading Association, 1970), p. 188.

material. These subsystems remained in the brain and were brought forth when triggered by appropriate symbols on the printed page. The substrata theory was based on Hebb's theory which proposed that a system of cell assemblies and phase sequences was developed during learning. When a stimulus activated two cells, a third connecting cell was activated. When the stimulus was repeated a new cell functionally related to the previously fired cells may be activated. At first learning was slow because of the growth of cell assemblies and phase sequences. But as more elaborate sequences were formulated, conceptual learning became facile.[2] A similar procedure was followed in reading. Holmes wrote that the memory engrams for visual symbols were localized in the angular gyrus portion of the brain, where symbolic expressions were categorized. The child learning symbols in the first reader must "see" or read a new word about thirty-five times before its engrams become established.[3]

According to Holmes, the substrata first became associated by mobilizers. He defined mobilizers as deep-seated value systems which motivated, consciously or unconsciously, the organism to select those factors which solved a specific problem according to one's fundamental value system. The

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[2]Smith and Dechant, Psychology in Teaching Reading, p. 55.

[3]Jack A. Holmes, "The Brain and the Reading Process," Claremont College Reading Conference, Twenty-second Yearbook (Claremont, California: Claremont College Curriculum Laboratory, 1957), p. 59.

mobilizers were the "controlling influences, electro-chemical biases, in the brain's scanning-search mechanisms which govern those cell assemblies which shall be selected and momentarily tied into a particular neural pattern of communication."

Individuals solved problems in different ways because of their individual working systems. A working system was a pattern in the brain that linked together substrata factors that had been mobilized into a workable communications system for the purpose of solving a particular problem. Successful solutions may have been reached in different individuals by the use of different sets of subabilities. Holmes contended that individual differences in the ability to reason about what was being read was dependent on the information storage and the "associative logic of the conceptualizing activity-of-perception stimulated within the brain, by the meaningfulness of the sequential input at the time of presentation and reception." The sequential input of teaching allowed the child to cortically associate for recall but more importantly to formulate and later reorganize his individual working system.

In order to develop a sequential input to the teaching of reading, Holmes isolated thirteen from thirty-seven variables that made statistically significant and independent contributions to the speed and power of reading by use of the Wherry-Doolittle-Holmes statistical model. The sample

consisted of 126 college students from which 22 most powerful and 24 least powerful readers were selected. The mean of the least powerful was at the seventh percentile; the mean of the most powerful was at the ninety-third percentile. Significant differences were found in the intellectual, linguistic, perceptual, and oculomotor areas but no significant differences were found in the personality traits. By use of the Wherry-Doolittle-Holmes statistical model, derived from the Wherry-Doolittle correlation technique, a hierarchy of subabilities were isolated from the significant substrata variables. The analysis began with the most valid predictor of the power of reading. By partialing out the explainable variance, the next most powerful predictor was isolated. The variance attributed to these two factors was partialed out, the next predictor isolated, and so the analysis proceeded. Four variables, perception of verbal relations, intelligence, vocabulary in context, and reciprocal of the number of eye-movement fixations, were the first order of variables contributing most to the power of reading. Appliance of the Wherry-shrinkage formula isolated the variables that preceded the first order variables, and the second order variables so that a sequential order of subabilities was formulated that led to speed and power of reading. For example in speed of reading, the third order subabilities; phonetics, vocabulary-in-context, and span of recognition combined into word sense. The second order variables, word

sense, intelligence, spelling, and vocabulary-in-context combined into word discrimination. The first order variables contributing most to speed of reading were word sense, 23%; word discrimination, 28%, and span of recognition 5%. Forty-four per cent of the variance, which Holmes stated may probably have been attributed to motivational habit and desire for speed, was not accounted for. In power of reading, the third order subabilities; general information, word discrimination, and suffixes combined to form the second order variable, vocabulary-in-isolation. The later combined with general information and prefixes to formulate the first-order variable, vocabulary-in-context. The first order variables were perception of verbal relations, 8%, intelligence 27%, vocabulary-in-context, 39%, fixations, 4%. Twenty-two per cent of the variance was not accounted for; Holmes stated this variance probably may have been attributed to sustained effort and desire to know.[4] The flowsheet in Figure 1 may facilitate the understanding of Holmes's analysis.

Using a similar technique, Singer isolated four systems for reading power and three systems for reading speed for the fourth-grade level. Beginning with the third level elements for reading speed, mental age, and chronological age combined to formulate conceptual ability. Visual verbal abstraction and spelling recognition combined to form word perception discrimination. The second level elements,

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[4]Holmes, "The Substrata-Factor Theory," pp. 189-196.

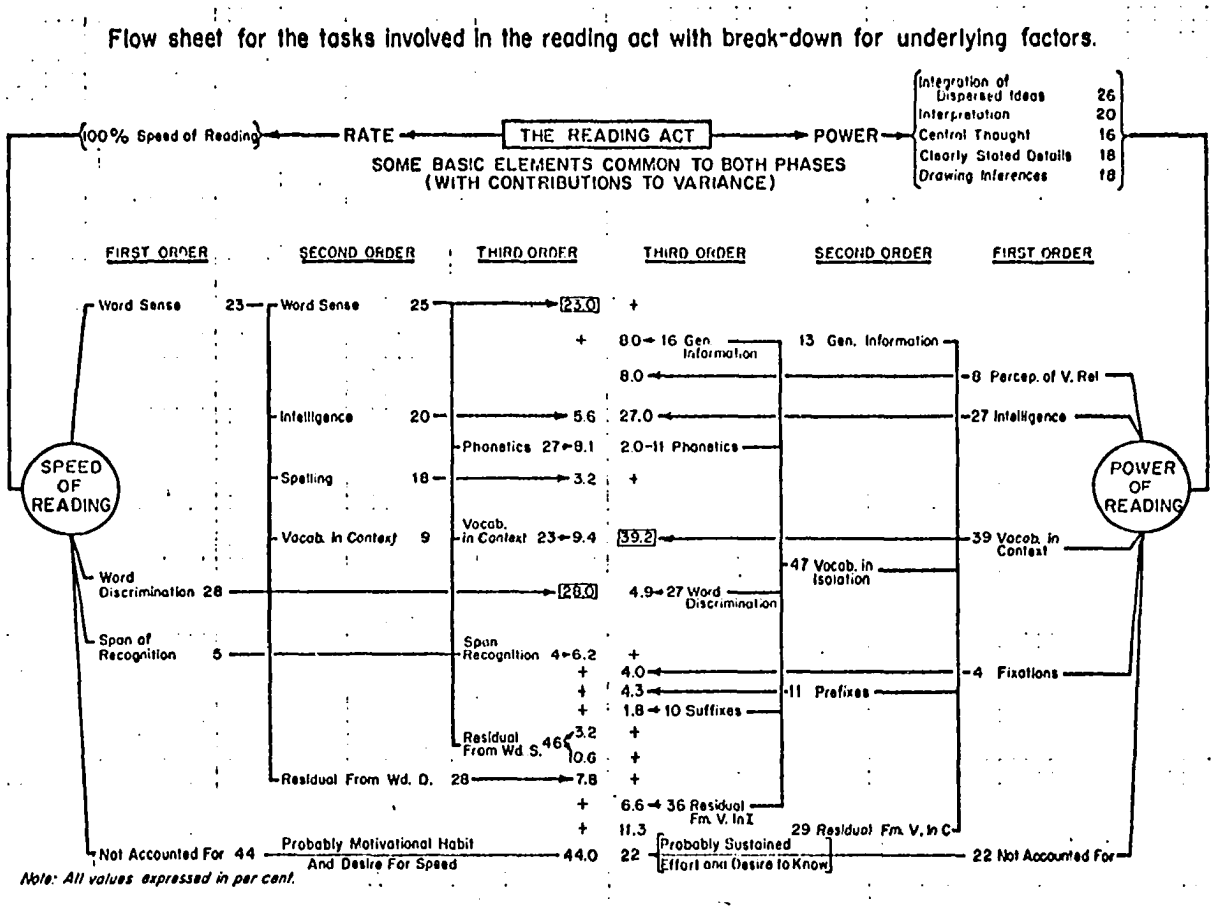

Fig. 1.--Flowsheet of Holmes's Analysis.

Source: Jack A. Holmes, "The Substrata-Factor Theory of Reading: Some Experimental Evidence," in Theoretical Models and Processes of Reading, ed. by Harry Singer and Robert B. Ruddell (Newark, Delaware: International Reading Association, 1970), Figure 2, p. 195.

conceptual ability, auding memory for stories combined to form the first level variable, auding vocabulary. Word recognition in context, word perception discrimination combined to form phrase perception discrimination. Level I elements which contributed most to speed of reading at the fourth grade level were mental age (reasoning in context) 32.7%, auding vocabulary, 9.0%, and phrase perception discrimination, 35.4%. Singer explained the 22.9% unaccounted variance as probably being due to 1) functional oculomotor efficiency, 2) psychosynchromeshing ability, 3) speed of processing visual stimuli, and/or verbal flexibility.

In the power of reading model, third order variables, prefixes, spelling recognition, spelling recall, formulated word recognition in context. The latter in combination with suffixes and mental age, combined to formulate the level I variable vocabulary-in-isolation. Level II elements; spelling recall, blending word sounds, combined to form the first order variable, matching sounds in words or word recognition. The Level I elements contributing most to power of reading were mental age, 28.7%, suffixes, 27.3%; vocabulary in isolation, 26%, matching sounds in words, 18.9%. The 10.7% of the variance not accounted for may be attributed to attitudinal factors, breadth and conceptualization of experience, methodological factors, mobilizers, and/or reorganization of subabilities. A negative 11.6 per cent contribution to the variance was due to the suppressor-like effect of phonics and

consonants.[5] Singer's model (Figure 2) represented the results emanating from a general method of reading instruction. He made the suggestion that more appropriate models could be made for those pupils with deficits in sensory modalities. Consideration should be made of the child's modality preference in the instructional input model. Deficiency in auditory modality required the visual approach and vice versa. Even children with no perceptual deficit would have profited in power and speed of reading if instructional practices had matched input to child's modality preference.[6]

The substrata theory asserted that speed and power of reading were separate but interrelated entities. However, Bond and Tinker contended that speed was of no consequence without comprehension and preferred the term, "rate of comprehension."[7]

From a neurological viewpoint, Crosby defined reading as the translation of "graphic symbols into sounds according to a recognized system." He saw comprehension of these translated sounds as a different function of the brain. He proposed three levels of reading. In Level I, the beginning reader picked up the image on the page, transferred it

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[5]Harry Singer, "Theoretical Models of Reading: Implications for Teaching and Research," in Theoretical Models and Processes of Reading, ed. by Harry Singer and Robert B. Ruddell (Newark, Delaware: International Reading Association, 1970), pp. 155-158.

[6]Singer, "Theoretical Models," pp. 163-164.

[7]Bond and Tinker, Reading Difficulties, p. 422.

Flow chart showing results of the substrata analysis of speed and power reading at the fourth grade level.

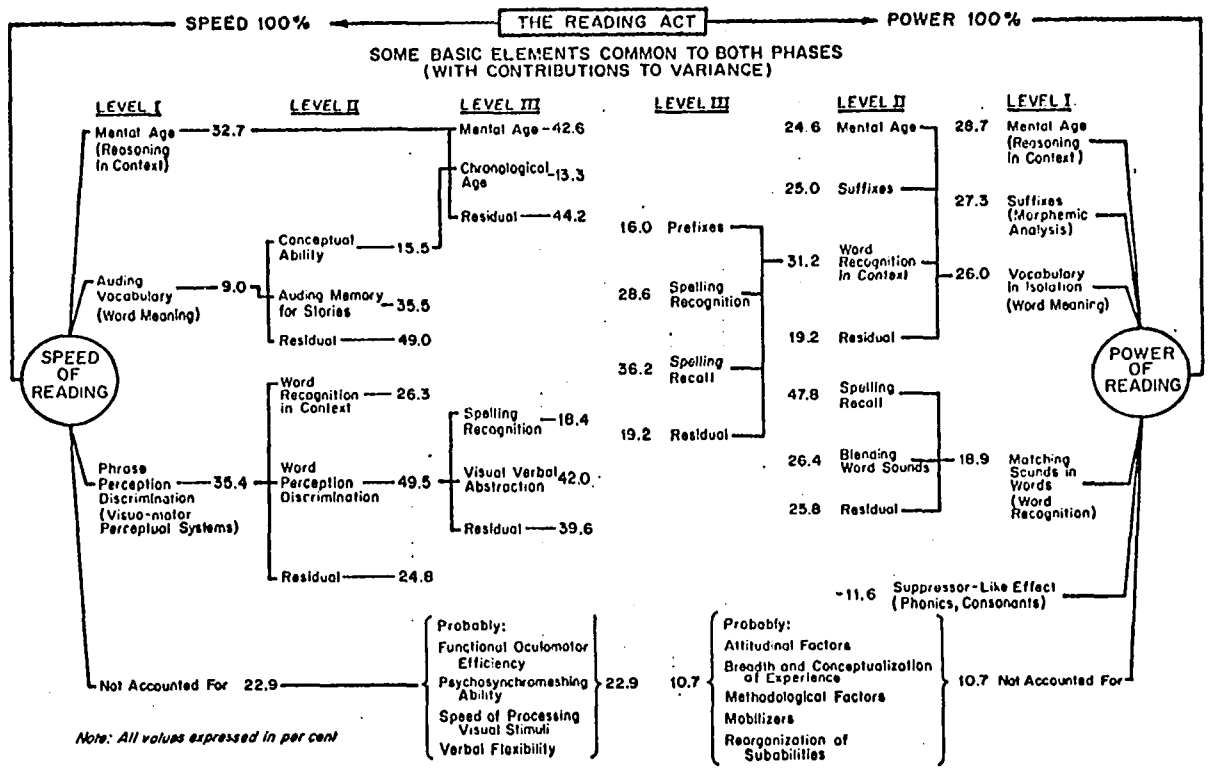

Fig. 2.--Flowsheet of Singer's Analysis.

Source: Harry Singer, "Theoretical Models of Reading: Implications for Teaching and Research," in Theoretical Models and Processes of Reading, ed. by Harry Singer and Robert B. Ruddell (Newark, Delaware: International Reading Association, 1970), Figure 2, p. 156.

to the visual areas of the brain, where visual perception enabled him to separate likenesses and differences of individual letters. The reading function followed in which he compared the image with other known word images. He said the word aloud using the motor speech area, motor brain mechanism, mouth and larynx, thus transferring the word to his ears where it traveled through the hearing areas, auditory perception, sensory speech area, and lastly to language comprehension. This process was long and tedious but observation of a beginning reader revealed his dependence on listening and speech. An important pre-reading function was auditory perception, which the child learned to use before he talked. Crosby stated listening preceded language comprehension which preceded the motor activities of speech, and these functions must necessarily have preceded the visual perception needed for beginning reading. When the child used his visual areas to read, he relied on the auditory and speech functions which initially brought him success in language comprehension. Figure 3, with the localized functions in squares and the non-localized functions in circles, illustrated the first level of reading.

The second level of reading omitted the mechanics of motor speech. However, Crosby stated that the second level reader says the word mentally without actually uttering it and uses the sensory speech function without using his ears in order to arrive at language comprehension. The latter

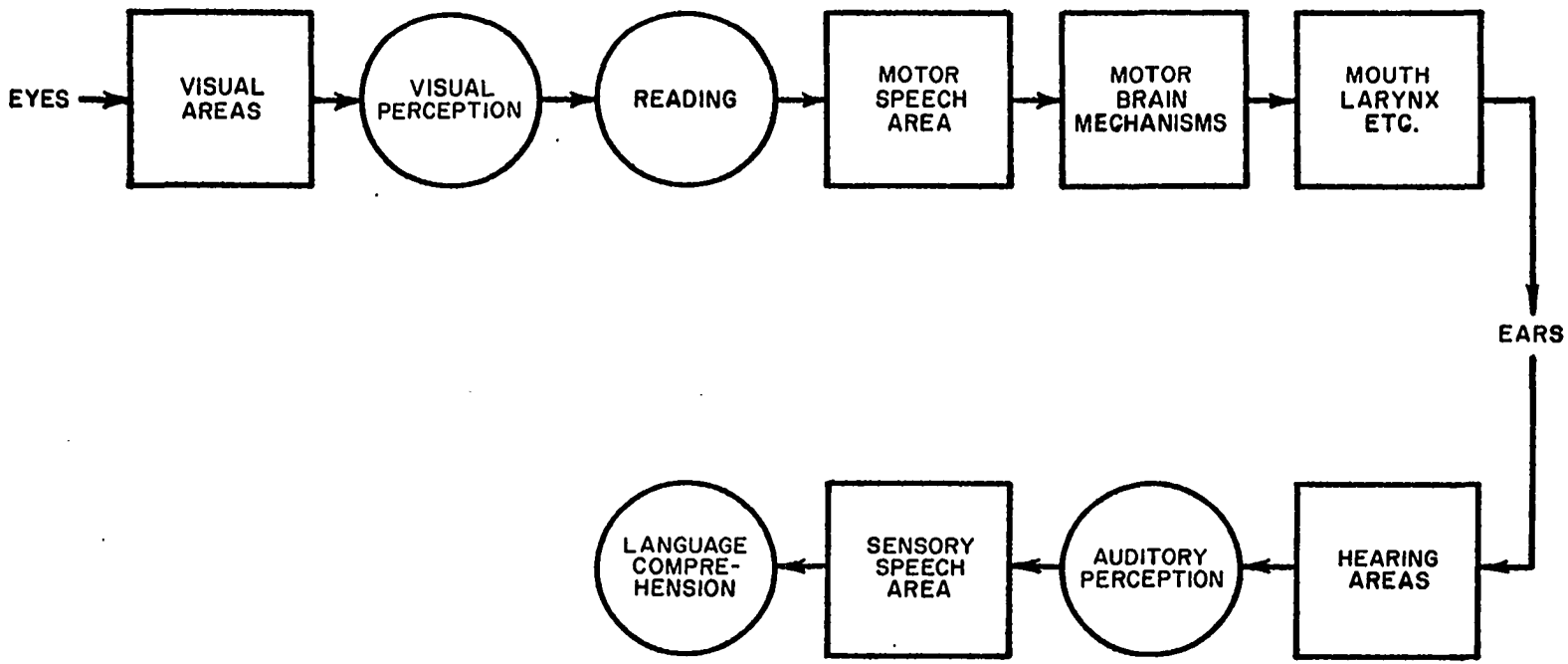

Fig. 3.--Crosby's First Level of Reading.

Source: R. M. N. Crosby, The Waysiders (New York: Delacorte Press, 1968, Illustration 5, p. 46.

was reminiscent of Watson's theory claiming that thought is implicit speech and that tongue movements or other movement could be detected by supersensitive instruments.[8] Crosby contended the majority of readers were on this level, which was used by all readers at certain times (Figure 4).

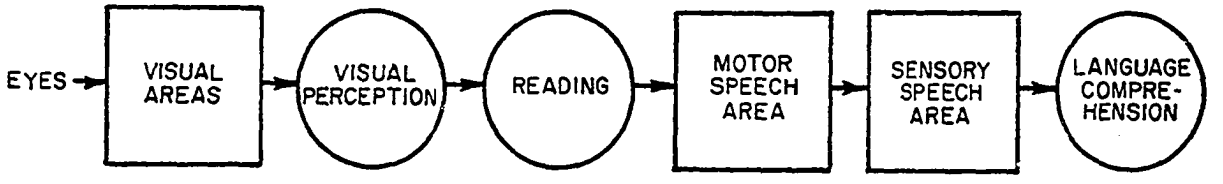

Fig. 4.--Crosby's Second Level of Reading.

Source: Crosby, The Waysiders, Illustration 6, p. 47.

The third level of reading was attained by a few rapid readers.[9] The eyes transmitted the image to the visual areas and in turn to visual perception and directly to language comprehension; thus the speech and auditory areas were omitted (Figure 5).

Strang astutely observed the interrelationship of models of teaching, skills and abilities, and processes in reading.[10] She summarized the sequential scheme of the

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[8]Ernest R. Hilgard and Gordon H. Bower, Theories of Learning (3rd ed.; New York: Appleton-Century-Crofts, 1966), p. 56.

[9]R. M. N. Crosby with Robert A. Liston, The Waysiders, A New Approach to Reading and the Dyslexic Reader (New York: Delacorte Press, 1968), pp. 46-48.

[10]Ruth Strang, "The Reading Process and Its Ramifications," Invitational Addresses, 1965 (Newark, Delaware: International Reading Association, 1965), pp. 49-74, cited by Singer, "Theoretical Models," p. 174.

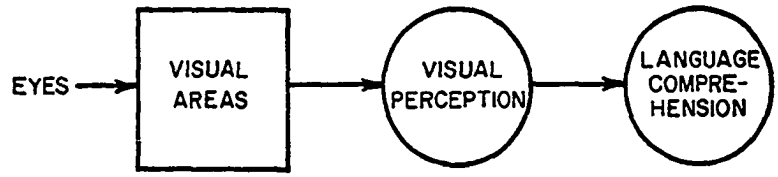
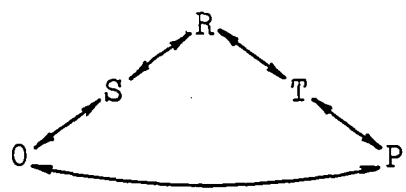


Fig. 5.--Crosby's Third Level of Reading.

Source: Crosby, The Waysiders, Illustration 7, p. 48.

reading act which involved 1) the student and what he brought to the classroom, 2) the classroom situation including his peers, teacher, etc., 3) his individual response, 4) his interaction storage and 5) what he perceived as a result (Figure 6).



O--the individual student and his background

S--the classroom situation

R--the individual response

T--the dynamic interaction storage (memory traces)

P--the student's resultant perception.

Fig. 6.--Strang's Model of Individual Reading Act in the Classroom.

Source: Harry Singer, "Theoretical Models and Processes of Reading: Implications for Teaching and Research," in Theoretical Models, Figure 9, p. 174.

The models reviewed contained a commonality in the inclusion of perceptual functions as prerequisite to the

reading act. Though they may have differed on whether comprehension was ultimately included in the definition of reading or education, they were in agreement that reading was a neurological function dependent in its beginnings on an auditory-visual act. The ultimate objective was meaningful interpretation of printed symbols. The achievement of this objective was dependent largely on the reader's store of experience.

Holmes and Singer isolated the subabilities needed for speed and power of reading for college and fourth-grade samples respectively. To date, no study has approached the relationship of reading comprehension to auditory, visual, and intellectual functioning of third-grade students in the transition from decoding to content area reading. The scope of this study necessitated the review of related research being divided into three sections: conservation, auditory discrimination, and visual-motor development, with emphasis on the relationship of each to reading comprehension.

Conservation

Piaget made no direct statements as to the relationship of reading and conservation ability but studies by Almy suggested that similar abilities were involved. A cross-sectional study of kindergarten, first- and second-grade pupils from a middle class and a lower class school was undertaken for the purposes of investigating the relationships between understanding the principle of conservation, and age,

other measures of intellectual functioning, readiness, and achievement. Three conservation tasks were administered: A, conservation of the equality of two rows of blocks through two transformations; B, conservation of the number of a row of blocks, that have been counted, through two transformations; and C, conservation of the equality of two amounts of water through one transformation. The child's performance was evaluated on whether or not he could conserve on each task. The population included 152 subjects from a middle class school and 93 subjects with adequate language understanding from a lower class school.

Findings showed that the mean intelligent quotients (based on Pintner-Cunningham Primary Test) of the middle class population who conserved on three tasks were higher than those conserving on one or two tasks. First-grade children from the middle class school who conserved on three tasks showed a higher mean score on the New York Test of Reading Readiness. This pattern was repeated on the New York Test of Growth in Reading for the second-grade subjects of the middle class group. However the first-grade and second-grade subjects in the lower class school had higher means in readiness and reading growth respectively when performing only one conservation task (B).

A discriminant function analysis investigated language ability as measured by Ammons Picture Vocabulary Test, logical ability as measured by Arthur Stencil Design Test and

chronological age as predictors of the ability to conserve. F ratios for the three variables revealed that the best predictor for the ability to conserve in the middle class school (F = 18.22) and the lower class school (F = 11.57) was chronological age. The vocabulary score was a better predictor than the stencil score for the middle class school while the reverse was true for the lower class school. The stencil design was described as a non-verbal test of logical thinking. Piaget held the language of a child was a tool of logic and that vocabulary per se did not reflect thinking.[11] The pupils from the lower class school may not have had the language tool available to express logic.

A longitudinal study involved the subjects in the cross-sectional study who remained in the two schools. The population consisted of forty-one subjects from the middle class school and twenty-four from the lower class school. Five interviews were given at six month intervals from mid-kindergarten to mid-second-grade to the two groups. The purposes were: to investigate whether the ability to conserve increased with age, to determine the order of difficulty of the tasks, and to investigate the relationship of conservation to mental aptitude and achievement.

In both the cross-sectional and longitudinal studies the ability to conserve increased with age. The number concept after counting (B), the conservation of the equality of

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[11] Almy, Young Children's Thinking, pp. 75-78.

two rows of blocks through two transformations (A), and conservation of equality of two amounts of water through one transformation (C), were in that order of difficulty.

Differences in conservation ability between the middle class school and the lower class school indicated rate of attaining conservation was slower for the lower class school. Forty-eight per cent of the second-grade subjects from the middle class school conserved on all three tasks; twenty-three per cent of the second-grade subjects from the lower class school conserved on three tasks. The data revealed more difference in the performance of three tasks between first- and second-grades for both groups than between kindergarten and first-grade. In the longitudinal study, 76% of the middle class group conserved on three tasks at second-grade, while 55% lower class group conserved only on the easiest task at second-grade. Almy suggested the slower rate of attainment for the lower class school could be attributed to differences in socioeconomic levels of the two groups.

The longitudinal study was concerned with the relationship of conservation to mental aptitude and achievement. Pragmatically, the question posed was, Does knowledge of a child's progress in conservation aid the instructor in the instructional approach to learning tasks in the classroom?

Eight factors as measures of mental aptitude were intercorrelated for the subjects of both groups. The eight factors were: vocabulary, stencil, Pintner-Cunningham

Primary Test, reading readiness, conservation, and three subtests from the Wechsler Intelligence Scale for Children; picture arrangement, block design, and object assembly. Reading readiness was placed in the mental aptitude category because of its use as an indicator of beginning instruction. The highest relationship to conservation was the Pintner-Cunningham Primary Test, .60; the next highest was reading readiness with a correlation of .53. A correlation of .53 was also found between stencil design and conservation. For the subjects in the lower class group the highest relationship to conservation was object assembly, .50. Pintner and block design correlated .49, respectively, stencil design, .45, and reading readiness, .39. Vocabulary had a low correlation; .25 in the middle class group and .09 in the lower class group. The latter findings contrasted the previous cross-sectional finding where vocabulary was a valid predictor for conservation ability for subjects of the middle class school. Almy suggested this discrepancy may be attributed to the restricted age range in the longitudinal study.

An intercorrelational matrix for achievement and conservation included four factors: reading growth, as measured by New York Test Of Growth in Reading; premeasurement, New York Premeasurement Test, dealing with concepts of size, shape, weight, time, indefinite quantity, place and distance; mathematical concepts, as measured by Numerical Concepts

Test; and conservation. The highest correlation with conservation was with mathematical concepts, .53. The correlation between reading growth and conservation was .37. In the lower class group, the highest correlation was .41 between conservation and premeasurement. A correlation of .39 was found between reading growth and conservation.

Almy concluded the correlations suggest that a teacher's knowledge of a child's progress in conservation ability will be an aid in approaching instructional tasks. The indication was that the child's ability to conserve is relevant to tasks encountered in the classroom.[12]

An experimental study by Kellogg investigated the relationship of gains in reading readiness between two groups of first-grade pupils; the experimental group using the Science Curriculum Improvement Study first level unit, Material Objects, as a pre-reading program. The control group was exposed to readiness activities through the Harper and Row Reading Readiness Program. The two groups were matched on pre-reading readiness tests. Application of t tests investigated differences in the gains in mean score from the pre-test to the post-test on the Metropolitan Reading Readiness Test. The highest level of significance was found on the word meaning subtest, $.10 > p > .05$. The level of

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[12] Ibid., pp. 85-108.

significance for the difference on the total test was between .20 and .10.[13]

A previous study by Stafford investigated the difference in the rate of achievement of conservation between one group of first-grade children using the SCIS Material Objects and a control group who did not have that experience. The overall increase in conservations between the experimental and control groups was significant beyond the .01 level of confidence (Chi square), substantiating the hypothesis that there was a difference in rate of achievement of conservation in favor of the group receiving the Material Objects unit. This data also indicated the rate of attainment of conservation is positively related to intelligent quotients and readiness scores.[14]

Almy's study indicated that conservation is related to reading readiness; Stafford's study indicated that SCIS Material Objects increases the rate of conservation. Kellogg based his study on their premises and indicated that SCIS Material Objects unit aids the acquisition of readiness skills, especially in the area of word meaning. The preceding three studies indicated both comprehension and

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[13]Donald H. Kellogg, "An Investigation of the Effect of the Science Curriculum Improvement Study's First Year Unit, Material Objects, on Gains in Reading Readiness" (unpublished Ph.D. dissertation, University of Oklahoma, 1971), pp. 14-16.

[14]Donald Gene Stafford, "The Influence of the First Grade Program of the Science Curriculum Improvement Study on the Rate of Attainment of Conservation" (unpublished Ph.D. dissertation, University of Oklahoma, 1969), pp. 21, 53-57.

conservation are related to intellectual functioning. As yet no study has been found in the literature that investigates reading comprehension in relation to conservation.

A study of conservation abilities of pupils in the Norman Public Schools showed that of forty-eight children ranging in chronological age from 7.9 to 9.0, 91 per cent could conserve number, 85 per cent, solid; 75 per cent, liquid; 58 per cent, length; 60 per cent, area; 77 per cent, weight.[15] Area and length seemed to be the most difficult conservation tasks to attain for this age group.

Auditory Discrimination

Wepman's study investigated the relationship of auditory discrimination, articulation, and reading achievement of 156 first- and second-grade subjects.[16] The instruments used were the Auditory Discrimination Test, (Forms I and II), the Speech and Language Clinics' Articulation Test, the Chicago Reading Tests, and the Kuhlmann-Anderson Intelligence Tests. On the basis of the scores made on the articulation and auditory discrimination tests, eighty first-graders were divided into three groups: Group I was composed of children whose auditory discrimination and articulation were adequate for their age group. Group II included children whose

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[15]John W. Renner et al., "Piaget IS Practical," Science and Children, IX (October, 1971), 23-26.

[16]Joseph M. Wepman, "Auditory Discrimination, Speech, and Reading," The Elementary School Journal, LX (March, 1960), 329-332.

articulation was adequate but whose discrimination was inadequate. Group III was composed of children who were inadequate in both auditory discrimination and articulation for their age. Seventy-six second-graders were divided into three groups by the same criteria. A significant difference at the .02 level was found between Groups I and II, and Groups I and III in the first grade sample. In the second grade, a significant difference existed between the mean reading grade equivalent of Group I and Group II, and Group II and Group III at the .01 level. The second-grade subjects who were adequate in both discrimination and articulation had a higher mean reading grade equivalent than those adequate in articulation but inadequate in discrimination. However, these second-grade subjects who were adequate in neither articulation nor discrimination were significantly different from the non-discriminators but not significantly different from the group that was adequate in both. The low number of participants in Groups II and III might be an explanation.

The number of children inadequate in auditory discrimination decreased at the higher age level, which substantiates Wepman's contention that auditory discrimination is developmental in nature. He attributed the significant relationship between discrimination and reading in the lower grades to the fact that phonics is emphasized.

Wepman made some statements about auditory

discrimination based on clinical experience that facilitated the understanding of the development of auditory discrimination. He stated:

> Essential to the development of auditory discrimination is the ability to retain individual sounds in mind to serve as models for later speech and as part of the phonic act necessary for reading. Both discrimination and retention must reach a satisfactory level of development before the child can use them for accuracy in speaking or for word attack in reading. Fortunately, the two capacities, discrimination and retention, tend to develop simultaneously.[17]

Wepman believed that audition develops in this sequence: first, acuity, the ability to hear; second, understanding, the ability to extract meaning from aural stimuli; third, discrimination and retention, which are the abilities to differentiate each sound from others and hold them in mind long enough to make phonic comparisons. Individuals varied in the rate at which they moved through this developmental sequence. Some children did not develop the ability to make fine aural distinctions until seven or eight years of age.[18]

As one must hold the auditory image in mind to discriminate, one must hold the mental image of an object after the object has changed form in order to conserve.

Durrell and Murphy contended facile reading is accomplished by the child who is able to notice separate sounds in spoken words. Phonics, consisting of giving the

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[17]Wepman, "Auditory Discrimination," 326.

[18]Ibid., 327-329.

sounds of letters and blends, did not insure discrimination ability, nor did mental age. Ear training by teaching unfamiliar words had merit, as exemplified in the following studies at Boston University.

Murphy gave ten minutes of ear training daily for a period of six weeks to fifty children who were having difficulty learning to read. This group was matched on intelligence and learning rate with a control group. Learning rate was determined by the number of words retained by the subject an hour after teaching him seven unfamiliar words. At the end of the six weeks teaching period, the experimental group had increased in learning rate from 2.5 to 5.2, a gain of 2.7 words while the control group had moved from 2.5 to 3.5, a gain of 1 word.

Murphy followed with a more sophisticated study including 540 subjects equated for mental age, learning rate, speaking vocabulary, and auditory discrimination ability. The subjects were divided into four groups: Group I was given ten minutes of ear training daily; Group II was given ten minutes training daily in visual discrimination of letters and words; Group III was given a combination of ear training and visual discrimination; Group IV followed the exercises in the regular reading program. The teaching began in October and lasted for six weeks. The learning rate tests in September showed mean scores of 1.9 for all four groups. The learning rate scores for November and June showed

improvement for the four groups; however, increase in learning rate favored the experimental groups (Table 1). No preference was shown for the ear training group. An individual reading test, using the words of the reading system, given in February showed higher scores in word recognition for the combined auditory and visual group.[19]

TABLE 1

LEARNING RATE SCORES FOR FOUR GROUPS

	November	June
Group I	4.3	6.9
Group II	4.5	6.4
Group III	4.5	6.9
Group IV	2.6	4.3

Bresnahan found that ten phonograph records, teaching the child to identify sounds in spoken words, were effective only with groups of children who were very low in auditory analysis ability.[20] Barry's study of 891 children in the primary grades found correlations between auditory analysis ability and reading ability: a correlation of .56 between

[19]Donald D. Durrell and Helen A. Murphy, "The Auditory Discrimination Factor in Reading Readiness and Reading Disability," Education, LXXIII, No. 10 (June, 1953), 556-8.

[20]M. Marie Bresnahan, "Evaluation of Recordings for Teaching Auditory Discrimination of Word Elements for Beginning Reading," unpublished Ph.D. dissertation, Boston University, 1952. Cited by Durrell and Murphy, "The Auditory Discrimination Factor," p. 558.

auditory analysis and reading in grade one; .52 in grade two; and .52 in grade three.[21]

Lingren's study revealed significant findings between disabled and adequate readers in auditory discrimination ability. A group of twenty disabled readers were matched on intelligence quotient (90-110), sex, and chronological age (8-14) with a group of twenty normal readers. Each pair was matched within five IQ points and two months of age. Visual perception was measured by the Bender Motor Gestalt Test, using the developmental scoring system. Auditory discrimination was measured by performance on the Wepman Auditory Discrimination Test. Visual-motor matching was measured by subject's performance in matching ten sets of three by three inch blocks on which were painted parts of faces.

The differences in the two groups on the Bender Motor Gestalt Test was not significant ($p = .10$). No significant difference was found between the two groups in visual-motor matching and speed. A review of findings on form perception between normal and disabled readers pointed to the fact that differences occur in younger children for the most part. A statistically significant difference was found between the two groups in auditory discrimination ($p = .01$).[22]

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[21]Florence Barry et al., "Analysis of Auditory Function in Grades One, Two, and Three," unpublished group master's thesis, Boston University, 1951. Cited by Durrell and Murphy, "The Auditory Discrimination Factor," p. 559.

[22]Ronald H. Lingren, "Performance of Disabled and Normal Readers on the Bender-Gestalt, Auditory Discrimination

In investigating the relationships of auditory and visual functions of good and poor readers, Golden's and Steiner's study indicated poor readers were lacking in auditory rather than visual function. The sample consisted of twenty second-grade subjects matched on intelligence quotient, mental and chronological age. Ten pairs were formulated matching a good reader with a poor reader. The good reader was defined as one reading one year above mental age expectancy and the poor reader reading one year below mental age expectancy on measures of silent and oral reading. Auditory ability was measured by performance on three subtests of the Illinois Test of Psycholinguistic Abilities: Auditory Sequential Memory, Auditory Closure, and Sound Blending. Visual ability was measured by the Visual Sequential Memory and Visual Closure subtests of the Illinois Test of Psycholinguistic Abilities; and the Monroe Visualization Test. The latter test is comprised of two sections; Letter Memory and Form Memory. The two groups differed significantly on Letter Memory ($p < .02$), and Form Memory ($p < .01$) but did not differ significantly on Visual Closure or Visual Sequential Memory. Good readers were significantly different from poor readers on Sound Blending ($p < .01$) and Auditory Sequential Memory ($p < .05$). They differed in Auditory Closure at the

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Test, and Visual-Motor Matching," Perceptual and Motor Skills, XXIX (August, 1969), 152-154.

.10 significance level.[23]

Visual-Motor Development

Visual-motor development may be best approached by a definition of visual perception. Perception was defined as the "mental process by which the nature of an object is recognized through the association of a memory of its other qualities with the special sense, bringing it to consciousness."[24] Therefore, visual perception may be defined as the recognition of an object through the association of a memory of its other qualities through the sense of vision. The latter definition implied that individuals with better visual memories and more associations would have better visual perception.

Sensory, motor, and integrating divisions are functional divisions of the organization of the nervous system. The input or sensory division receives stimuli through the auditory, visual, tactual, olfactory, or gustatory. The output or motor function controls activities involving muscles and endocrine glands. The integrating or processing division performs between the sensory input and the motor

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[23]Nancy E. Golden and Sharon R. Steiner, "Auditory and Visual Functions in Good and Poor Readers," Journal of Learning Disabilities, II, No. 9 (September, 1969), 476-481.

[24]Isaac Asimov et al., ed., Stedman's Medical Dictionary (21st ed.; Baltimore: William and Wilkins Company, 1966), p. 1200.

output.[25] Visual-motor functioning can be described as the motor output elicited by the visual input. The importance of the knowledge of a child's visual-motor functioning lies in its revelation of what is perceived in the processing function. A pupil's response to visual stimuli through motor functioning, as in drawing the Bender figures, gives insight as to how he perceived the stimuli in the integrating function.

The physical act of seeing and the act of visual perception are two separate entities. Frostig wrote that the normal period of maximum visual perceptual development ranges from about 3 1/2 to 7 1/2 years of age. However, children lag in their development of visual perception for no specific reason. The lag may be due to emotional disturbance, neurological dysfunction, cultural deprivation, deafness, or lack of visual and verbal experiences.[26]

In order to read, a child must perceive shapes and patterns of words and letters, figure-ground relationships and organizations of configurations. A certain degree of visual-motor perception is necessary before beginning reading. A descriptive study by Koppitz pointed out relationships between visual-motor functioning, reading, and

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[25]Ebersole, Kephart, and Ebersole, Steps to Achievement, p. 31.

[26]Marianne Frostig, Ann-Marie Miller; and David Horne, The Developmental Program in Visual Perception, Beginning Pictures and Patterns, Teacher's Guide (New York: Follett Educational Corporation, 1966), p. 6.

arithmetic. This investigation was designed to discover whether any particular deviation on the Bender Motor Gestalt was related to deficiencies in reading or arithmetic. The subjects in the study were first- and second-grade pupils divided into four groups. One hundred seventy-four test profiles were evaluated, however several subjects were in more than one group. Each group was dichotomized into high or low achievers on reading or arithmetic. The Bender protocols, given earlier, were examined to determine whether any difference existed among the groups with respect to performance on the Bender Motor Gestalt. Group I included 45 subjects who were given the Bender at the beginning of the first-grade. At the end of the third-grade, the reading subtest on the Metropolitan Achievement Test showed that 29 of the subjects were reading at 5.3 or higher grade level and 16 were reading 3.5 grade level or less. Group II included 29 subjects administered the Bender at the beginning of the first-grade. At the end of the third-grade, 16 achieved 4.6 arithmetic level on the Metropolitan Achievement Test and 13 achieved 3.6 or below. Group III consisted of 49 subjects given the Bender at the beginning of the second grade. At the end of the second grade, 28 achieved 4.0 reading level or above on the Metropolitan Achievement Test and 21 achieved 2.3 grade level or below. Group IV consisted of 51 subjects administered the Bender at the beginning of the second-grade. At the end of the

second-grade 29 subjects were 3.6 or above on the arithmetic subtest of the Metropolitan Achievement Test and 22 attained an arithmetic grade level of 2.3 or less. Differences in the high and low achievers in scores below and above the norm of their age group on the Bender, were computed by the use of Chi square. A significant difference was found between the high and low reading groups on their performance on Bender scores at less than the .01 level for Group I; at less than the .001 level of confidence for Group III. Significant differences were also found in arithmetic achievement for Groups II and IV at the .01 and .001 levels respectively. Out of the 47 subjects with above norm Bender scores in Groups I and III, 40 showed outstanding reading improvement. Koppitz found that the total Bender score was more closely related to reading and number achievement than any single scoring item; and also that the total Bender score was more closely related to arithmetic than to reading.[27]

A study by Koppitz et al. was conducted with 145 first-grade pupils from six classrooms in five different schools in 1959. A correlation of .54, significant at the .001 level, was found between the first-grade Bender and the first-grade reading achievement as measured by the

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[27]Koppitz, The Bender Gestalt Test For Young Children, pp. 61-63.

Metropolitan Achievement Test.[28] A longitudinal study (Sullivan and Blyth, 1961), using as many of the original subject population as possible, showed a correlation of .54, significant at the .001 level between the first-grade Bender and the third-grade total achievement on the Metropolitan Achievement Test.[29]

The preceding review of selected research gave impetus to the following investigation concerning the relationship of reading comprehension to conservation ability, auditory discrimination, and visual-motor functioning.

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[28] Ibid., p. 58.

[29] J. Sullivan and D. Blyth, "Prediction of Later Achievement Patterns from Earlier Administration of the Bender Gestalt Test." Unpublished manuscript cited by Koppitz, The Bender Gestalt Test, p. 58.

CHAPTER III

METHODOLOGY

Subject Selection

From the ten participating schools, the following six schools were chosen randomly from the Midwest City-Del City Elementary Public Schools: Cleveland Bailey, Country Estates, Ridgecrest, Sooner-Rose, Steed, and Traub. Five-hundred-ten subjects were available using the total third-grade population of each of the identified schools.

The rationale of choosing third-grade pupils for this study was as follows:

1) third-grade pupils have been exposed to auditory discrimination practices which preceded decoding in the developmental reading, language-arts program.

2) third-grade pupils have been exposed to visual perception and visual-motor techniques in the developmental reading, language-arts program.

3) third-grade pupils, being approximately eight years old, generally fell into the concrete operational stage of intellectual development and should be able to conserve. Though Piaget did not specify that certain ages accompany

stages, he indicated that the onset of the concrete operational stage occurred at approximately six or seven years and extended to a point between eleven and thirteen years.[1]

4) differences in high and low reading comprehension levels needed to be examined in third-grade pupils before the transition into more complex reading skills in the content areas which are introduced in the intermediate grades.[2]

Procedure of Subject Selection and Data Collection

The Gates-MacGinitie Reading Tests, Primary C, Form 1 comprehension subtest was administered by school testing personnel to the 510 subjects. The population was categorized into a high reading comprehension group, composed of pupils reading on and above 4.9 grade score on the comprehension subtest; and a low reading comprehension group composed of pupils falling on and below 1.9 grade score on the comprehension subtest. Those pupils in the normal range, 2.0 to 4.8, according to the grade level norms of the Gates-MacGinitie Reading Tests, subtest comprehension, were arbitrarily omitted, the rationale being that extreme ends of the curve revealed more definitive differences. The random sample of extreme scores, 18 per cent low reading comprehension group and 16 per cent high reading comprehension

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[1]Hans G. Furth, Piaget for Teachers (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970), p. 33.

[2]Heilman, Principles and Practices, p. 419.

group reduced the number of subjects to 179 of the original 510.

Pupils in either group who were not in the average or above range of intelligence were omitted. Average or above intelligence range was determined by reading comprehension level in the high reading comprehension group, as Gates-MacGinitie Reading Tests comprehension subtest for the fourth-grade correlates .60 with the Lorge-Thorndike Intelligence Test.[3] The Slosson Intelligence Test was administered to the low reading comprehension group in order to control low intelligence scores as a factor in poor comprehension.

Conservation tasks, The Bender Gestalt Test for Young Children, and the Wepman Auditory Discrimination Test, Form 1, were administered individually. Testing personnel included five examiners experienced in individual testing. Three training sessions were held on the presentation of the six conservation tasks. The last two sessions were held at Irving Middle School, where the examiners actually presented the tasks to students. Uniform procedure was followed in the presentation of the tasks.[4]

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[3]Arthur I. Gates and Walter H. MacGinitie, Technical Manual, Gates-MacGinitie Reading Tests (Teachers College, Columbia University, New York: Teachers College Press, 1965), p. 8.

[4]Renner, Bibens, and Shepherd, Guiding Learning in the Secondary School, pp. 95-100.

School nurses were interviewed for the purpose of omitting pupils who fell outside the normal range of hearing, as they could not discriminate auditorily. Screening was done from September to mid-November, 1972 with the Beltone Audiometer. If the pupil's threshold was above 30 decibels in frequencies 250-4000, he was excluded. The above criteria was established by the school system for referral. Conferences were held with school nurses in order to omit pupils outside the normal range of vision without correction. The instrument used for vision screening was the Titmus Vision Tester. Pupils were excluded whose vision was less than 20/40 at either near or far point in each eye, or who showed below average balance and fusion at either near or far point.[5]

Pupils were excluded who were outside the chronological age range, 7.10--9.0, so that subjects would be nearer in age range and years in school. After exclusions were made for intelligence in the low reading comprehension group; vision, hearing, and age range in the total group, 135 subjects remained. Thirty-seven boys and 48 girls remained in the high reading comprehension group; 24 boys and 25 girls remained in the low reading comprehension group. The groups were equated as to number from each sex by random selection. Therefore, 24 remained in each group, making the total

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[5]Titmus School Vision Tester Reference Manual (Boston, Massachusetts: Titmus Optical Company, Inc., 1958, rev., 1971), p. 10.

population 96 subjects.

Scores on the Slosson Intelligence Tests, Wepman Auditory Discrimination Tests, and conservation tasks were rechecked for accuracy. The Bender Motor Gestalt Tests, using the developmental Bender scoring system, were checked separately by three certified psychometrists. The examiners met together to recheck Bender protocols until examiner agreement (two out of three) was reached on each discrepant score.

Description of Instruments

The Slosson Intelligence Test is an individual screening instrument for both children and adults to evaluate the subject's mental ability. A reliability coefficient of .97 (test-retest interval within a period of two months) was obtained on 139 individuals from age 4 to 50 years. The standard error of measurement was found to be 4.3. The concurrent validity was indicated by high correlations with the Stanford-Binet Intelligence Scale Form L-M: $r = .98$ at age 7; $r = .94$ at age 8; $r = .97$ at age 9.[6]

The Gates-MacGinitie Reading Tests, Primary C, Form 1, comprehension subtest measures the ability to read and understand whole sentences and paragraphs. The test contains twenty-four paragraphs of increasing length and

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[6]Richard L. Slosson, Slosson Intelligence Test (SIT) for Children and Adults (East Aurora, New York: Slosson Educational Publications, 1963), v.

difficulty followed by two questions with four alternative answers. The reliability coefficients for Primary C, comprehension subtest was .87 alternate form reliability; .91 split-half reliability.[7] Validity was achieved by establishing norms by the administration of tests to a nationwide sample of approximately 40,000 pupils in 38 communities.[8]

The Wepman Auditory Discrimination Test measures the child's recognition ability of fine differences between the phonemes used in English speech. The examiner reads pairs of words and the child indicates whether the words read are the same or different. The word pairs selected were matched for familiarity by selecting words as close together as possible from The Teacher's Word Book of 30,000 Words.[9] As auditory discrimination is developmental, error scores have different meanings for different ages. Children eight years of age and older are considered inadequate discriminators when they make more than three errors on X scores (those made when the subject indicates the two different words pronounced by the examiner are the same). Validity of the test is evaluated by the Y scores, which are made when the subject

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[7]Gates and MacGinitic, Technical Manual, p. 8.

[8]Ibid., p. 2.

[9]Edward L. Thorndike and Irving Lorge, The Teacher's Word Book of 30,000 Words (Teachers College, Columbia University, New York: Bureau of Publications, 1944), pp. 1-274.

indicates "same" when the same word is said twice by the examiner.

Test-retest administration showed a reliability of .91 (N = 109). The difficulty of each phoneme on the two forms showed a rank-order correlation of .67 (n = 124).

Validity of the test was established by five studies, four of which related to reading.[10] DiCarlo stated that studies suggested relationships between auditory discrimination and intelligence, hearing, speaking, and reading; but they did not necessarily support the validity of the test.[11]

The Bender Gestalt Test for Young Children (also called The Bender Motor Gestalt Test), evaluates the subject's perceptual maturity, possible neurological impairment, and emotional adjustment. The present concern was the evaluation of the child's visual perception as determined by his visual-motor functioning. The child is presented nine cards with nine figures which he reproduces. The figure reproductions are evaluated by the developmental Bender scoring system and a composite score is received which can be translated into a visual-motor age and visual-motor development score. Score points are given on deviations from the norm so that the higher the score attained the lower the visual-motor age and visual-motor development score. When the child's score

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[10]Wepman, Auditory Discrimination Test, Manual, p. 2.

[11]Oscar K. Buros, ed., The Sixth Mental Measurements Yearbook (Highland Park, New Jersey: Gryphon, 1965), p. 1023.

falls in the second standard deviation below the mean of his age group, perceptual difficulty is indicated.

On the initial developmental scoring system, scorer reliability among five experienced examiners correlated significantly between .88 and .96 (Pearson R). The test-retest method after a four month interval furnished significant correlations at the .001 level, from .547 to .659 (Kendall's Tau) on two kindergarten and two first grade classes.[12]

The validity for the present scoring system was achieved by establishing norms based on scores of 1104 public school children from twelve different schools in rural, urban, suburban, and small town settings in the Mideast and Eastern states. The ages ranged from 5-0 to 10-11.[13]

Conservation tasks measure the child's ability to hold a mental image of the original form, or the ability to conserve. His ability to conserve or not is measured by his performance on each of the six tasks: number, liquid, solids, area, length, and weight. The suggestion was made from experience that conservation of number precedes conservation of liquid and the remaining four follow no specific pattern.[14] Reliability and validity of the tasks as a measure of cognitive level have not been established. Rationale for the tasks was based on Piaget's model of cognitive development

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[12]Koppitz, The Bender Gestalt Test, pp. 12-14.

[13]Ibid., pp. 33, 188.

[14]Renner, Bibens, Shepherd, Guiding Learning, p. 101.

which emanated from years of detailed clinical observation of children of all ages. Recent research has been reported on the stages of development of college freshmen. Performance on the formal operational tasks revealed that 78 out of 131 entering college freshmen at the University of Oklahoma were on the concrete operational level of cognitive functioning.[15] An improvement in conservation abilities was noted in first-grade pupils after materials of Science Curriculum Improvement Study were used. Differences in performance on the conservation tasks between experimental and control groups were significant. Performance on each of the six conservation tasks was used as a pretest and posttest measure for both groups. Substantiating the previous suggestion by Renner, the highest number of subjects conserved on number in both pre- and post-testing for both groups.[16] No hierarchy or equivalence of tasks has been established by research; nor has it been determined which task or tasks develop in conjunction with or precede reading comprehension.

Treatment of Data

The Chi square test of independence with Yates'

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[15]Joe W. McKinnon, "The Influence of a College Inquiry-Centered Course in Science on Student Entry into the Formal Operational Stage" (unpublished Ph.D. dissertation, University of Oklahoma, 1970), p. 33.

[16]Don G. Stafford, and John W. Renner, "SCIS Helps the First Grade to Use Logic in Problem Solving," School Science and Mathematics (February, 1971), p. 162.

correction for continuity[17] was used to determine whether or not statistically significant differences existed between the high and low reading comprehension groups in conservation ability, auditory discrimination, and visual-motor development. Whether statistically significant differences existed between male and female subjects on those variables were also investigated.

High and low auditory discrimination classifications were determined by Wepman's criteria which designated scores 28 and above as those of discriminators and those subjects scoring below 28 as non-discriminators for a chronological age of 8 or older. The median of the groups was 27.6 which set the division of the groups between 27 and 28 and was commensurate with Wepman's criteria.[18]

High and low visual-motor development was determined by division at the median of the groups, which was 3.3. Koppitz norms for third grade showed a mean of 2.2, with a standard deviation of 2.03.[19] A subject with a score of 3,2,1,0, was classified as high in visual-motor development; a score of 4 or higher placed the subject in the low classification of visual-motor development.

High, medium, and low classifications of conservation

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[17]N. M. Downie and R. W. Heath, Basic Statistical Methods (2nd ed.; New York: Harper and Row, 1965), p. 166.

[18]Wepman, Auditory Discrimination Test Manual, p. 3.

[19]Koppitz, The Bender Gestalt Test, p. 188.

tasks were arbitrarily set. High was interpreted to mean the subject successfully performed five or six conservation tasks. Medium indicated the subject performed successfully three or four tasks. Low classification included those subjects who had performed one, two, or none of the conservation tasks. However, since the expected frequencies in the medium and low classifications were too small to meet the requirements of a 2-by-3 contingency table,[20] medium and low classifications were combined. The combination of the adjacent cells resulted in a 2-by-2 contingency table with high conservers being those subjects conserving on five or six tasks, and medium-low classification including subjects conserving on four tasks or less.

The relationship of reading comprehension scores and sex to conservation ability levels, auditory discrimination scores, and visual-motor development scores was investigated by the use of the Kendall rank correlation coefficient, τ, (tau). Tau coefficients were converted to z scores to determine levels of significance.[21] The alpha level was set at .05 for testing the significance of the hypotheses.

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[20]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill Book Company, 1956), p. 110.

[21]Ibid., p. 221.

CHAPTER IV

ANALYSIS OF DATA

The first general hypothesis stated no significant differences exist on measures of the three variables, conservation ability, auditory discrimination, and visual-motor development among third-grade subjects classified by sex and reading comprehension levels. This hypothesis was inclusive of null hypotheses, Ho_1 through Ho_6 and their sub-hypotheses, with the significance determined at the .05 confidence level. Chi square with Yates' correction was applied to test the hypotheses. Application of Yates' correction for continuity was needed when expected frequencies were less than ten; some writers advised its use regardless of sample size.[1]

Ho_1 stated no significant statistical differences exist between the number of subjects in the high reading comprehension group and the number of subjects in the low reading comprehension group on two classifications of measure of conservation ability, auditory discrimination, and visual-motor development.

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[1]Downie and Heath, Basic Statistical Methods, p. 166.

Ho_1a stated that no statistically significant difference exists between the number of subjects in the high reading comprehension group and the number of subjects in the low reading comprehension group on high and medium-low classifications of conservation ability as measured by performance on six conservation tasks. No subjects in the high reading comprehension group fell into low classification in conservation. Medium and low cells were combined in the low reading comprehension group for statistical computation. The Chi square value was 1.709, $p < .20$. Since a $\underline{X}^2$ value of 3.84 was required for the .05 level of significance with one degree of freedom, Ho_1a was not rejected. The interpretation was that there is no statistically significant difference between the high reading comprehension group and the low reading comprehension group on conservation ability (Table 2).

TABLE 2

COMPARISON OF READING COMPREHENSION GROUPS ON CONSERVATION ABILITY

Group	Conservation Ability	
	High	Medium-low
High Reading Comprehension	42	6
Low Reading Comprehension	36	12

$\underline{X}^2 = 1.709$; df = 1; $p < .20$

Ho_1b stated that no statistically significant differences exist between the high reading comprehension group and the low reading comprehension group on high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test. Treatment of the data yielded a $\underline{X}^2$ value of .669, $p < .70$. Ho_1b was accepted and interpreted to mean that no significant differences exist between the high reading comprehension group and the low reading comprehension group on auditory discrimination (Table 3).

TABLE 3

COMPARISON OF READING COMPREHENSION GROUPS ON AUDITORY DISCRIMINATION

	Auditory Discrimination	
Group	High	Low
High Reading Comprehension	28	20
Low Reading Comprehension	23	25
$\underline{X}^2 = .669$; df = 1; $p < .70$		

Ho_1c stated no significant difference existed between the number of subjects in the high reading comprehension group and the number of subjects in the low reading comprehension group on high and low classifications of visual-motor development as measured by the Bender Gestalt Test. The $\underline{X}^2$ value was 9.391, $p < .01$. Ho_1c was rejected and interpreted to mean there is a significant difference

between the high reading comprehension group and the low reading comprehension group on visual-motor development (Table 4).

TABLE 4

COMPARISON OF READING COMPREHENSION GROUPS ON VISUAL-MOTOR DEVELOPMENT

	Visual-Motor Development	
Group	High	Low
High Reading Comprehension	33	15
Low Reading Comprehension	17	31

$\underline{X}^2 = 9.391$; df = 1; $p < .01$

The acceptance of two of the three sub-hypotheses of Ho_1 and the rejection of null hypothesis Ho_1c, led to a partial rejection of Ho_1. The interpretation followed that no significant differences exist between the high reading comprehension group and the low reading comprehension group on measures of conservation ability, and auditory discrimination; however a significant difference exists between the two groups in visual-motor development (Table 5).

Ho_2 stated no statistically significant differences exist between the number of male subjects and the number of female subjects on two classifications of measures of conservation ability, auditory discrimination, and visual-motor development. Ho_2a stated no statistically significant

differences exists between the number of male subjects and the number of female subjects in high and medium-low classifications of conservation ability as measured by performance on six conservation tasks. The same number of female subjects as male subjects fell into each classification, yielding a $\underline{X}^2$ value of 0, $p < .99$, which led to acceptance of null hypothesis Ho_2a. The inference was drawn that there is no significant difference between male subjects and female subjects in measures of conservation ability (Table 6).

TABLE 5

SUMMARY OF COMPARISONS OF READING COMPREHENSION GROUPS ON CONSERVATION ABILITY, AUDITORY DISCRIMINATION AND VISUAL-MOTOR DEVELOPMENT

Group	Conservation Ability		Auditory Discrimination		Visual-Motor Development	
	High	Medium-Low	High	Low	High	Low
High Reading Comprehension	42	6	28	20	33	15
Low Reading Comprehension	36	12	23	25	17	31
$\underline{X}^2$	1.709		.669		9.391	
df	1		1		1	
p	<.20		<.50		<.01	

Ho_2b stated no statistically significant difference exists between the number of male subjects and the number of female subjects in high and low classifications of auditory

TABLE 6

COMPARISON OF MALE AND FEMALE SUBJECTS ON CONSERVATION ABILITY

Group	Conservation Ability	
	High	Medium-low
Males	39	9
Females	39	9

$\underline{X}^2 = 0$; df = 1; $p < .99$

discrimination as measured by the Wepman Auditory Discrimination Test. The $\underline{X}^2$ value of .167, $p < .70$, led to acceptance of null hypothesis Ho_2b. The interpretation was that no significant difference exists between male and female subjects in auditory discrimination (Table 7).

TABLE 7

COMPARISON OF MALE AND FEMALE SUBJECTS OF AUDITORY DISCRIMINATION

Group	Auditory Discrimination	
	High	Low
Males	27	21
Females	24	24

$\underline{X}^2 = .167$; df = 1; $p < .70$

Ho_2c stated that no statistically significant difference exists between male subjects and female subjects in

high and low classifications of visual-motor development as measured by the Bender Gestalt Test. Chi square was .376, $p < .70$, which led to the acceptance of null hypothesis Ho_2c. The interpretation was that no significant difference exists between male and female subjects in visual-motor development (Table 8).

TABLE 8

COMPARISON OF MALE AND FEMALE SUBJECTS ON VISUAL-MOTOR DEVELOPMENT

Group	Visual-Motor Development	
	High	Low
Males	23	25
Females	27	21

$\underline{X}^2 = .376$; df = 1; $p < .70$

Null hypothesis 2 must be accepted and interpreted to mean no significant differences exist between male and female subjects in measures of conservation ability, auditory discrimination, and visual-motor development (Table 9).

Null hypothesis 3 stated no statistically significant differences exist between the number of male subjects in the high reading comprehension group and the number of female subjects in the high reading comprehension group on two classifications of measures of conservation ability, auditory discrimination, and visual-motor development. Ho_3a stated

TABLE 9

SUMMARY OF COMPARISONS OF MALE AND FEMALE SUBJECTS ON CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT

Group	Conservation Ability		Auditory Discrimination		Visual-Motor Development	
	High	Medium-low	High	Low	High	Low
Males	39	9	27	21	23	25
Females	39	9	24	24	27	21
$\underline{X}^2$	0		.167		.376	
df	1		1		1	
p	<.99		<.70		<.70	

no statistically significant difference exists between the number of male subjects in the high reading comprehension group and the number of female subjects in the high reading comprehension group in high and medium classifications of conservation ability as measured by performance on six conservation tasks. No low classification was included as no subject in the high reading comprehension group conserved on less than three tasks. The Chi square value with Yates' correction was 1.714, $p < .20$. Ho_3a was accepted and interpreted to mean there is no significant difference between male subjects in the high reading comprehension group and female subjects in the high reading comprehension group in measures

of conservation ability (Table 10).

TABLE 10

COMPARISON OF HIGH READING COMPREHENSION MALE AND FEMALE SUBJECTS ON CONSERVATION ABILITY

High Reading Comprehension Group	Conservation Ability	
	High	Medium
Males	19	5
Females	23	1
$\underline{X}^2 = 1.714$; df = 1; $p < .20$		

Ho_3b stated no statistically significant difference exists between the number of male subjects in the high reading comprehension group and the number of female subjects in the high reading comprehension group in high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test. Chi square value was .086, $p < .80$, which led to the acceptance of Ho_3b. The interpretation was that no significance difference exists between male subjects in the high reading comprehension group and female subjects in the high reading comprehension group in auditory discrimination (Table 11).

Ho_3c stated no statistically significant difference exists between the number of male subjects in the high reading comprehension group and the number of female subjects in the high reading comprehension group in high and low

TABLE 11

COMPARISON OF HIGH READING COMPREHENSION MALE AND FEMALE SUBJECTS ON AUDITORY DISCRIMINATION

High Reading Comprehension Group	Auditory Discrimination	
	High	Low
Males	13	11
Females	15	9
$\underline{X}^2 = .086$; df = 1; $p < .80$		

classifications of visual-motor development as measured by the Bender Gestalt Test. Chi square was .388 with $p < .70$, which led to the acceptance of Ho_3c and was interpreted to mean that no significant difference exists between male subjects in the high reading comprehension group and female subjects in the high reading comprehension group in visual-motor development (Table 12).

TABLE 12

COMPARISON OF HIGH READING COMPREHENSION MALE AND FEMALE SUBJECTS ON VISUAL-MOTOR DEVELOPMENT

High Reading Comprehension Group	Visual Motor Development	
	High	Low
Males	15	9
Females	18	6
$\underline{X}^2 = .388$; df = 1; $p < .70$		

The acceptance of the three preceding sub-hypotheses led to the acceptance of null hypothesis 3 that there are no significant differences between the number of male subjects in the high reading comprehension group and the number of female subjects in the high reading comprehension group in measures of conservation ability, auditory discrimination, and visual-motor development (Table 13).

TABLE 13

SUMMARY OF COMPARISONS OF HIGH READING COMPREHENSION MALE AND FEMALE SUBJECTS ON CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT

High Reading Comprehension Group	Conservation Ability		Auditory Discrimination		Visual-Motor Development	
	High	Low	High	Low	High	Low
Males	19	5	13	11	15	9
Females	23	1	15	9	18	6
$\underline{X}^2$	1.714		.086		.388	
df	1		1		1	
p	<.20		<.80		<.70	

Null hypothesis 4 stated there are no statistically significant differences between the number of male subjects in the low reading comprehension group and the number of female subjects in the low reading comprehension group on two classifications of measures of conservation ability,

auditory discrimination, and visual-motor development. Ho_4a stated there is no statistically significant difference between the number of male subjects in the low reading comprehension group and the number of female subjects in the low reading comprehension group in high and medium-low classifications of conservation ability as measured by performance on six conservation tasks. Chi square was 1.000, $p < .50$, which led to the acceptance of Ho_4a. The interpretation followed that no significant difference exists between the two groups on conservation ability (Table 14).

TABLE 14

COMPARISON OF LOW READING COMPREHENSION MALE AND FEMALE SUBJECTS ON CONSERVATION ABILITY

Low Reading Comprehension Group	Conservation Ability	
	High	Low
Males	20	4
Females	16	8
$\underline{X}^2 = 1.000$; df = 1; $p < .50$		

Ho_4b stated no statistically significant difference exists between the number of male subjects in the low reading comprehension group and the number of female subjects in the low reading comprehension in high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test. Chi square was 1.336, $p < .30$.

Therefore, Ho_4b was accepted and interpreted to mean no significant difference exists between the two groups in measures of auditory discrimination (Table 15).

TABLE 15

COMPARISON OF LOW READING COMPREHENSION MALE AND FEMALE SUBJECTS ON AUDITORY DISCRIMINATION

Low Reading Comprehension Group	Auditory Discrimination	
	High	Low
Males	14	10
Females	9	15
$\underline{X}^2 = 1.336$; df = 1; $p < .30$		

Ho_4c stated there is no statistically significant difference between the number of male and female subjects in the low reading comprehension group in high and low classifications of visual-motor development as measured by the Bender Gestalt Test. Chi square was 0, $p < .99$. Therefore, Ho_4c was accepted and interpreted to mean no significant difference exists between male and female subjects in the low reading comprehension group in visual-motor development (Table 16).

Acceptance of the preceding null sub-hypotheses led to the acceptance of null hypothesis 4 that there are no statistically significant differences between male subjects in the low reading comprehension group and female subjects

in the low reading comprehension group on measures of visual-motor development (Table 17).

TABLE 16

COMPARISON OF LOW READING COMPREHENSION MALE AND FEMALE SUBJECTS ON VISUAL-MOTOR DEVELOPMENT

Low Reading Comprehension Group	Visual-Motor Development	
	High	Low
Males	8	16
Females	9	15
$\underline{X}^2 = 0$; df = 1; $p < .99$		

TABLE 17

SUMMARY OF COMPARISONS OF LOW READING COMPREHENSION MALE AND FEMALE SUBJECTS ON CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT

Low Reading Comprehension Group	Conservation Ability		Auditory Discrimination		Visual-Motor Development	
	High	Low	High	Low	High	Low
Males	20	4	14	10	8	16
Females	16	8	9	15	9	15
$\underline{X}^2$	1.000		1.336		0	
df	1		1		1	
p	<.50		<.30		<.99	

Null hypothesis 5 stated no statistically significant differences exist between male subjects in the high reading comprehension group and male subjects in the low reading comprehension group on two classifications of measures of conservation ability, auditory discrimination, and visual-motor development. Ho_5a stated no statistically significant difference exists between the number of male subjects in the high reading comprehension group and the number of male subjects in the low reading comprehension group on high and medium-low classifications of conservation ability as measured by performance on six conservation tasks. Chi square for the data was 0, $p < .99$, which led to the acceptance of Ho_5a and was interpreted to mean no significant difference exists between the two groups on measures of conservation ability (Table 18).

TABLE 18

COMPARISON OF HIGH AND LOW READING COMPREHENSION MALE SUBJECTS ON CONSERVATION ABILITY

Group	Conservation Ability	
	High	Medium-low
High Reading Comprehension Males	19	5
Low Reading Comprehension Males	20	4

$\underline{X}^2 = 0$; df = 1; $p < .99$

Ho_5b stated no significant difference exists between the number of male subjects in the high reading comprehension group and the number of male subjects in the low reading comprehension group in high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test. Chi square value was 0, $p < .99$, which led to the acceptance of Ho_5b and was interpreted to mean no significant difference exists between the two groups in measures of auditory discrimination (Table 19).

TABLE 19

COMPARISON OF HIGH AND LOW READING COMPREHENSION MALE SUBJECTS ON AUDITORY DISCRIMINATION

Group	Auditory Discrimination	
	High	Low
High Reading Comprehension Males	13	11
Low Reading Comprehension Males	14	10

$\underline{X}^2 = 0$; df = 1; $p < .99$

Ho_5c stated that no significant difference exists between the number of male subjects in the high reading comprehension group and the number of male subjects in the low reading comprehension group in two classifications of visual-motor development as measured by the Bender Gestalt Test. Chi square value was 3.005, $p < .10$. Therefore, Ho_5c must be accepted and interpreted to mean no significant difference

exists between the two groups in measures of visual-motor development (Table 20).

TABLE 20

COMPARISON OF HIGH AND LOW READING COMPREHENSION MALE SUBJECTS ON VISUAL-MOTOR DEVELOPMENT

	Visual-Motor Development	
Group	High	Low
High Reading Comprehension Males	15	9
Low Reading Comprehension Males	8	16
$\underline{X}^2 = 3.005$; df = 1; $p < .10$		

With the acceptance of the three preceding null sub-hypotheses, null hypothesis 5 that no statistically significant differences exist between male subjects in the high reading comprehension group and male subjects in the low reading comprehension group on measures of visual-motor development, must be accepted (Table 21).

Null hypothesis 6 stated there are no statistically significant differences between the number of female subjects in the high reading comprehension group and the number of female subjects in the low reading comprehension group on two classifications of measures of conservation ability, auditory discrimination, and visual-motor development. Ho_6a stated there is no statistically significant difference between the number of female subjects in the high reading

TABLE 21

SUMMARY OF COMPARISONS OF HIGH AND LOW READING COMPREHENSION MALE SUBJECTS ON CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT

Group	Conservation Ability		Auditory Discrimination		Visual-Motor Development	
	High	Medium-Low	High	Low	High	Low
High Reading Comprehension Males	19	5	13	11	15	9
Low Reading Comprehension Males	20	4	14	10	8	16
$\underline{X}^2$	0		0		3.005	
df	1		1		1	
p	<.99		<.99		<.10	

comprehension group and the number of female subjects in the low reading comprehension group in high and medium-low classifications of conservation ability as measured by performance on six conservation tasks. Chi square value for the data was 4.923, $p < .05$. Chi square value for rejection of the null hypothesis at the .05 level was 3.84. Therefore Ho_6a was rejected and interpreted to mean that a statistically significant difference exists between the number of female subjects in the high reading comprehension group and the number of female subjects in the low reading

comprehension group in high and medium-low classifications of measures of conservation ability (Table 22).

TABLE 22

COMPARISON OF HIGH AND LOW READING COMPREHENSION FEMALE SUBJECTS ON CONSERVATION ABILITY

Group	Conservation Ability	
	High	Medium-low
High Reading Comprehension Females	23	1
Low Reading Comprehension Females	16	8

$\underline{X}^2 = 4.923$; df = 1; $p < .05$

Ho_6b stated no statistically significant difference exists between the number of female subjects in the high reading comprehension group and the number of female subjects in the low reading comprehension on high and low classifications of auditory discrimination as measured by the Wepman Auditory Discrimination Test. Chi square was 2.083, $p < .20$, which led to an acceptance of null hypothesis, Ho_6b, that no statistically significant difference exists between the number of female subjects in the high reading comprehension group and the number of female subjects in the low reading comprehension group on high and low classifications of measures of auditory discrimination (Table 23).

Ho_6c stated that no statistically significant difference exists between the number of female subjects in the

TABLE 23

COMPARISON OF HIGH AND LOW READING COMPREHENSION FEMALE SUBJECTS ON AUDITORY DISCRIMINATION

	Auditory Discrimination	
Group	High	Low
High Reading Comprehension Females	15	9
Low Reading Comprehension Females	9	15
$\underline{X}^2 = 2.083$; df = 1; $p < .20$		

high reading comprehension group and the number of female subjects in the low reading comprehension group on high and low classifications of visual-motor development as measured by the Bender Gestalt Test. Chi square for the data was 5.418, $p < .02$. Therefore Ho_6c was rejected and the inference made that a significant difference exists between the two groups in visual-motor development (Table 24).

TABLE 24

COMPARISON OF HIGH AND LOW COMPREHENSION FEMALE SUBJECTS ON VISUAL-MOTOR DEVELOPMENT

	Visual-Motor Development	
Group	High	Low
High Reading Comprehension Females	18	6
Low Reading Comprehension Females	9	15
$\underline{X}^2 = 5.418$; df = 1; $p < .02$		

Rejection of null sub-hypotheses Ho_6a and Ho_6c and acceptance of null sub-hypothesis Ho_6b, led to the partial rejection of Ho_6. The conclusions drawn were that there is no statistically significant difference between female subjects in the high reading comprehension group and female subjects in the low reading comprehension group in measures of auditory discrimination but there are statistically significant differences in the two groups in measures of conservation ability and visual-motor development (Table 25).

TABLE 25

SUMMARY OF COMPARISONS OF HIGH AND LOW COMPREHENSION FEMALE SUBJECTS ON CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT

Group	Conservation Ability		Auditory Discrimination		Visual-Motor Development	
	High	Low	High	Low	High	Low
High Reading Comprehension Females	23	1	15	9	18	6
Low Reading Comprehension Females	16	8	9	15	9	15
$\underline{X}^2$	4.923		2.083		5.417	
df	1		1		1	
p	$<.05$		$<.20$		$<.02$	

Chi square tests made for the investigation of differences for null hypotheses 1 through 6 revealed three significant differences. A statistically significant difference existed between the high and low reading comprehension groups on visual-motor development. Also, statistically significant differences were revealed between high and low reading comprehension female subjects on visual-motor development and conservation ability (Table 26).

The second general hypothesis stated that no statistically significant relationships exist between reading comprehension and conservation ability, auditory discrimination, and visual-motor development among third-grade subjects classified by sex and reading comprehension levels. Kendall rank correlation coefficient, Tau, τ, was used to investigate relationships. Tau coefficients were converted to z-scores to determine the significance levels.

Null hypothesis 7 stated no statistically significant relationships exist between reading comprehension scores and conservation ability levels of male and female subjects in the high and low reading comprehension groups. Ho_7a stated no statistically significant relationship exists between reading comprehension scores and conservation ability levels of male and female subjects in the high and low reading comprehension groups. The Tau coefficient value of .18486 converted to a z-score of 2.67, $p = .0076$. Ho_7a was rejected and interpreted to mean there is a statistically significant

TABLE 26

SUMMARY OF COMPARISONS OF GROUPS ON CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT

Group	Conservation Ability		Auditory Discrimination		Visual-Motor Development	
	$\underline{X}^2$	p	$\underline{X}^2$	p	$\underline{X}^2$	p
High Reading Comprehension and Low Reading Comprehension	1.709	<.20	.669	<.50	9.391	<.01**
Males and Females	0	<.99	.167	<.70	.376	<.70
High Reading Comprehension Males and High Reading Comprehension Females	1.714	<.20	.086	<.80	.388	<.70
Low Reading Comprehension Males and Low Reading Comprehension Females	1.000	<.50	1.336	<.30	0	<.99
High Reading Comprehension Males and Low Reading Comprehension Males	0	<.99	0	<.99	3.005	<.10
High Reading Comprehension Females and Low Reading Comprehension Females	4.923	<.05*	2.083	<.20	5.418	<.02*

*Statistically significant at the .05 level.

**Statistically significant at the .01 level.

relationship between reading comprehension scores and conservation ability levels of male and female subjects in the high and low reading comprehension groups. Ho_7b stated no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of male and female subjects in the high and low reading comprehension groups. Tau coefficient, .16140, converted to a $\underline{z}$-score of 2.33, $p = .0198$. Null sub-hypothesis 7_b was rejected and interpreted to mean a statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of male and female subjects in the high and low reading comprehension groups. Ho_7c stated that no statistically significant relationship exists between reading comprehension scores and visual-motor development scores of male and female subjects in the high and low reading comprehension groups. The Tau coefficient, .23947, converted to $\underline{z}$, 3.46, which was significant at the .0006 level. Therefore, Ho_7c was rejected and there was a statistically significant relationship between reading comprehension scores and visual-motor development scores of male and female subjects in the high and low reading comprehension groups.

The rejection of the preceding three null sub-hypotheses led to the rejection of null hypothesis Ho_7. Therefore, statistically significant relationships existed between reading comprehension scores and conservation

ability levels, auditory discrimination scores, and visual-motor development scores of male and female subjects in the high and low reading comprehension groups (Table 27).

TABLE 27

RELATIONSHIPS OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR ALL SUBJECTS
(N = 96)

Conservation Ability			Auditory Discrimination			Visual-Motor Development		
Tau	z	p	Tau	z	p	Tau	z	p
.18486	2.67	.0076**	.16140	2.33	.0198*	.23947	3.46	.0006**

*Statistically significant at the .05 level.

**Statistically significant at the .01 level.

Null Ho_8 stated no statistically significant relationships exist between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of female subjects in the high reading comprehension group. Ho_8a which stated no statistically significant relationship exists between reading comprehension scores and conservation ability levels of female subjects in the high reading comprehension group must be accepted. The Tau coefficient, -.07608 converted to a z-score of -.52 with a significance level of .6030. Ho_8b which stated no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of female subjects in the high reading comprehension

group also must be accepted. The Tau value, .06520, converted to z-score, .45, with a significance level, .6528. Ho_8c stated no statistically significant relationship exists between reading comprehension scores and visual-motor development scores. The Tau coefficient, .04347, converted to z-score, .30, p = .7642. Therefore Ho_8c was accepted. The acceptance of the three null sub-hypotheses examining each relationship led to the acceptance of null hypothesis 8 which stated no significant relationships exist between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of female subjects in the high reading comprehension group (Table 28).

TABLE 28

RELATIONSHIPS OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR HIGH READING COMPREHENSION FEMALE SUBJECTS (N = 24)

Conservation Ability			Auditory Discrimination			Visual-Motor Development		
Tau	z	p	Tau	z	p	Tau	z	p
-.07608	-.52	.6030	.06520	.45	.6528	.04347	.30	.7642

Ho_9 stated no statistically significant relationships exist between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male subjects in the high

reading comprehension group. Three sub-hypotheses were established to investigate the relationships. Ho_9a stated no statistically significant relationships exist between reading comprehension scores and conservation ability levels of male subjects in the high reading comprehension group. Tau coefficient, .10507, converted to a z-score of .72 with a significance level of .4716, which led to acceptance of Ho_9a. Ho_9b stated no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of male subjects in the high reading comprehension group. With a Tau value of .43120, z-score of 2.96, significance level .0030, Ho_9b must be rejected. The interpretation followed that a statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of male subjects in the high reading comprehension group. Ho_9c stated no statistically significant relationship exists between reading comprehension scores and visual-motor development scores of male subjects in the high reading comprehension group. The Tau coefficient, .10140 converted to a z-score of .70 with a significance level .4840. Therefore Ho_9c was accepted and interpreted to mean that no statistically significant relationship exists between reading comprehension scores and visual-motor development scores of male subjects in the high reading comprehension group.

The acceptance of null subhypotheses Ho_9a and Ho_9c

and the rejection of null subhypothesis Ho_9b led to the partial rejection of null hypothesis 9. The interpretation followed that no significant relationships exist between reading comprehension scores and conservation ability levels; between reading comprehension scores and visual-motor development scores of male subjects in the high reading comprehension group; however a significant relationship exists between reading comprehension scores and auditory discrimination scores of the male subjects in the high reading comprehension group (Table 29).

TABLE 29

RELATIONSHIPS OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR HIGH READING COMPREHENSION MALE SUBJECTS (N = 24)

Conservation Ability			Auditory Discrimination			Visual-Motor Development		
Tau	z	p	Tau	z	p	Tau	z	p
.10507	.72	.4716	.43120	2.96	.0030**	.10140	.70	.4840

**Statistically significant at the .01 level.

Ho_{10} stated there are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of female subjects in the low reading comprehension group. $Ho_{10}a$ asserted there is no statistically significant relationship between reading

comprehension scores and conservation ability levels of female subjects in the low reading comprehension group. Tau coefficient, .03623, converted to a z-score of .25, which gave a significance level of .8026. Therefore $Ho_{10}a$, that no significant relationship exists between reading comprehension scores and conservation ability levels of female subjects in the low reading comprehension group, must be accepted. $Ho_{10}b$ stated no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of female subjects in the low reading comprehension group. The Tau coefficient showed a relationship of .06521, with a z-score of .45, and significance level, .6528. Therefore, $Ho_{10}b$ was accepted and interpreted to mean no significant relationship exists between reading comprehension scores and auditory discrimination scores of female subjects in the low reading comprehension group. $Ho_{10}c$ asserted there is no statistically significant relationship between reading comprehension scores and visual-motor development scores of female subjects in the low reading comprehension group. The Tau coefficient showed a correlation of .33690, which converted to z-score 2.31 with a significance level, .0214. Ho_9c was rejected and there was a statistically significant relationship between reading comprehension scores and visual-motor development scores of female subjects in the low reading comprehension group.

Null hypothesis 10 which stated that no statistically

significant relationships exist between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores must be partially rejected. The interpretation followed that no significant relationships exist between reading comprehension scores and conservation ability levels, between reading comprehension scores and auditory discrimination scores, but a significant relationship exists between reading comprehension scores and visual-motor development scores of female subjects in the low reading comprehension group (Table 30).

TABLE 30

RELATIONSHIP OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR LOW READING COMPREHENSION FEMALE SUBJECTS (N = 24)

Conservation Ability			Auditory Discrimination			Visual-Motor Development		
Tau	z	p	Tau	z	p	Tau	z	p
.03623	.25	.8026	.06521	.45	.6528	.33690	2.31	.0214*

*Statistically significant at the .05 level.

Null hypothesis 11 stated there are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of low reading comprehension male subjects. $Ho_{11}a$ stated no statistically significant relationship exists between reading

comprehension scores and conservation ability levels of male subjects in the low reading comprehension group. The Tau coefficient, .0181, converted to a z-score, .12, which gave a significance level of .9044. $Ho_{11}a$ was accepted. $Ho_{11}b$ stated no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of male subjects in the low reading comprehension group. The Tau coefficient, .00724, z-score, .05, p, .9602, led to acceptance on $Ho_{11}b$. $Ho_{11}c$ stated that no statistically significant relationship exists between reading comprehension scores and visual-motor development scores of male subjects in the low reading comprehension group. The Tau coefficient, -.00724, converted to a z-score -.05, with a significance level of .9602. Therefore $Ho_{11}c$ was accepted.

The acceptance of the three preceding null subhypotheses led to the acceptance of null hypothesis 11, which stated that no significant relationships exist between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male subjects in the low reading comprehension group (Table 31).

Null hypothesis 12 stated that no significant relationships exist between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male and female subjects in the high reading comprehension group. $H_{12}a$ asserted

TABLE 31

RELATIONSHIPS OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR LOW READING COMPREHENSION MALE SUBJECTS
(N = 24)

Conservation Ability			Auditory Discrimination			Visual-Motor Development		
Tau	z	p	Tau	z	p	Tau	z	p
.0180	.12	.9044	.00724	.05	.9602	-.00724	-.05	.9602

no significant relationship exists between reading comprehension scores and conservation ability levels of male and female subjects in the high reading comprehension group. The Tau coefficient, -.01773, converted to a z-score of -.18, with a significance level of .8572. $Ho_{12}a$ was accepted that no statistically significant relationship exists. $Ho_{12}b$ stated no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of male and female subjects in the high reading comprehension group. The Tau coefficient, .19946, converted to a z-score of 2.00, which was significant at .0456. Therefore, $Ho_{12}b$ was rejected and interpreted to mean that a statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of male and female subjects in the high reading comprehension group. $Ho_{12}c$ stated there is no statistically significant relationship between reading comprehension scores and

visual-motor development scores of male and female subjects in the high reading comprehension group. The Tau coefficient, .08687, converted to a z-score, .87, which was significant at .3844. Therefore $Ho_{12}c$, that no statistically significant relationship exists, must be accepted.

Ho_{12} must be partially rejected because of the significant findings of $Ho_{12}b$. The interpretation followed that no statistically significant relationship exists between reading comprehension scores and conservation ability levels, between reading comprehension scores and visual-motor development scores; however a statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of male and female subjects in the high reading comprehension group (Table 32).

TABLE 32

RELATIONSHIPS OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR HIGH READING COMPREHENSION GROUP (N = 48)

Conservation Ability			Auditory Discrimination			Visual-Motor Development		
Tau	z	p	Tau	z	p	Tau	z	p
-.01773	-.18	.8572	.19946	2.00	.0456*	.08687	.87	.3844

*Statistically significant at the .05 level.

Null hypothesis 13 stated that no statistically significant relationships exist between reading comprehension scores and conservation ability levels, auditory

discrimination scores, and visual-motor development scores of male and female subjects in the low reading comprehension group. $Ho_{13}a$ stated no statistically significant relationship exists between reading comprehension scores and conservation ability levels of male and female subjects in the low reading comprehension group. The Tau coefficient, .05851, converted to a z-score of .59, with significance level of .5552. $Ho_{13}a$ was accepted and interpreted to mean no statistically significant relationship exists between reading comprehension scores and conservation ability levels for this group. $Ho_{13}b$ stated no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of male and female subjects in the low reading comprehension group. The Tau coefficient, .04521, converted to z-score, .45, which was significant at .6528. $Ho_{13}b$ was accepted and no statistically significant relationship existed between measures of the two variables for male and female subjects in the low reading comprehension group. $Ho_{13}c$ asserted there is no statistically significant relationship between reading comprehension scores and visual-motor development scores of male and female subjects in the low reading comprehension group. The Tau coefficient, .14270, z-score, 1.43, with significance level, .1528, led to the acceptance of $Ho_{13}c$.

The acceptance of the preceding three null sub-hypotheses, necessitated the acceptance of null hypothesis 13

which stated no statistically significant relationships exist between reading comprehension scores, conservation ability levels, auditory discrimination scores, and visual-motor development scores of male and female subjects in the low reading comprehension group (Table 33).

TABLE 33

RELATIONSHIPS OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR LOW READING COMPREHENSION GROUP (N = 48)

Conservation Ability			Auditory Discrimination			Visual-Motor Development		
Tau	z	p	Tau	z	p	Tau	z	p
.05851	.59	.5552	.04521	.45	.6528	.14270	1.43	.1528

Null hypothesis 14 stated there are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of female subjects in the high and low reading comprehension groups. $Ho_{14}a$ stated there is no statistically significant relationship between reading comprehension scores and conservation ability levels of female subjects in the high and low reading comprehension groups. The Tau coefficient, .19410, z-score, 1.95, and significance level .0512, led to the rejection of $Ho_{14}a$. The interpretation followed that a statistically significant relationship exists between reading comprehension

scores and conservation ability levels of female subjects in the high and low reading comprehension groups. $Ho_{14}b$ stated that no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores of female subjects in the high and low reading comprehension groups. The Tau coefficient, .17198, converted to a z-score, 1.72, which was significant at .0854. Therefore, $Ho_{14}b$ was accepted and interpreted to mean no statistically significant relationship exists between measures of the two variables for this group. $Ho_{14}c$ stated that no statistically significant relationship exists between reading comprehension score and visual-motor development scores of female subjects in the high and low reading comprehension groups. Computation of the Tau coefficient revealed a correlation of .31382, which converted to a z-score, 3.15, with a significance level, .0016. $Ho_{14}c$ was rejected and interpreted to mean there is a statistically significant relationship between reading comprehension scores and visual-motor development scores of female subjects in the high and low reading comprehension groups.

Null hypothesis 14 which stated there are no statistically significant relationships between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores, must be partially rejected because of the statistically significant relationship found between reading comprehensior -es

and conservation ability levels, and the statistically significant relationship found between reading comprehension scores and visual-motor development scores. However, no statistically significant relationship was found between reading comprehension scores and auditory discrimination scores of female subjects in the high and low reading comprehension groups (Table 34).

TABLE 34

RELATIONSHIPS OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR FEMALE SUBJECTS (N = 48)

Conservation Ability			Auditory Discrimination			Visual-Motor Development		
Tau	z	p	Tau	z	p	Tau	z	p
.19410	1.95	.0512*	.17198	1.72	.0854	.31382	3.15	.0016**

*Statistically significant at the .05 level.

**Statistically significant at the .01 level.

Null hypothesis 15 stated there is no statistically significant relationship between reading comprehension scores and conservation ability levels, auditory discrimination scores, and visual-motor development scores of male subjects in the high and low reading comprehension groups. $Ho_{15}a$ stated no statistically significant relationship exists between reading comprehension scores and conservation ability levels of male subjects in the high and low reading

comprehension groups. The Tau coefficient, .13475, converted to a z-score of 1.35, with a significance level of .1770. $Ho_{15}a$ was accepted and interpreted to mean no statistically significant relationship exists between reading comprehension scores and conservation ability levels of male subjects in the high and low reading comprehension groups. $Ho_{15}b$ stated there is no statistically significant relationship between reading comprehension scores and auditory discrimination scores of male subjects in the high and low reading comprehension groups. The Tau coefficient, .07978, converted to a z-score of .80, which was significant at .4238. Therefore, $Ho_{15}b$ was accepted and interpreted to mean no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores for this group. $Ho_{15}c$ stated no statistically significant relationship exists between reading comprehension scores and visual-motor development scores of male subjects in the high and low reading comprehension groups. The Tau coefficient, .26950, converted to a z-score, 2.70, which was significant at .0070. Therefore $Ho_{15}c$ was rejected and the inference drawn that there is a statistically significant relationship between reading comprehension scores and visual-motor development scores of male subjects in the high and low reading comprehension groups.

Ho_{15} which stated there is no statistically significant relationship between reading comprehension scores and

conservation ability levels, auditory discrimination scores, and visual-motor development scores, must be partially rejected because of the significant relationship found between reading comprehension scores and visual-motor development scores of male subjects in the high and low reading comprehension groups. The interpretation followed that no statistically significant relationship exists between reading comprehension scores and conservation ability levels; no statistically significant relationship exists between reading comprehension scores and auditory discrimination scores; however, a statistically significant relationship exists between reading comprehension scores and visual-motor development scores of male subjects in the high and low reading comprehension group (Table 35).

TABLE 35

RELATIONSHIPS OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR MALE SUBJECTS
(N = 48)

Conservation Ability			Auditory Discrimination			Visual-Motor Development		
Tau	z	p	Tau	z	p	Tau	z	p
.13475	1.35	.1770	.07978	.80	.4238	.26950	2.70	.0070**

**Statistically significant at the .01 level.

In investigating twenty-seven relationships, nine statistically significant relationships were found. Two

statistically significant relationships were revealed between measures of reading comprehension and conservation ability; three were found between measures of reading comprehension and auditory discrimination; and four were found between measures of reading comprehension and visual-motor development (Table 36).

TABLE 36

SUMMARY OF RELATIONSHIPS OF READING COMPREHENSION TO CONSERVATION ABILITY, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT

		Conservation Ability			Auditory Discrimination			Visual-Motor Development		
N	Group	Tau	z	p	Tau	z	p	Tau	z	p
96	All Subjects	.18486	2.67	.0076**	.16140	2.33	.0198*	.23947	3.46	.0006**
48	High Reading Comprehension	-.01773	-.18	.8572	.19946	2.00	.0456*	.08687	.87	.3844
48	Low Reading Comprehension	.05851	.59	.5552	.04521	.45	.6528	.14270	1.43	.1528
48	Males	.13475	1.35	.1770	.07978	.80	.4238	.26950	2.70	.0070**
48	Females	.19410	1.95	.0512*	.17198	1.72	.0854	.31382	3.15	.0016**
24	High Reading Comprehension Males	.10507	.72	.4716	.43120	2.96	.0030**	.10140	.70	.4840
24	High Reading Comprehension Females	-.07608	-.52	.6030	.06520	.45	.6528	.04347	.30	.7642
24	Low Reading Comprehension Males	.01810	.12	.9044	.00724	.05	.9602	-.00724	-.05	.9602
24	Low Reading Comprehension Females	.03623	.25	.8026	.06521	.45	.6528	.33690	2.31	.0208*

*Statistically significant at the .05 level.

**Statistically significant at the .01 level.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study purported to investigate the differences and relationships of measures of reading comprehension, conservation ability, auditory discrimination, and visual-motor development of third-grade pupils.

Six elementary schools were selected randomly from ten available elementary schools in the Midwest City-Del City Elementary Public Schools. Five-hundred-ten third-grade subjects were available from the six identified schools. The Gates-MacGinitie Reading Tests, Primary C, Form 1, were administered and scored by school personnel in September, 1972. From the five-hundred-ten subjects, one-hundred seventy-nine were selected by categorization into one of two groups: the high reading comprehension group and the low reading comprehension group. Subjects in the high reading comprehension group were reading 4.9 grade level or above on the comprehension subtest of the Gates-MacGinitie Reading Tests. Subjects in the low reading comprehension group were reading

1.9 grade level or below. Subjects in the low reading comprehension group were administered the Slosson Intelligence Test in order to control low intelligence scores as a factor in poor reading comprehension. Subjects were administered individually the six conservation tasks, the Wepman Auditory Discrimination Test, and the Bender Gestalt Test for Young Children to measure conservation ability, auditory discrimination, and visual-motor development respectively. Subjects with below normal hearing and vision, according to the school nurses' evaluations, were omitted from the study. Subjects who were not in the age range, 7-10 to 9, were also excluded from the study. After exclusions were made for intelligence, vision, hearing, and age range; and subjects were equated as to number from each sex by random selection, ninety-six subjects remained. Twenty-four girls and twenty-four boys were in the high reading comprehension group and twenty-four girls and twenty-four boys were in the low reading comprehension group.

The first general hypothesis stated no significant differences exist in measures of conservation ability, auditory discrimination, and visual-motor development among third-grade subjects classified by sex and reading levels. Null hypotheses 1 through 6 were established to determine whether differences exist in twelve subject groupings. Chi square with Yates' correction was used to find the statistically significant differences between two groups on two

classifications of each variable. In investigation of eighteen relationships, three significant differences were revealed.

The second general hypothesis stated there were no significant relationships between measures of reading comprehension and conservation ability, auditory discrimination, and visual-motor development among third-grade subjects classified by sex and reading comprehension levels. Null hypotheses 7 through 15 investigated the relationships of reading comprehension to each variable in nine subject groupings. Kendall Tau, τ, rank correlation coefficient was applied to the data to investigate relationships. In investigation of twenty-seven relationships, nine significant relationships were revealed. The alpha level was set at .05 to test the hypotheses.

Findings

Treatment of the data yielded the following results:

1. There were no significant differences between high and low reading comprehension groups in their measures of conservation ability and auditory discrimination.

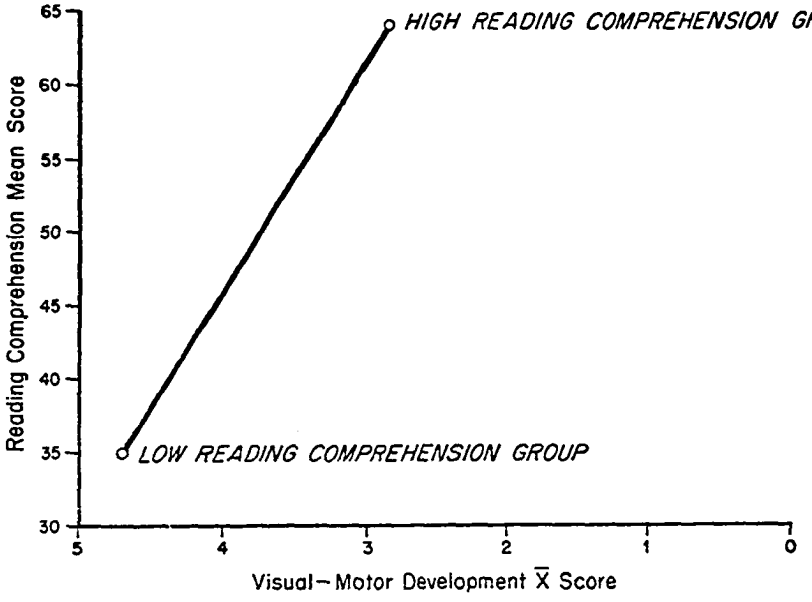
2. There was a significant difference between the high and low reading comprehension group in their measures of visual-motor development (Graph 1).

3. There were no significant differences between male and female subjects in their measures of conservation

ability, auditory discrimination, and visual-motor development.

Graph 1

COMPARISONS OF MEANS OF VISUAL-MOTOR DEVELOPMENT AND READING COMPREHENSION SCORES OF HIGH AND LOW READING COMPREHENSION GROUPS.



4. There were no significant differences between male and female subjects in the high reading comprehension group in their measures of conservation ability, auditory discrimination, and visual-motor development.

5. There were no significant differences between male and female subjects in the low reading comprehension group in their measures of conservation ability, auditory discrimination, and visual-motor development.

6. There were no significant differences between male subjects in the high reading comprehension group and

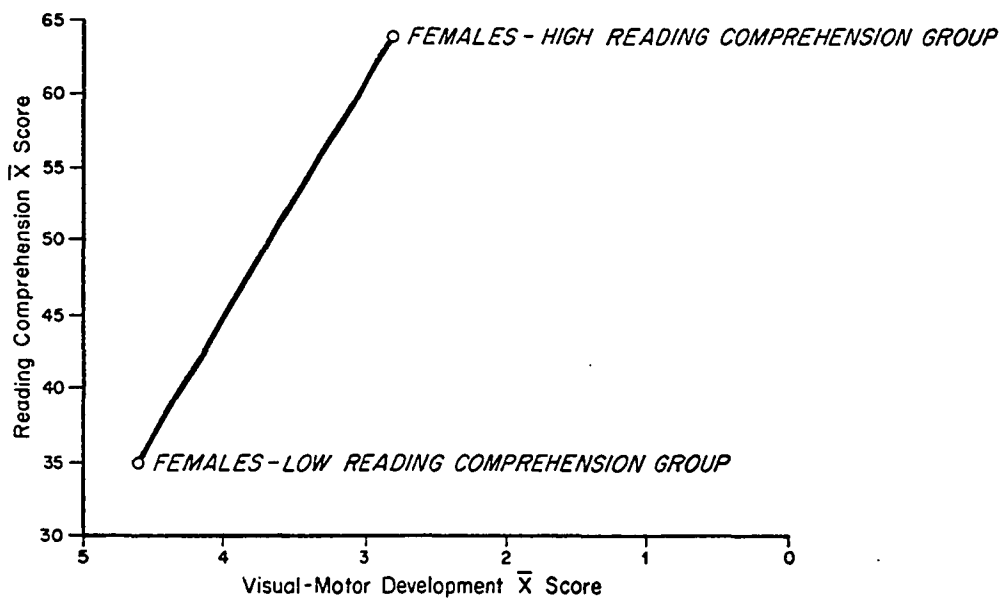
male subjects in the low reading comprehension group in their measures of conservation ability, auditory discrimination, and visual-motor development.

7. There was no significant difference between female subjects in the high reading comprehension group and female subjects in the low reading comprehension group in their measures of auditory discrimination.

8. There were significant differences between female subjects in the high and low reading comprehension groups in their measure of conservation ability and visual-motor development (Graph 2).

Graph 2

COMPARISONS OF MEANS OF VISUAL-MOTOR AND READING COMPREHENSION SCORES OF FEMALE SUBJECTS IN HIGH AND LOW READING COMPREHENSION GROUPS.



9. Significant relationships were found between the measures of reading comprehension and conservation ability, auditory discrimination, and visual-motor development in all subjects.

10. There were no significant relationships between the measures of reading comprehension and conservation ability, auditory discrimination, and visual-motor development in female subjects in the high reading comprehension group.

11. There were no significant relationships between the measures of reading comprehension and conservation ability or between reading comprehension and visual-motor development of male subjects in the high reading comprehension group.

12. There was a significant relationship between the measures of reading comprehension and auditory discrimination of male subjects in the high reading comprehension group.

13. There were no significant relationships between the measures of reading comprehension and conservation ability, between reading comprehension and auditory discrimination of female subjects in the low reading comprehension group.

14. There was a significant relationship between the measures of reading comprehension and visual-motor development of females in the low reading comprehension group.

15. There were no significant relationships between

the measures of conservation ability, auditory discrimination, and visual-motor development of male subjects in the low reading comprehension group.

16. There were no significant relationships between the measures of reading comprehension and conservation ability, between reading comprehension and visual-motor development of male and female subjects in the high reading comprehension group.

17. There was a significant relationship between the measures of reading comprehension and auditory discrimination of male and female subjects in the high reading comprehension group.

18. There were no significant relationships between the measures of reading comprehension and conservation ability, auditory discrimination, and visual-motor development of male and female subjects in the low reading comprehension group.

19. There was a significant relationship between the measures of reading comprehension and conservation ability of female subjects in the high and low reading comprehension groups.

20. There was no significant relationship between the measures of reading comprehension and auditory discrimination of female subjects in the high and low reading comprehension groups.

21. There was a significant relationship between

the measures of reading comprehension and visual-motor development of female subjects in the high and low reading comprehension groups.

22. There were no significant relationships between the measures of reading comprehension and conservation ability, between reading comprehension and auditory discrimination of male subjects in the high and low reading comprehension groups.

23. There was a significant relationship between the measures of reading comprehension and visual-motor development of male subjects in the high and low reading comprehension groups.

Subsidiary Findings

Trends were revealed in the data concerning conservation that merit attention. Appendix B presents the raw data showing individual performance on each conservation task. None of the subjects in the high reading comprehension group conserved on less than three conservation tasks.

Table 37 presents the data for various categories of all subjects on each of six conservation tasks. In examination of the number of subjects in each group that conserved on each task, the following observations were made:

1. The greatest difference in task performance between the high reading comprehension and the low reading comprehension group was in the conservation of area. Thirty-three out of 48 subjects, 69%, of the high reading

TABLE 37

NUMBER AND PERCENTAGE OF SUBJECTS CONSERVING ON EACH TASK

N	Group	Number N	Number %	Liquid N	Liquid %	Solids N	Solids %	Area N	Area %	Length N	Length %	Weight N	Weight %
48	High Reading Comprehension	46	96	48	100	48	100	33	69	41	85	46	96
48	Low Reading Comprehension	46	96	36	75	42	88	21	44	37	77	39	81
48	Males	47	98	44	92	45	94	27	56	40	83	44	92
48	Females	45	94	40	83	45	94	27	56	38	79	41	85
	High Reading Comprehension												
24	Males	23	96	24	100	24	100	16	67	19	79	23	96
24	Females	23	96	24	100	24	100	17	71	22	92	23	96
	Low Reading Comprehension												
24	Males	24	100	20	83	21	88	11	46	21	88	21	88
24	Females	22	92	16	67	21	88	10	42	16	67	18	75
	Males												
24	High Reading Comprehension	23	96	24	100	24	100	16	67	19	79	23	96
24	Low Reading Comprehension	24	100	20	83	21	88	11	46	21	88	21	88
	Females												
24	High Reading Comprehension	23	96	24	100	24	100	17	71	22	92	23	96
24	Low Reading Comprehension	22	92	16	67	21	88	10	42	16	67	18	75
96	All	92	96	84	87.5	90	94	54	56	78	81	85	89

comprehension group conserved on area, as compared to 21 of 48, 44% who conserved in the low reading comprehension group. Both percentages were below Piaget's criteria. Piaget considered a task successfully passed when 75% of subjects the same age had passed the task.[1] Graph 3 compares the high reading comprehension group with the low reading comprehension group on performance of each conservation task.

2. Male and female subjects were closely matched in performance of each task. The lowest number conserved on area, 27 of 48, or 56% for both the male and female subjects (Graph 4).

3. In comparing the male subjects in the high reading comprehension group with the female subjects in the high reading comprehension group, the lowest number conserved on area. Sixteen out of 24 male subjects as compared with 17 out of 24 female subjects, conserved on area (Graph 5).

4. In comparison of the male and female subjects in the low reading comprehension group, the greatest differences were found in conservation of liquid and area, with a larger number of boys conserving on each task. Both groups were low in the conservation of area (Graph 6).

5. In comparing male subjects in the high reading comprehension group and male subjects in the low reading comprehension group, the greatest difference was in area,

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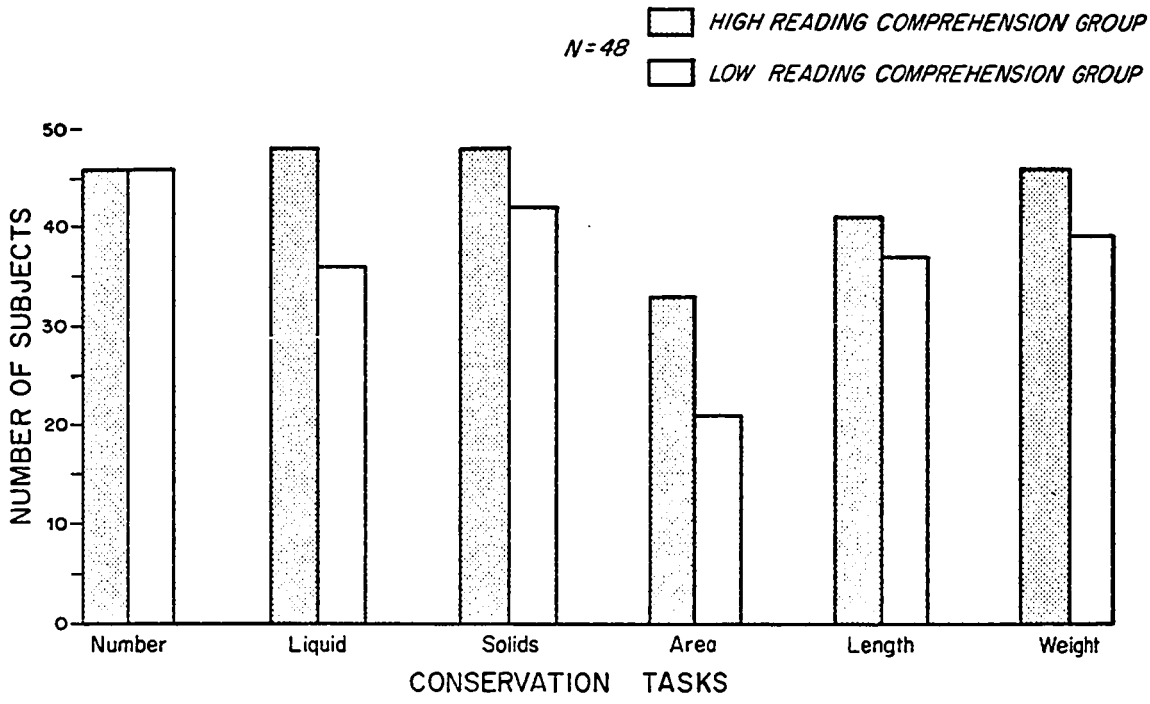
[1]Jean Piaget, Judgment and Reasoning in the Child (Totowa, New Jersey: Littlefield Adams, 1966), p. 100.

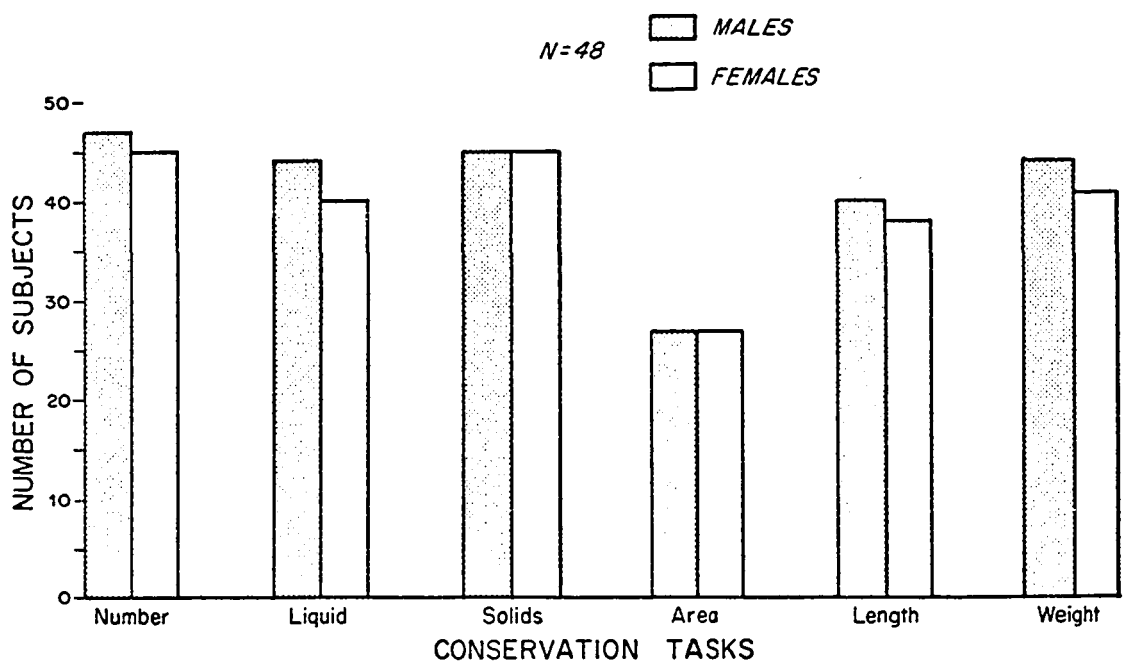
Graph 3

COMPARISON OF HIGH AND LOW READING COMPREHENSION GROUPS ON SIX CONSERVATION TASKS



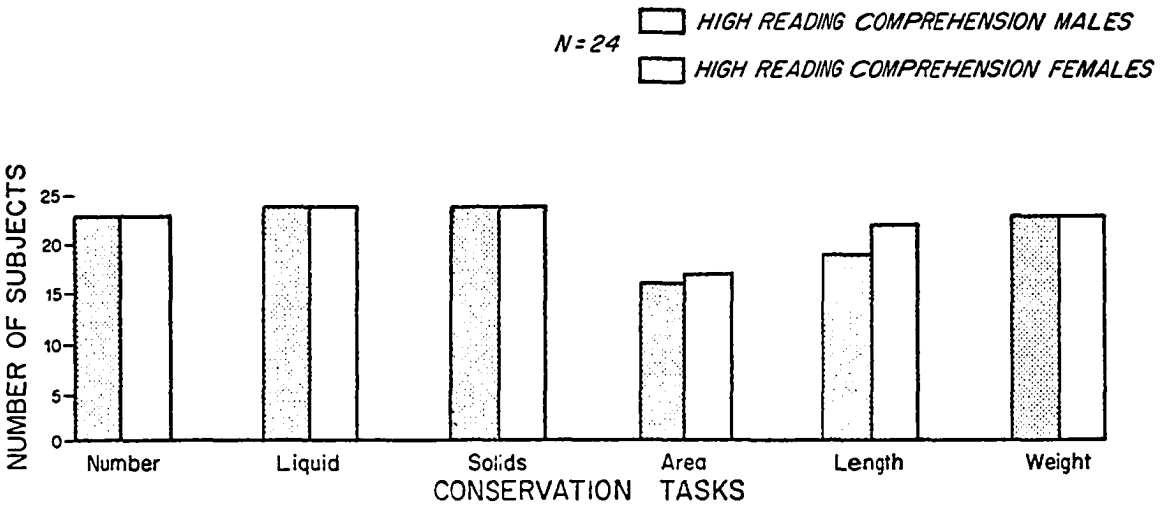
Graph 4

COMPARISON OF MALE AND FEMALE SUBJECTS ON SIX CONSERVATION TASKS



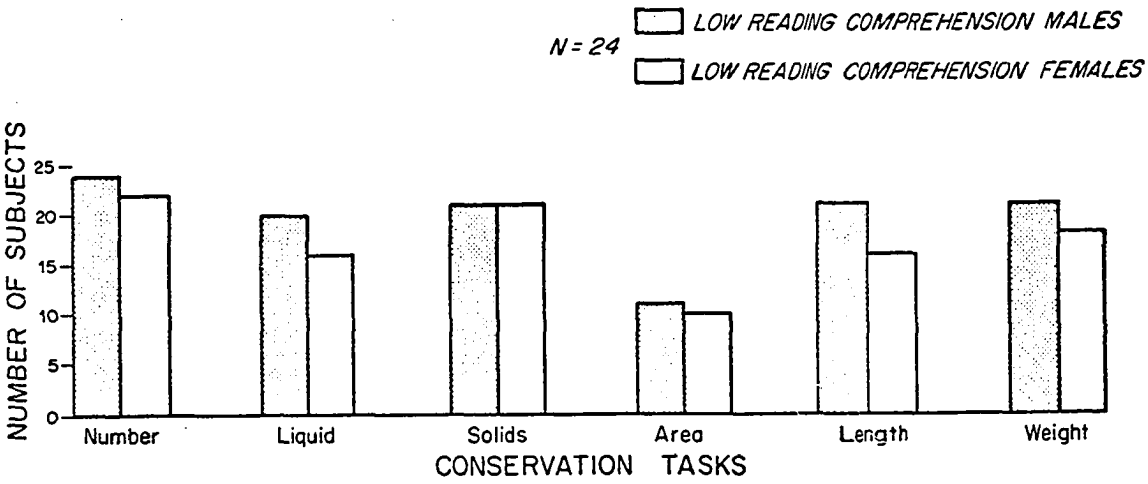
Graph 5

COMPARISON OF HIGH READING COMPREHENSION MALE AND FEMALE SUBJECTS ON SIX CONSERVATION TASKS



Graph 6

COMPARISON OF LOW READING COMPREHENSION MALE AND FEMALE SUBJECTS ON SIX CONSERVATION TASKS



favoring the male subjects in the high reading comprehension group. Both groups fell below the 75% criteria (Graph 7).

6. Comparison of the female subjects in high reading comprehension group and the female subjects in the low reading comprehension group substantiated the significant findings of difference between groups. A greater number in the high reading comprehension group conserved on each task. The greatest difference was found in the conservation of area. The next greatest difference was liquid and the third greatest difference was length (Graph 8).

The number of subjects conserving on six tasks in the high reading comprehension group was 29 or 60%. The number conserving on six tasks in the low reading comprehension group was 14 or 29% of the 48 subjects in the low reading comprehension group. Forty-two per cent of the female subjects of 48 population could conserve on six tasks. Forty-eight per cent of the male subjects of their group conserved on six tasks. Table 38 presented data on twelve groups and all subjects; the number and percentage conserving on three or more, four or more, five or more, and six tasks.

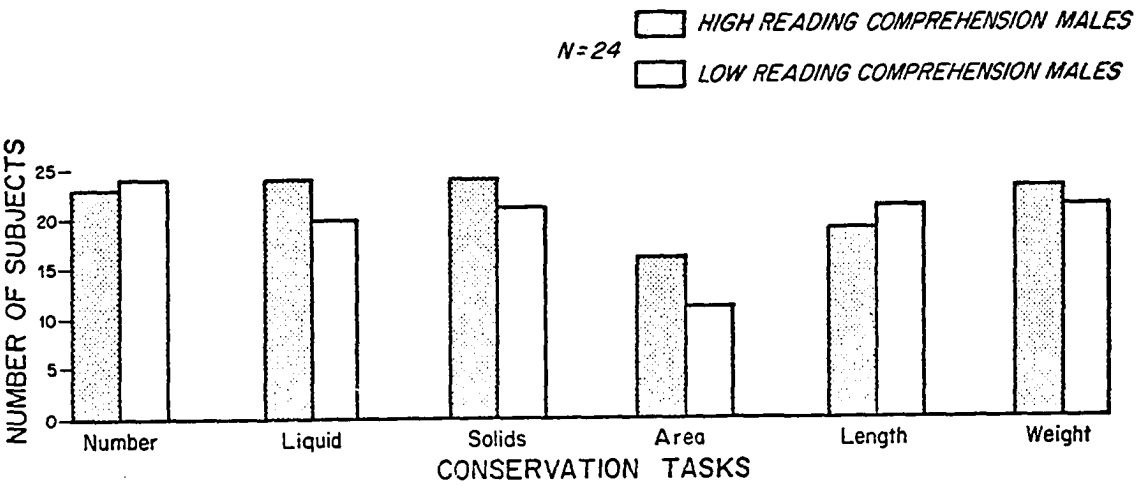
Conclusions

Investigation of differences and relationships in this study led to the following conclusions:

1. Subjects in the high reading comprehension group surpassed subjects in the low reading comprehension group in visual-motor development.

Graph 7

COMPARISON OF HIGH AND LOW READING COMPREHENSION MALE SUBJECTS ON SIX CONSERVATION TASKS



Graph 8

COMPARISON OF HIGH AND LOW READING COMPREHENSION FEMALE SUBJECTS ON SIX CONSERVATION TASKS

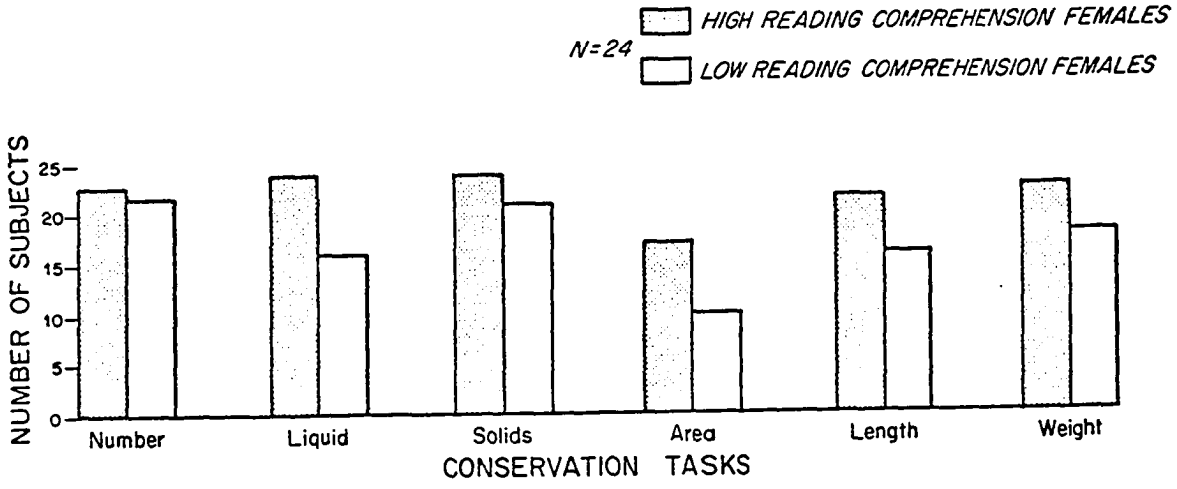


TABLE 38

NUMBER AND PERCENTAGE OF SUBJECTS CONSERVING ON THREE, FOUR, FIVE AND SIX TASKS

		3+		4+		5+		6	
N	Group	N	%	N	%	N	%	N	%
48	High Reading Comprehension	48	100	47	98	42	87.5	29	60
48	Low Reading Comprehension	41	85	37	77	36	75	14	29.2
48	Males	45	94	44	92	39	81	23	48
48	Females	44	92	40	83	39	81	20	42
	High Reading Comprehension								
24	Males	24	100	23	96	19	79	15	63
24	Females	24	100	24	100	23	96	14	58
	Low Reading Comprehension								
24	Males	21	88	21	88	20	83	8	33
24	Females	20	83	16	67	16	67	6	25
	Males								
24	High Reading Comprehension	24	100	23	96	19	79	15	63
24	Low Reading Comprehension	21	88	21	88	20	83	8	33
	Females								
24	High Reading Comprehension	24	100	24	100	23	96	14	58
24	Low Reading Comprehension	20	83	16	67	16	67	6	25
96	All	89	93	84	87.5	78	7.1	43	45

2. Female subjects in the high reading comprehension surpassed female subjects in the low reading comprehension group in visual-motor development.

3. There was a relationship between reading comprehension and visual-motor development of female subjects in the low reading comprehension group.

4. There was a relationship between reading comprehension and visual-motor development of female subjects in the high and low reading comprehension groups.

5. There was a relationship between reading comprehension and visual-motor development of male subjects in the high and low reading comprehension groups.

6. There was a relationship between reading comprehension and auditory discrimination in the high reading comprehension group while no significant relationship was found in the low reading comprehension group. This finding may indicate that the high reading comprehension group made use of auditory perception and phonetic attack in comprehension.

7. There was a significant relationship between reading comprehension and auditory discrimination of male subjects in the high reading comprehension group. No significant relationship was found for girls in the high reading comprehension group. This finding indicated that the high comprehension boys use the auditory modality while the girls do not.

8. Female subjects in the high reading comprehension group conserved on more tasks than females in the low reading comprehension group.

9. A significant relationship was found between reading comprehension and conservation ability of female subjects in both the high and low conservation groups.

The last two statements could be interpreted to mean that female subjects in the high comprehension group used the rational powers in conservation to comprehend reading material; whereas the female subjects of the low reading comprehension group had less conservation ability to lead them to comprehension.

Significant relationships were found between reading comprehension and conservation ability, auditory discrimination, and visual-motor development of all subjects, male and female, high and low comprehension groups. Higher significance was found between reading comprehension and conservation ability, and reading comprehension and visual-motor ability. This finding could indicate that greater instructional emphasis could be well placed on conservation ability and visual-motor functioning. Sufficient evidence was revealed that warranted instruction through auditory modality where such instruction was needed.

Recommendations

The following recommendations were made for further research:

1. An experimental study showing the relationship of reading comprehension to conservation ability could be designed using female subjects in the low reading comprehension

group. A pre-test, post-test, control group design, similar to Kellogg's[2] could be implemented.

2. An experimental study as described above could be made with visual-motor training in the low reading comprehension group to establish whether training is effective.

3. An experimental study could be conducted comparing the effects of auditory discrimination on readiness. This study should include preschool, kindergarten, and first grade; when subjects rely strongly on auditory modality.

4. A longitudinal study should be conducted following the experimental studies to see if results are maintained over time.

5. The Illinois Test of Psycholinguistic Abilities[3] could be administered to inefficient readers to isolate the deficient sensory modality. The relationship of reading to the auditory or visual modality could be investigated. An experimental study could follow; testing the effects of training in the necessary modality.

6. The design of this descriptive study could be replicated across grade, socio-economic, and intelligence levels.

7. A longitudinal study could be designed to discover how the relationship of the variables to reading comprehension change over time.

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[2]Kellogg, "An Investigation," pp. 1-52.

[3]Samuel A. Kirk, James J. McCarthy, and Winifred D. Kirk, Illinois Test of Psycholinguistic Abilities (Urbana, Illinois: The University of Illinois Press, 1968), pp. 5-100.

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APPENDIX A

RAW DATA OF SCORES ON READING COMPREHENSION, CONSERVATION, AUDITORY DISCRIMINATION, AND VISUAL-MOTOR DEVELOPMENT FOR ALL SUBJECTS

High Reading Comprehension--Female Subjects

Subject Number	Reading Comprehension*	Grade Equivalent	Conservation Ability	Auditory Discrimination	Visual-Motor Development
01	60	4.9	6	27	2
03	64	5.6	5	23	5
06	60	4.9	5	26	6
07	69	6.2	5	30	3
08	62	5.2	6	28	2
10	60	4.9	6	27	4
11	61	5.0	6	28	2
13	63	5.4	6	26	4
15	64	5.6	6	28	3
17	67	6.0	6	28	1
18	61	5.0	5	30	0
20	67	6.0	6	30	1
22	64	5.6	5	28	0
27	66	5.8	5	25	2
29	62	5.2	6	28	3
30	61	5.0	6	29	3
33	60	4.9	5	28	2
35	67	6.0	5	27	2
36	75	7.2	6	27	9
39	66	5.8	6	29	2
40	63	5.4	4	29	3
42	66	5.8	5	29	1
46	60	4.9	6	29	5
48	60	4.9	6	27	2

High Reading Comprehension--Male Subjects

Subject Number	Reading Comprehension*	Grade Equivalent	Conservation Ability	Auditory Discrimination	Visual-Motor Development
01	69	6.2	6	28	2
03	61	5.0	6	26	1
04	63	5.4	4	27	1
06	67	6.0	6	30	1
07	67	6.0	6	29	2
10	63	5.4	6	27	4
14	66	5.8	4	25	1
15	64	5.6	6	29	1
16	63	5.4	5	26	1
17	62	5.2	4	28	1
18	73	7.0	5	29	2
19	62	5.2	5	26	7
20	64	5.6	5	26	4
23	60	4.9	3	24	6
24	60	4.9	6	27	1
25	67	6.0	6	28	6
26	69	6.2	6	29	3
29	60	4.9	6	28	5
30	73	7.0	6	29	2
32	64	5.6	6	30	4
33	61	5.0	6	28	3
35	61	5.0	6	27	4
36	67	6.0	4	29	4
37	63	5.4	6	26	1

Low Reading Comprehension--Female Subjects

Subject Number	Reading Comprehension*	Grade Equivalent	Conservation Ability	Auditory Discrimination	Visual-Motor Development
02	34	1.6	6	28	5
03	29	1.4	5	20	4
04	41	1.9	1	26	0
05	39	1.8	5	27	4
06	31	1.5	3	25	6
07	30	1.5	6	27	12
08	29	1.4	3	27	8
09	34	1.6	1	23	3
10	29	1.4	5	26	9
11	31	1.5	2	25	7
12	32	1.5	5	27	6
13	31	1.5	5	27	1
14	31	1.5	5	29	2
15	32	1.5	3	25	3
16	34	1.6	1	29	5
17	32	1.5	5	29	5
18	38	1.7	6	26	4
19	36	1.6	5	28	2
20	36	1.6	3	28	4
21	34	1.6	5	30	9
22	38	1.7	6	27	5
23	31	1.5	6	28	2
25	38	1.7	5	29	3
26	41	1.9	6	27	1

Low Reading Comprehension--Male Subjects

Subject Number	Reading Comprehension*	Grade Equivalent	Conservation Ability	Auditory Discrimination	Visual-Motor Development
01	32	1.5	6	26	3
02	34	1.6	6	27	4
03	29	1.4	6	28	4
04	29	1.4	5	28	2
05	31	1.5	2	26	6
06	38	1.7	6	22	5
07	32	1.5	5	28	1
08	41	1.9	5	28	2
09	41	1.9	5	26	3
10	36	1.6	2	28	9
11	32	1.5	5	29	7
12	36	1.6	5	28	6
13	39	1.8	6	29	5
14	36	1.6	5	26	1
15	38	1.7	2	26	6
16	32	1.5	4	27	3
17	38	1.7	5	29	7
18	39	1.8	5	27	3
19	38	1.7	5	30	9
20	30	1.5	5	27	7
21	41	1.9	6	29	9
22	41	1.9	5	29	4
23	29	1.4	6	30	5
24	38	1.7	6	28	4

*Standard Score, Gates-MacGinitie Reading Tests, Primary C, Form 1, comprehension subtest.

APPENDIX B

RAW DATA ON PERFORMANCE OF SIX CONSERVATION TASKS FOR ALL SUBJECTS

High Reading Comprehension--Female Subjects

Subject Number	Conservation Tasks*					
	Number	Liquid	Solids	Area	Length	Weight
01	+	+	+	+	+	+
03	+	+	+	+	-	+
06	+	+	+	-	+	+
07	+	+	+	+	+	-
08	+	+	+	+	+	+
10	+	+	+	+	+	+
11	+	+	+	+	+	+
13	+	+	+	+	+	+
15	+	+	+	+	+	+
17	+	+	+	+	+	+
18	+	+	+	-	+	+
20	+	+	+	+	+	+
22	+	+	+	-	+	+
27	+	+	+	-	+	+
29	+	+	+	+	+	+
30	+	+	+	+	+	+
33	+	+	+	-	+	+
35	+	+	+	-	+	+
36	+	+	+	+	+	+
39	+	+	+	+	+	+
40	-	+	+	+	-	+
42	+	+	+	-	+	+
46	+	+	+	+	+	+
48	+	+	+	+	+	+

High Reading Comprehension--Male Subjects

Subject Number	Conservation Tasks*					
	Number	Liquid	Solids	Area	Length	Weight
01	+	+	+	+	+	+
03	+	+	+	+	+	+
04	+	+	+	-	-	+
06	+	+	+	+	+	+
07	+	+	+	+	+	+
10	+	+	+	+	+	+
14	+	+	+	-	-	+
15	+	+	+	+	+	+
16	+	+	+	-	+	+
17	+	+	+	-	-	+
18	+	+	+	+	-	+
19	+	+	+	-	+	+
20	+	+	+	-	+	+
23	-	+	+	-	+	-
24	+	+	+	+	+	+
25	+	+	+	+	+	+
26	+	+	+	+	+	+
29	+	+	+	+	+	+
30	+	+	+	+	+	+
32	+	+	+	+	+	+
33	+	+	+	+	+	+
35	+	+	+	+	+	+
36	+	+	+	-	-	+
37	+	+	+	+	+	+

Low Reading Comprehension--Female Subjects

Subject Number	Conservation Tasks*					
	Number	Liquid	Solids	Area	Length	Weight
02	+	+	+	+	+	+
03	+	+	+	+	+	-
04	+	-	-	-	-	-
05	+	+	+	-	+	+
06	+	+	+	-	-	-
07	+	+	+	+	+	+
08	+	-	+	-	-	+
09	-	-	-	-	+	-
10	+	+	+	-	+	+
11	+	-	-	-	-	+
12	+	+	+	-	+	+
13	+	+	+	+	-	+
14	+	+	+	+	-	+
15	+	-	+	-	-	+
16	-	-	+	-	-	-
17	+	-	+	+	+	+
18	+	+	+	+	+	+
19	+	+	+	-	+	+
20	+	-	+	-	+	-
21	+	+	+	-	+	+
22	+	+	+	+	+	+
23	+	+	+	+	+	+
25	+	+	+	-	+	+
26	+	+	+	+	+	+

Low Reading Comprehension--Male Subjects

Subject Number	Conservation Tasks*					
	Number	Liquid	Solids	Area	Length	Weight
01	+	+	+	+	+	+
02	+	+	+	+	+	+
03	+	+	+	+	+	+
04	+	+	+	-	+	+
05	+	-	-	-	-	+
06	+	+	+	+	+	+
07	+	+	+	-	+	+
08	+	+	+	-	+	+
09	+	+	-	+	+	+
10	+	-	+	-	-	-
11	+	+	+	+	-	+
12	+	+	+	-	+	+
13	+	+	+	+	+	+
14	+	+	+	-	+	+
15	+	-	-	-	+	-
16	+	+	+	-	+	-
17	+	+	+	-	+	+
18	+	+	+	-	+	+
19	+	+	+	-	+	+
20	+	+	+	-	+	+
21	+	+	+	+	+	+
22	+	-	+	+	+	+
23	+	+	+	+	+	+
24	+	+	+	+	+	+

*+ = Conservation

\- = Non-conservation

APPENDIX C

MEANS AND MEDIANS OF CONSERVATION ABILITY, AUDITORY DISCRIMINATION, VISUAL-MOTOR DEVELOPMENT AND READING COMPREHENSION SCORES FOR NINE GROUPS

N	Group	Conservation Ability		Auditory Discrimination		Visual-Motor Development		Reading Comprehension	
		$\bar{X}$	Mdn.	$\bar{X}$	Mdn.	$\bar{X}$	Mdn.	$\bar{X}$	Mdn.
96	All Subjects	4.97	5.30	27.40	27.60	3.74	3.30	49.35	39.55
48	High Reading Comprehension	5.45	5.67	27.64	27.83	2.79	3.66	64.10	62.58
48	Low Reading Comprehension	4.47	5.05	27.16	27.46	4.68	5.62	34.60	32.59
48	Males	5.15	5.44	27.54	27.75	3.79	5.73	49.98	39.60
48	Females	4.79	5.29	27.27	26.42	3.69	4.87	48.73	39.55
24	High Reading Comprehension Males	5.38	5.70	27.54	27.70	2.79	2.25	64.54	62.56
24	High Reading Comprehension Females	5.54	5.71	27.75	27.90	2.79	2.30	63.66	62.52
24	Low Reading Comprehension Males	4.92	5.10	27.54	27.90	4.79	4.50	35.40	34.56
24	Low Reading Comprehension Females	4.04	4.80	26.79	27.00	4.58	4.25	33.79	31.62