THE EFFECT OF SELECTED SCIENCE ACTIVITIES ON THE ATTAINMENT OF READING READINESS SKILLS WITH KINDERGARTEN CHILDREN

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ABSTRACT

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By

Donald Edward Maxwell

The Problem

The purpose of this study was to determine the effect of science activities, which use concrete objects to develop science concepts and process skills, on the attainment of reading readiness in kindergarten children. The factors of visual perception, language facility, and experience were examined to determine the effect of the science activities upon the attainment of these specific factors.

The Method

Selected activities from the Science Curriculum Improvement Study's (SCIS) physical science unit Material Objects was used as the treatment.

The population of interest in the study was the kindergarten children in the Waterford School District located near Detroit, Michigan. Waterford Township, a predominately white suburban community, has little industry or agriculture with most of the adult working population being employed in industry outside the community proper. The social economic status of its inhabitants ranges from lower class to lower upper class.

All kindergarten children (132) in two suburban schools were given the Metropolitan Readiness Test Form A in January, 1971. Based on the scores from this test, the 102 students who fell in the C, D, and E categories were considered to be the population of interest. These students were then randomly assigned to one of three groups. The groups were treatment, placebo control, and control. The treatment group received science activities from Material Objects. The placebo control group received fine and gross motor activities instead of science activities, and the control group received the normal kindergarten program.

After eight weeks of instruction consisting of twenty to twenty-five minutes each day for five days each week, the three groups were again observed. The effects were assessed by four measures: the Metropolitan Readiness Test Form B, The Marianne Frostig Developmental Test of Visual Perception, the Verbal Expression subjest of the Illinois Test of Psycholinguistic Abilities, and the Material Objects Test.

Each test was used in determining the overall effect on reading readiness while certain subtests scores were examined to determine the treatment effect upon the individual readiness factors.

The Results

The data were evaluated using multivariate analyses of variance. Analysis of the data indicated that science activities from the Science Curriculum Improvement Study's (SCIS) physical science unit Material Objects did significantly effect kindergarten children's reading readiness $p. \leq 0.0001$ as measured by the instruments. Specific factors of readiness effected in this study were language facility $p. \leq 0.0001$ and

experience p. $\leq$ 0.0001. While the factor of visual perception was not statistically significant in this study, there were indications in the data that warrant further study of this factor.

Conclusions

Analysis of the findings indicate that:

1) The treatment group, those kindergarten children who were actively engaged in a sequenced series of science activities with concrete objects, made greater gains in the attainment of reading readiness than placebo control or the control group.
2) The treatment group made significant gains in the development of language facility over those kindergarten children who had a traditional kindergarten program. Concrete science experiences in kindergarten provided children with a broader vocabulary and skill in expressing themselves.
3) The treatment group made significant gains in the experience factor over those kindergarten children who received the traditional kindergarten program.

Educational Implications

The significant growth in reading readiness observed in the treatment children in this study indicate that there should be greater emphasis placed upon kindergarten programs which encourage the child's interaction with concrete objects prior to his receiving instruction in reading which is primarily representative and symbolic. Treatment children showed significant gains in both language facility and experience which have been identified as important readiness factors by reading experts.

Learning activities for kindergarten children should be developed logically and sequenced so that the child may proceed from simple to more complex concepts with meaning. The children who were in the placebo group were engaged in activities which utilized concrete objects, but unlike the treatment children they were not sequenced to insure logical development of concepts or skills.

In planning for kindergarten instruction, science activities which stress concrete experiences such as those in the Science Curriculum Improvement Study (SCIS) Material Objects unit should be included. The child in such a program will not only benefit from the science instruction, but will also develop certain reading readiness factors.

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A THESIS

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Dedicated to my parents

Edward S. and Glenda E. Maxwell

for their love, encouragement and faith.

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CHAPTER I

THE PROBLEM

The development of elementary science programs which stress the learner's use of concrete objects in carrying on investigations has created a problem for many early elementary teachers. The implementation of these programs requires more instructional time be spent in the area of science education than is normally available at this level. The problem that faces the early elementary teacher therefore, is one of providing the additional instructional time for science and still having sufficient time for developing the reading readiness skills the children need to begin reading. This study was undertaken to determine whether both purposes might be served through the science instruction.

Statement of the Problem

In this study the Science Curriculum Improvement Study's (SCIS) physical science unit Material Objects was taught to selected kindergarten children to determine its effect upon attainment of reading readiness skills. In addition to determining the effect of this instruction upon overall reading readiness, certain specific factors were examined, namely those of visual perception, language facility, and experience. It should be noted that the authors of the Science Curriculum Improvement Study (SCIS) program make no claim that their

program develops reading readiness. They, however, have evidence that students do attain certain process skills and concepts in science (Renner, Stafford, Weber, Coffia, and Kellogg, 1971).

The Need for the Study

Few educators would deny the importance of reading in the education of the child. Without basic reading skills the child in our educational system is usually destined for failure. Reading may be considered the cornerstone of our educational enterprise and much of the young child's early schooling evolves around preparation for the reading task.

While reading authorities are in agreement with the importance of reading to the young learner, there is however, less agreement as to how to prepare the child for reading or which method of instruction should be utilized. The majority of reading authorities have identified and agreed on certain factors which are important in attaining reading readiness. Most agree on these factors: maturity, intelligence, language facility, visual and auditory perceptual development, and experience.

With the advent of science programs such as Science--A Process Approach (SAPA), Elementary Science Study (ESS), and Science Curriculum Improvement Study (SCIS), there has been a greater emphasis placed upon science and working with objects to teach science in the elementary school. Prior to these developments, science was, in many instances, limited to nature study activities, specific content units; i.e., magnets, simple machines, or impromptu discussions about events

which occurred on the spur of the moment. With the development of modern science programs and the subsequent implementation in many schools in the nation, there developed a demand for a greater portion of the instructional time for science. In early elementary this demand created problems for many teachers because they feel that there is not sufficient time to properly develop basic skills required for arithmetic and reading and also teach science.

Realizing the difficult position with which educators were faced, it became imperative that to be truly functional, the science program, in addition to developing process skills and science concepts, should also contribute to the child's basic skills.

Through examination of the Science Curriculum Improvement Study's (SCIS) unit Material Objects and after discussions with teachers using it, it appears that some of the readiness skills may be developed through the use of this program. Many of the activities appear to involve skill development in areas such as language facility, visual perception, recognizing relationships, and concept and process experiences.

Hypotheses, Questions, and Definitions

Of interest in this study are the following questions:

Will activities from the Science Curriculum Improvement Study (SCIS) Material Objects unit taught to kindergarten children affect their attainment of reading readiness skills?

Will the activities from Material Objects enable students to make significant gains in visual perception over those students who have had the regular kindergarten program?

Will the Material Objects activities provide readiness experiences which would not normally occur in a regular kindergarten program?

Will the activities from Material Objects enable students to make significant gains in language facility attainment over those students who have had a regular kindergarten program?

Which science experiences, as measured by the Material Objects Test have significant correlations with readiness subtests?

The Hypotheses to be Tested in This Study

Reading Readiness - Null hypothesis tested: The treatment will have no effect on the attainment of readiness skills in kindergarten children as measured by the Metropolitan Readiness Test Form B, The Marianne Frostig Developmental Test of Visual Perception, the Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities, and the Material Objects Test.

Visual Perception - Null hypothesis tested: The treatment will have no effect on the development of visual perceptual skills in kindergarten children as measured by the individual subtest scores of the Frostig test and Metropolitan Form B's subtests; subtest 3 Matching, and subtest 6 Copying.

Experience - Null hypothesis tested: The treatment will have no effect on the acquisition of experience for kindergarten children as measured by the Material Objects Test.

Language Facility - Null hypothesis tested: The treatment will have no effect on the development of language facility in kindergarten

children as measured by the Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities.

Definitions

In this study the following definitions are being used:

Readiness - Reading Readiness: In this study reading readiness refers to the child's attainment of sufficient experiences and skills to enable him to begin a reading program with a high probability of achieving success in learning to read.

Visual Perception: The child's interpretation of stimuli which he receives from his environment. It involves not only his ability to "see" differences and likenesses, but also to recognize and remember them.

Language Facility: For the purposes of this study, language facility refers to the child's vocabulary of descriptive words and his ability to use them correctly in communicating with others as he describes familiar objects.

Experience: In this study experience is defined as the child's conceptual background which is acquired as the child interacts with objects and other children in his environment. It may be measured by the child's ability to successfully apply these concepts when presented with new objects or situations.

Material Objects Test: For the purposes of this study the Material Objects Test refers to the instrument initially developed by the Science Curriculum Improvement Study (SCIS) staff in Berkeley,

California and modified by the investigator for use in this study. See Appendix A.

Science Curriculum Improvement Study (SCIS) Material Objects Activities: Those Science Curriculum Improvement Study (SCIS) activities which the treatment children were engaged in during the daily training sessions. The activities and materials with which the children worked come from the Science Curriculum Improvement Study's (SCIS) unit Material Objects. The activities require the child to manipulate various concrete objects, examining them and identifying properties of those objects. The children are encouraged to interact with one another while working with the objects.

Properties: The attributes or characteristics of an object.

Concrete Experience: In this study a concrete experience is one in which the child manipulates and examines objects.

Treatment: Those activities selected from the Science Curriculum Improvement Study's (SCIS) unit Material Objects which were used with kindergarten children who were placed in the treatment group. Treatment group children spent between twenty to twenty-five minutes each school day involved in science activities.

Control: The normal kindergarten program which kindergarten children were engaged in. The control children were post-tested with the placebo and treatment children.

Placebo: Gross and fine motor activities which were used with the children who worked with the investigators in small groups away from the kindergarten classroom. Each placebo session involved between twenty to twenty-five minutes.

Readiness Factor: Readiness factors are those skills or attributes which one should have before a formal reading program is begun. If a child lacks sufficient readiness factors his chances for success in reading are limited.

Gross and Fine Motor Activities: In this study children were engaged in games, relays, and special projects which involved the coordinated use of their large and small muscles. Such activities were not sequenced or presented in any particular order for the purpose of developing a particular skill.

Comparison: The child while manipulating concrete objects is required to use the greater than (>) or less than (<) sign to compare a set of objects which have a particular property. An example might be to use comparison signs to describe the size relationship between a baseball, softball, and volleyball.

Material: Material refers to the substance that an object is composed of. Examples of materials would include such things as wood, metal, and plastic.

Object: A piece of matter, solid, liquid, or gas, is referred to as an object. Such things as love, hate, and democracy are non-objects.

Sort: In examining collections of objects, the children were asked to separate these objects into groups using one or more properties.

Science Curriculum Improvement Study (SCIS) Learning Cycle: The learning cycle in Science Curriculum Improvement Study (SCIS) is the process by which concepts and process skills are introduced to children. The learning cycle involves three stages which are called exploration, invention, and discovery.

Exploration: This is the first stage in the Science Curriculum Improvement Study (SCIS) learning cycle. In exploration the children handle and manipulate concrete objects with a minimum of instructions and specific directions. The children, during the exploration stage, are provided with experiences in working with concepts or processes on a non-verbal level. The children carry on certain kinds of predictable activities, due to the nature of the objects, and later the instructor uses these activities as a basis for concept identification.

Invention: Invention lessons (second stage in Science Curriculum Improvement Study (SCIS) learning cycle) occur after exploration when the children are ready for a definition and label for a particular concept with which they have worked. Such definitions and labels are presented through the use of examples called "operational definitions." The children look for examples of the "invented" concept from their past work and identify additional examples which fit their definition.

Discovery: Discovery is the third stage of the Science Curriculum Improvement Study (SCIS) learning cycle and it involves the children in several activities in which they apply the concept or process skills that were developed through the exploration and invention lessons.

Assumptions and Limitations

In this study the following assumptions have been made:

a. All the instruction for each subgroup of the treatment, placebo, and control groups was the same.

b. The regular kindergarten teacher could teach the Material Objects unit as well as the special male instructors used in this study.

c. The individuals who post-tested the children were the same in their interactions with all children during the testing program.

d. Children in other elementary schools in Waterford are similar to those children in the two study schools.

e. The children in the placebo and treatment groups did not systematically miss a particular segment of their regular kindergarten program while taking part in the study activities.

The following limitations have been recognized in this study:

a. The size of the subgroups for the placebo and treatment groups ranged from nine to twelve children which is considerably less than a typical kindergarten class.

b. The length of time for treatment was limited to eight weeks of instruction with treatment children having a daily session each school day during the eight week period. (Five sessions twenty to twenty-five minutes each, per week.)

c. The time limitation, number of subgroups, and other factors did not allow for coordination of the science instruction within the framework of the children's regular kindergarten instruction.

d. The post-treatment observations were made by examiners who had not previously worked with the children. This may have created some reluctance on the part of many of the children at this age level.

e. The gross and fine motor activities in which the placebo children were engaged would have an effect upon these children's attainment of visual perceptual skills.

Summary of Procedures Used in Study

One hundred and thirty-two kindergarten children, the total kindergarten population of the two study schools, were given the Metropolitan Readiness Test Form A from January 11 through 15, 1971. Based upon the scores from this test, those children who placed in the C, D, and E categories were considered to be the population of interest (a total of 102 subjects). The thirty children who placed in categories A and B were not included in the study as their readiness status is considered "Superior" and "High Normal" by the Metropolitan Readiness Test authors, (Hildreth, Griffiths, and McGauvran, 1969). They define these five categories as:

A. Superior - Apparently very well prepared for first-grade work. Should be given opportunity for enriched work in line with abilities indicated.

B. High Normal - Good prospects for success in first-grade work provided other indications, such as health, emotional factors, etc., are consistent.

C. Average - Likely to succeed in first-grade work. Careful study should be made of specific strengths and weaknesses of pupils in this group and their instruction planned accordingly.

D. Low Normal - Likely to have difficulty in first-grade work. Should be assigned to slow section and given more individualized help.

E. Low - Chances of difficulty high under ordinary instructional conditions. Further readiness work, assignment to slow sections, or individualized work is essential (p. 11).

Students were selected from this population to form three groups. Each student was placed in a group through the use of a table of random numbers. The groups differed in the following manner:

Control: Students who would receive the regular kindergarten program but would be post-tested with placebo and treatment groups (twenty-eight subjects).

Placebo: Students who were to be taken from class to work with the experimenters. They spent the same amount of time out of their classroom as the treatment group, but did not work with activities from the Science Curriculum Improvement Study (SCIS) program. The students were involved in gross and fine motor activities (thirty-two subjects).

Treatment: Students who spent twenty to twenty-five minutes each school day with experimenters involved in activities from the Science Curriculum Improvement Study's (SCIS) Material Objects (forty-two subjects).

Upon completion of eight weeks of treatment, all three groups were again tested using: 1) Form B of the Metropolitan Readiness Test, 2) The Marianne Frostig Developmental Test of Visual Perception, 3) The Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities, and 4) Material Objects Test.

The data were evaluated using a program of multivariate analysis of variance programmed by Jeremy Finn, State University of New York at Buffalo.

Overview of Chapters II through V

In Chapter II the literature is reviewed to provide the theoretical basis for reading readiness.

Background on reading readiness based upon reading experts descriptions is presented, including the identification of many of the readiness factors which are said to contribute to the child's attainment of reading readiness skills.

The specific factors which were utilized in this study are then examined in greater detail and their potential relationship to a child-centered object-oriented science program is developed. In examining the experience factor and its attainment, the related research in science education is reviewed.

In Chapter III the procedures used in the study are described. Also included in Chapter III are the descriptions of the various instruments used in post-testing.

Chapter IV consists of the presentation and analysis of data. Each hypothesis is examined and its significance is determined.

In Chapter V the data related to each of the hypotheses are examined and conclusions drawn. The educational implications and implications for future research are presented.

CHAPTER II

REVIEW OF LITERATURE

A theoretical basis for using elementary school science activities to develop reading readiness is examined in this chapter. Background on reading readiness based upon reading experts' descriptions is presented, including the identification of many of the readiness factors which are said to contribute to the child's attainment of reading readiness.

The specific factors which were utilized in this study are then examined in greater detail; their potential relationship to a child-centered, object-oriented science program is developed. In examining the literature regarding the experience factor and its attainment, the related research in science education is also reviewed.

Theoretical Basis for Readiness

Almy (1964) in studying beginning reading programs found that there were two conceptions of preparing children for formal reading instruction. One view identifies a series of stages or levels. The other view consists of a continuous process of reorganization, in which each new experience is, at least in part, dependent on what has happened before. She further stated that the work of Piaget lends considerable support to the latter view.

Almy in examining some of the implications for beginning reading instruction that may be drawn from Piaget's theories and research related to them, stated:

> Piaget was concerned primarily with various aspects of children's thought in relation to the evolution of mental operations involved in the adult's abstract logical thought. He traced this evolution from the earliest reflex behavior of the infant, describing how he thought such initially diverse functions as looking, grasping, and sucking gradually become organized into increasingly complex patterns, or 'schemata.' These schemata, originally occurring as actions, were eventually internalized and became mental pictures or ideas, to which words were attached, according to Piaget (p. 98).

She felt that once the ability to comprehend and use words is developed, these schemata are organized into increasingly complex patterns and associations. As these patterns and associations increase in number we say that the child is developing additional concepts. Almy further indicates that the implications for beginning reading instruction (Readiness) seem to imply that to neglect providing many and varied concrete experiences may hinder the development of abstract thinking and may interfere with the development of reading comprehension. Piaget's theory further implies the need for the child to discover his own errors in thinking so that he can attempt to correct them.

Anderson (1956) in discussing implications of Piaget's work in preparing young children for reading suggested that teachers should know how to use concrete, specific, and tangible materials rather than verbal, symbolic, and abstract materials in instruction. The young child thinks in concrete rather than abstract terms and his thought is closely connected with the object or situations in which the thought

arises. Anderson (1956) and Almy (1964) both have stressed the importance of the child having experiences with concrete materials for concept development which is important in the preparation for reading in young children.

In examining the learning cycle which is an integral part of the Science Curriculum Improvement Study (SCIS) program one can see the importance of the exploration lessons in which the child is provided with materials and allowed to manipulate and explore them. This provides him with the opportunity to develop or focus in on a concept at a preverbal level. Later during invention lessons the child is introduced to the concept name or the label used to represent the concept. Then he is provided numerous opportunities to apply the concept in working with other concrete objects in discovery lessons.

Further support for Almy's (1964) position regarding concrete experiences and beginning reading can be seen in comments of other reading experts. Reading itself is a complex process which is not a general ability but a composite of many specific abilities. (DeBoer, 1960). If you consider this and Betts' (1938) statement that educators may help the child develop basic skills, abilities, and attitudes which will serve him as he begins reading then you can infer that readiness training is important to the child. Smith (1961) in describing the nature of reading stated:

> Reading is a perceptual rather than merely a sensory process and, as such, it includes more than mere recognition of words. Neither printed pages nor orally spoken words transmit meaning. The essence of meaning comes from the reader's fund of experiences (p. 12).

Reading Readiness

Success with the reading process is dependent upon the child's attainment of a number of inextricably interrelated factors. DeChant (1970) indicated that there are both biological and environmental factors which determine readiness for and achievement in reading. The development of many of these factors form the basis of reading readiness.

Kawin (1956) defined readiness as the ability to learn. It has been further defined as that stage where the child is able to cope with the diverse aspects of the reading process. Murphy (1962) pointed out that readiness is not something we wait for, but it is something that is brought about through careful instruction.

Henderson (1969) in discussing the importance of reading readiness, indicated that many parents judge their child's progress by his growth in reading. Many administrators use standardized reading test results to gauge the standing of their schools. With the needs of the child and the demands of parents and educators to produce better readers, the importance of developing readiness skills is undeniable.

Reading experts have identified numerous factors which have an effect upon the child's ability to attain reading readiness. Some of these factors are dependent upon the individual genetic background or his physiological development. Others may be affected by his interactions with his environment. The following list of factors have been identified by reading experts as being important:

Visual Perception (Harris 1970) (Frostig 1963) (Strang 1965)

Auditory Perception (Harris 1970) (Barrett 1965) (Huus 1967) (Murphy 1962)

Language Facility (Huus 1967) (Factor 1940) (Kephart 1965) (Alsham 1965)

Experience (Barrett 1962) (Huus 1967) (Harris 1970) (Evans 1945)

Age (Harris 1970) (Gray 1963) (Barrett 1962)

Sex (Harris 1970)

General Intelligence (Harris 1970)

Physical Health (Harris 1970)

In this study the specific factors of visual perception, language facility, and experience are examined, they appear to be the factors that may be influenced most by the child's interactions with his environment.

Visual Perception

Visual perception involves the transmission and interpretation of stimuli that have been received by the eyes. Goins (1958) described visual perception as the process by which phenomena are apprehended by the mind through the medium of the eye. Visual perception is the ability to differentiate between two or more forms, such as objects, written words, or letters, according to DeBoer (1960). It starts as a crudely differentiated and grossly selective process, and as the learner acquires additional skill he is able to identify distinguishing features by making finer and finer discriminations.

In describing the importance of visual perception in learning to read, Hildreth (1950) indicated that the child must attach meanings to a series of abstract symbols which in themselves are made up from combinations of the twenty-six symbols we call letters. In doing so the learner has to be able to distinguish between such similar forms as

"bell," "ball," and "bill." Heilman (1961) stated that visual perception is one of the major objectives of beginning instruction for reading. The child must make fine visual discriminations in reading. If the child has not had sufficient experience in making visual discriminations prior to attending school, he should be provided such opportunities as are needed. Heilman stated "Maturation cannot be hastened, but visual discrimination can be sharpened through practice (p. 53)."

In a study with kindergarten children, Earhart (1969) found that certain factors which act as indicators of potential reading problems could be identified. These factors were sex, social position, perceptual quotient, and teacher's expectations. The perceptual quotient (from the Frostig test) is a measure of the child's visual perceptual abilities. An individual with a perceptual quotient (PQ) of 90 or below is considered to require specific training.

Goins (1958) in an investigation of first grade children found a multiple correlation of +0.827 with visual perception tests used and reading success at the end of first grade.

Frostig (1964) in working with children at the Marianne Frostig School of Educational Therapy found that most of the children with learning difficulties also had visual or auditory perceptual disturbances. She indicated that visual perception disturbances were the most frequent and identified five areas of visual perception problems which were:

1) Eye-hand coordination--related to writing.
2) Figure ground perception--related to word recognition.
3) Form constancy--related to recognition of letters or words when they are written in different cases, color, or sizes.

4) Position in space--related to difficulties with reversals or rotations.

5) Spatial relationships associated with interchanging the order of letters in a word.

She developed an instrument, The Marianne Frostig Developmental Test of Visual Perception, to measure these five areas. Frostig (1964) reported that in studies with beginning reading situations a correlation coefficient of between 0.4 and 0.5 was found between the visual perception test and reading. In another study 36 percent of the subjects had perceptual quotients of 90 or less and of these 70 percent fell below the mid-point on the Reading Achievement Test.

Spache (1964) examined many studies on form perception and reading readiness. He pointed out that there is no clear indication of what type of perceptual training is needed, but his tentative conclusions were:

1) Children vary a great deal in the amount of form perception training needed.

2) Training should proceed from gross to fine discrimination.

3) The more closely the final perceptual tasks resemble word forms the more effective the training will be.

4) Emphasis upon speed discrimination should probably occur late in the training process, after a high degree of accuracy has been developed.

Goins (1961) in a study with first grade children to determine if there was a relationship between visual perception and reading ability and whether training in rapid recognition of digits, geometric and abstract figures would aid in reading, found a correlation of 0.47

between visual discrimination and reading. She found rapid recognition training of value to good readers, but of little value to those children with visual perception problems.

DeHirsch (1966) reported that there was research in Russia that showed that small children are better able to understand the relationship between parts of objects when they manipulate these objects (Figure Ground).

Developing Visual Perception

Betts (1957) suggested a number of ways the child may be aided in development of visual perception through activities. Class discussions of how objects and pictures of objects are alike and how they are different is helpful for visual perception development. Betts also pointed out that to be effective the activities should be of interest to the children and have some purpose and meaning for the child.

Gray (1963) in discussing the role of visual skills required for reading suggested that the learner be given an opportunity to: recognize likenesses and differences, classify objects that look alike, observe internal details, see part-to-whole relationships, and associate ideas in a sequence. Durbin (1967) basically supported these ideas and further suggested that use of objects, pictures, and shapes would prove helpful in developing visual discrimination. Spache (1964) in dealing with the importance and development of visual perception skills relates that the child tends to explore objects in space by learning shapes and spatial relationships first with his hands (and mouth) and later with his eyes.

While most of the studies have found a positive relationship between visual perception and working with objects, Brzeinski (1967) chose to use an alternative approach in a study with 122 kindergarten classes in Denver. The treatment individuals in Brzeinski's study were engaged in activities which provided practice in using beginning consonant sounds with contextual or meaning clues to identify a printed word. He found that they could overcome children's difficulties in visual perception through specific training which apparently did not involve using concrete materials.

In the materials selected in this study the children repeatedly worked with concrete objects identifying properties and making comparisons of specific properties between similar objects. After reviewing the literature on visual perception and studying this unit, it would seem reasonable to predict that the child in the program would be able to make significant gains in the attainment of visual perceptual skills.

The Experience Factor and Reading Readiness

The role of experience in developing reading readiness in the young child has been elaborated upon by many reading experts. Hildreth (1950) indicated that the child with broader experiences will have more words in his vocabulary and a better understanding of conversation about common objects than will the child who has had limited experiences. Along the same line Henderson (1969) stated: "We must take meanings to print in order to secure meanings from it (p. 18)." Martin (1958) felt that the child should have experiences necessary to understand the concepts being presented. DeChant (1968) felt that experience is one

factor that accounts for differences among children and a lack of experiences may be a cause of reading disability. DeChant stated:

> Differences in learning ability of children are related to their biological potentials, but also to the environmental opportunities. Some children become reading disability cases because the environment does not call forth their potential (p. 59).

DeChant also indicated that poor reading or reading failure may be caused by the child's lack of interest, which is a result of little motivational readiness. Motivation for reading can be developed by direct contact with objects, people, and events. Hildreth (1963) in discussing the relationship of experience and reading readiness stated that the experiences should be rich and relevant. Kawin (1956) says if the child lacks the environmental and experiential background essential for readiness, the home and the school are obligated to provide these experiences.

Smith (1961) reported that studies have shown that the greater the child's experiences, the greater are his possibilities for success in reading.

In discussing direct and vicarious experiences and their relationship to reading readiness with young learners, Betts (1957) related that direct, or first-hand experiences are of prime importance and that they may be extended through vicarious or second-hand experiences. Appropriate experiences are essential if the learner is to gain perceptual readiness commensurate with his overall capabilities, reported Smith (1961).

The Experience Factor - Its Function in Concept Development

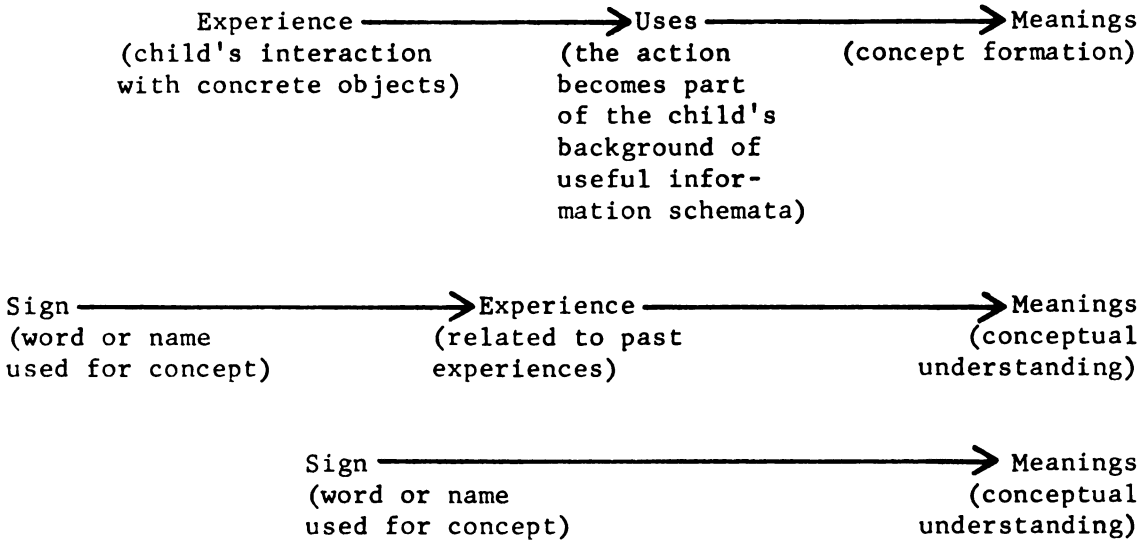
One of the major contributions that experiences provide for the young learner is in the area of concept formation. This idea was supported by Hildreth (1963); she related that a word is easier to recall when some meaningful association can be established between the word, its form or sound, and the ideas it represents. DeBoer (1960) suggests that by means of objects displayed in the classroom the child's fund of information or concept base can be extended. Harrison (1939) stated that meaningful concepts aid in the interpretation of symbols; objects also aid in fixing the memory of printed symbols or words. Russell (1961) stated:

> Since, at best, words represent a second-hand, or vicarious, experience, the teacher will provide many opportunities for children, especially young children, to touch, taste, hear, see, or manipulate the thing for which the word stands. Additional background for understanding will be built through dramatic play, dramatization, games, excursions, construction, and science experiences. By such activities the teacher avoids mere verbalizations in favor of true learning (p. 283).

Yoakam (1955) indicated that children who lack sufficient experiences to build a good concept background should be identified early so that experiences can be provided to enrich the child's conceptual knowledge.

Anderson (1956) pointed out that learning experiences and opportunities should be arranged in some order or pattern to be meaningful. Henderson (1969) referred to Thorndike's work in 1917 when he found in a study with sixth graders that unless they had some conceptual understanding of the written word it had no meaning even though they could read the words. Henderson developed a model to explain how the child

proceeds in stages from experiences in the development of concepts to the use of signs which represent concepts or symbols such as those we see in books. The simplified model follows:



Hildreth (1963) suggested that we start reading with the things the child knows about, talks, and asks about, with materials that are related to things he can actually pick up, touch, and examine.

Experience and Developing Reading Readiness

Crews (1972) in describing some of the myths of reading made the following statement:

> A curriculum that includes activities in science, math, and social studies provides the background of experiences and thinking that is of prime importance when trying to read material (p. 412).

Hillerich (1965) in his review of current research on reading readiness, found that an experience approach appeared to be better than use of workbooks when the latter involved interpreting pictures and gross kinds of discriminations. He concluded that the traditional experience approach and the general kind of readiness workbooks were

teaching the same thing. He felt that neither approach developed specific skills, but that the experience approach had the advantage of spontaneity and enthusiasm.

Ayers (1969) conducted a study in which he measured gains in readiness scores on the Metropolitan Readiness Test with two groups; one, a readiness program, lasted three hours per day, five days per week for the school year and the other used Part A of Science--A Process Approach (SAPA) for one hour per week for twenty-two weeks. He used a pre- and post- measure for each group and a t-test was used to determine if there were significant differences between the pre- and post-test means of subtest scores and mean gain scores. His results showed that the experimental group made significant gains in five of the six subtest scores and in mean gain. Word Meaning subtest was not significant. The control group showed significant gains in four of the six subtests and in mean gain. Listening and Numbers subtests were not significant. Ayers concludes that Science--A Process Approach could contribute to reading readiness with five year old children. However, teachers using the program might use other programs to develop vocabulary.

Ritz (1969) in a study which involved twenty-four kindergarten classes in ten different school systems looked at the effect of Part A of Science--A Process Approach (SAPA) and the Frostig Program for the Development of Visual Perception upon the attainment of reading readiness, visual perception, and science process skills. He used three groups--one used SAPA Part A alone, the second SAPA Part A and the Frostig Perceptual Constancy unit, while the third used only the Frostig Perceptual Constancy unit. He measured their gains through

Metropolitan Readiness Test, Form B (Readiness), Frostig Developmental Test of Visual Perception (Visual Perception), and SAPA's Competency Measures for Groups. Ritz concluded that science and visual perception instruction can be included in kindergarten programs without impairing the reading readiness attainment of children.

Kellogg (1971) conducted a study with first grade children using the Science Curriculum Improvement Study (SCIS) Material Objects unit and its effect on reading readiness attainment. He used the Metropolitan Readiness Test as a measure of the reading readiness gains with two groups; one receiving the science program alone and the other using their regular commercial reading readiness program. He reports that the experimental group out-gained the control in total score and all subtest areas except Copying. The levels of significance of the differences in gains between experimental and control groups as reported by Kellogg were:

	t value	Level of Significance
Word Meaning	1.9041	0.1
Listening	0.1377	Not significant
Matching	1.5426	0.2
Alphabet	0.5010	Not significant
Numbers	1.4599	0.2
Copying	0.2202	Not significant
Total	1.4511	0.2

He concluded that the greater gains made by the experimental group were due to two factors.

1) The nature of the Materials Objects unit which allows the child to develop through concrete experiences.
2) The program makes a contribution to the development of the child's reasoning ability which is a major purpose of education.

Stafford (1971) in an evaluation of the Science Curriculum Improvement Study (SCIS) Material Objects unit at the kindergarten level, attempted to measure, among other things, the effect of Material Objects upon the attainment of reading readiness. The Metropolitan Readiness Test was used to assess readiness gains and Stafford reported the experimental group out-scored the control on all bases of comparison on the Metropolitan Readiness Test, but none were significant at the 0.05 level of confidence.

Language Facility and Reading Readiness

The young child's facility with language or his ability to communicate with others is a measure of his conceptual knowledge. Many reading authorities have stated that the young child's skill in language usage is a prime indicator of the child's readiness for reading. Hildreth (1950) stated that unless children can speak well, listen attentively, and comprehend what they hear they are not ready for reading. She further stated:

> The connecting link between concrete experiences and abstract word symbols is to be found in oral language, which is actually symbolic but has become meaningful to the child through use in daily experiences (p. 251-252).

Anderson (1956), Spache (1964), Huus (1967), and DeChant (1968) have identified the child's facility with language as one of the major factors in determining a child's readiness for reading. Betts (1957) stated that in determining a child's readiness for reading one should appraise the child's ability to put words together in a form suitable for communication. He also stated that girls tend to have a larger vocabulary than do boys. This may be a possible explanation for the trend in beginning reading where girls out-perform boys.

Spache (1964) found that auditory vocabulary, or the breadth of words that a child recognizes when he hears them, is significantly related to readiness.

Earhart (1969) in her study with kindergarten children had done some initial work in the area of language facility as a predictor of reading difficulties. She found that there was a definite positive relationship between language facility and reading, but that the language factor was not retained in the prediction formula as a predictor of achievement in reading.

In relating the experience and language facility factors DeBoer (1960) stated:

> If direct experience is to be of substantial aid in reading, it must be accompanied by an adequate fund of experience with language (p. 33).

Additionally, Gray (1963) reported that when a child has new experiences they usually add new words to the child's vocabulary which contribute to his readiness for reading. Martin's (1958) contention that the core of reading is language development and that this is a key to readiness would also be in basic agreement with DeBoer and Gray.

Loban (1963) in a study of relationship between the size of children's vocabulary, the use and control of sentence patterns, and the inter-relations of oral language and competence in writing, reading, and listening found that children who were high in general language ability were also high in reading ability. He also found that there was a positive relationship between speaking, reading, writing, and listening. Loban's study involved 338 subjects beginning in the kindergarten and the first six years of elementary school. It is of interest to note the similarity between Loban's method of evaluating the child's

language facility and those that are used in the Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities which was used in this study.

As a result of reviewing Earhart's (1969) work and through personal communications with her, a decision to use the Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities and tape record the children's responses was made. Recording each session would allow the examiner the opportunity to make a detailed study of each individual's responses and insure accuracy in scoring.

In the Science Curriculum Improvement Study (SCIS) program the children are encouraged to interact with each other as they work with concrete objects. Discussions between children regarding the properties of the objects being investigated occur often. A number of simple games are played where the children use properties of objects as clues to identify a single object from a collection. In total group discussions each child is given an opportunity to contribute and later through use of objects they are given additional opportunities to apply the concepts discussed. It seems logical that such an approach should lead to better conceptual understanding and an increase in the child's language ability.

Summary

In this chapter a theoretical basis for reading readiness has been examined. What reading readiness means to reading experts and some of the factors which they feel are important in the child's attainment of reading readiness have been identified. The background for each of the

factors used in this study was reviewed, including how each of these factors may be developed through the use of concrete experiences such as those advocated in the Science Curriculum Improvement Study (SCIS) program. Related research dealing with these factors was identified and reviewed, including research that dealt with science education and reading readiness.

Reviewing the literature and related research clearly indicates that there is a need to determine the effect of science programs which stress the child's involvement with concrete objects upon their attainment of reading readiness and to identify which factors such training enhances.

CHAPTER III

METHODS AND PROCEDURES

Design

The population for this study was those children who were identified as having an average or below average chance of success in an initial reading program by the use of a recognized readiness test. The instrument selected was the Metropolitan Readiness Test Form A. Children who placed in the categories C, D, and E of that test were, therefore, considered the population.

The kindergarten children within this population were randomly assigned to three groups for the purposes of this study. They were: a treatment group, a control, and a placebo control. The treatment group received selected activities from the Science Curriculum Improvement Study's (SCIS) unit Material Objects in addition to the regular kindergarten program. The placebo control group received placebo activities in addition to the normal kindergarten program. The placebo group worked with the experimenters under similar time and location conditions as did the treatment group. However, they were primarily engaged in gross and fine motor activities.

The design consisted of the initial observation to select the population of interest. Once the population was identified and groups assignments were made the treatment group had eight weeks of science

activities while the placebo group engaged in placebo activities and the control group continued with the regular kindergarten program. At the end of the eight weeks a second observation was made of all three groups.

T	O_1	Tr	O_2
P.C.	O_1	P.T.	O_2
C	O_1		O_2

T = treatment group

P.C. = placebo control

C = control

O_1 = first observation

Tr = treatment

P.T. = placebo treatment

O_2 = second observation

Description of Population

The treatment, placebo control and control groups were selected from two suburban elementary schools in Waterford Township, Michigan. Waterford Township is a predominately white suburban community which is located close to the large industrial city of Detroit, Michigan. The community has little industry or agriculture with most of the adult working population being employed in industry outside the community proper. The socio-economic status of its inhabitants ranges from lower class to lower upper class. The average annual income, according to the 1970 census was $13,583.00. The two schools were selected because the number of kindergarten children in attendance was large and the children in both schools come from a broad social and economic background. The number of children was a limiting factor in the selection of schools, because the use of small treatment and placebo groups (9-12 per group) would create time problems for the trainers if they had to

travel between more than two schools. It was felt that a broad socio-economic background, ranging from lower middle to upper middle class, would provide a substantial number of children lacking readiness.

The kindergarten children in the two selected schools are representative of the kindergarten children in the district. This may be substantiated through the examination of the Michigan Department of Education's Michigan Educational Assessment Program (MEAP) scores for the schools for the 1970-1971 and 1971-1972 school years. Note should be made that while the scores given are not for kindergarten children but fourth graders they do reflect how fourth graders in the two schools compared with others throughout the state. One could infer that kindergarten children from these same schools would bear a similar relationship to other kindergarten children in the district and in the state. In one of the schools the fourth graders in 1970-1971 scored 48.2 in Reading, 46.4 in Mechanics of Written English, 48.5 in Mathematics and 49.5 in Word Relationship. (All scores are standard scores.) In the 1971-1972 school year its standard scores were: Reading 52.8, Mechanics of Written English 50.1, Mathematics 50.3, and Relationships 49.8 (see Table 3-1). The second school had MEAP Standard Scores of: Reading 50.7, Mechanics of Written English 51.1, Mathematics 51.1, and Word Relationships 51.8, in the 1970-1971 school year. During the 1971-1972 school year its standard scores were: Reading 52.6, Mechanics of Written English 50.9, Mathematics 54.9, and Word Relationships 50.7 (see Table 3-2).

TABLE 3-1

STANDARD SCORES FOR MICHIGAN EDUCATIONAL ASSESSMENT PROGRAM (MEAP)

School A

	1970-1971	1971-1972
Reading	48.2	52.8
Mechanics of Written English	46.4	50.1
Mathematics	48.5	50.3
Word Relationships	49.5	49.8

(Standard Scores for the MEAP are defined using a mean of 50 and a standard deviation of 10)

TABLE 3-2

STANDARD SCORES FOR MICHIGAN EDUCATIONAL ASSESSMENT PROGRAM (MEAP)

School B

	1970-1971	1971-1972
Reading	50.7	52.6
Mechanics of Written English	51.1	50.9
Mathematics	51.1	54.9
Word Relationships	51.8	50.7

(Standard Scores for the MEAP are defined using a mean of 50 and a standard deviation of 10)

Table 3-3 represents the district's standard scores for the 1970-1971 and 1971-1972 school year. These scores support the assertion that the children in the two study schools represent all of the children in Waterford's School District reasonably well. Because the district's MEAP scores are reasonably similar to those of the state, it can be further asserted that the study children are representative of kindergarten children in the state of Michigan.

TABLE 3-3

STANDARD SCORES FOR MICHIGAN EDUCATIONAL ASSESSMENT PROGRAM (MEAP)

School District Fourth Grade

	1970-1971	1971-1972
Reading	50.0	51.3
Mechanics of Written English	49.3	49.3
Mathematics	51.1	51.5
Word Relationships	50.9	49.0

(Standard Scores for the MEAP are defined using a mean of 50 and a standard deviation of 10)

Another important consideration was the cooperation of teachers and building administrators as the study would require removing children from their classroom and using a special teaching station for the training sessions. With these considerations and through discussions with Dr. Maurice Pelton, Director of Elementary Education, the two building principals and Dr. Eileen Earhart, who had prior knowledge of

the social and economic structure of the neighborhoods of both schools, the two schools were selected.

All 132 kindergarten children in the two schools were given the Metropolitan Readiness Test Form A in January of 1971. Of these, 107 scored in the lower three categories C, D, and E of that test. These children then were the population for this study. Each child in the population was assigned to one of three groups using a table of random numbers.

The number of students assigned to each group is presented in Table 3-4.

TABLE 3-4

GROUP ASSIGNMENT

Group Assignment - January, 1971	Males	Females	Total	
Treatment	24	20	44	
Placebo Control	19	13	32	
Control	17	14	31	
			107	
Group Assignment as of April, 1971				**Lost From Sample**
Treatment	23	19	42	2
Placebo Control	19	13	32	0
Control	16	12	28	3
			102	5

Lost from sample = Children who moved out of attendance area.

Special Considerations

The children participating in the study came from five different kindergarten classrooms and were taught by three different teachers. One teacher taught only a morning session. The use of special instructors would, therefore, remove teacher differences as a variable in the study as each child in the placebo and treatment groups had the same instructor. The placebo groups were used for two basic reasons: one to control for any Hawthorne effect which might occur as a result of the children leaving the regular kindergarten classroom for a "special" class and second, to control for the possible effect of male instructors, which are not normally found at the kindergarten level. All children in the study, however, were already exposed to a male instructor. A male physical education instructor worked with the children once each week.

To control for the possibility of the children in the treatment and placebo groups from systematically missing a portion of the regular kindergarten instructional program, the classroom teachers were asked to vary their instruction during the time groups were out of the classroom and asked not to teach a particular subject area or portion of their program to those children who remained.

Each child in the placebo and treatment group did not receive his instruction independently from the others in his group. In the Science Curriculum Improvement Study (SCIS) program a critical part of the instructional program is based upon child-child interactions. It was therefore imperative that the individuals be allowed to work in small groups to insure that this interaction took place.

Description of Placebo and Treatment Procedures

The children who were involved in the treatment and the placebo groups in the study were taken to a special room each day to receive twenty to twenty-five minutes of activities. The instructors of these sessions were not the classroom teachers, but special instructors who worked both with placebo and treatment children.

The children in the placebo group were engaged in gross and fine motor activities in which they played games, ran relays, constructed pre-cut wooden airplanes and cars. While these activities might be expected to have some effect on the experience factor in reading readiness, there was no attempt made during the study to develop skills or concepts in a sequential manner such as Science Curriculum Improvement Study (SCIS) has in the Material Objects unit.

A total of eight weeks or forty sessions with an average of twenty-three minutes per session with each group was conducted throughout the study. A total of approximately 930 minutes of treatment was involved. Both the treatment and placebo groups were further broken down into smaller groups for instructional purposes. The individual groups ranged in size from nine to twelve children in both treatment and placebo groups.

Treatment Group Activities

The following is a brief description of activities, concepts and mode of operation which are stressed in the Science Curriculum Improvement Study (SCIS) program and were used as the treatment in this study.

Material Objects - Part I: Introducing Objects and Their Properties

The children observe, describe, and sort collections of objects according to their common properties. They do this first through the use of objects found in and around their classroom. Later they work with objects and object collections provided by the teacher. As the children sort objects they focus initially on single properties but later begin to examine objects based upon more than one property.

Material Objects - Part II: Introducing the Concept of Material

The children continue to work with objects, examining them for their properties. In Part II, however, the children also work with objects that are the same size and shape but made of different materials. They are encouraged to sort by material once they have had sufficient experience with the concept. They investigate small pieces of wood and find that they can change the size and shape and it can still remain the same material. They also work with objects made of more than one material and sort objects based upon the property of one or more than one material.

In Part I the children work with solid objects and in Part II they eventually investigate the properties of liquid and gaseous objects. Later they compare two or more objects on the basis of the quantity of a particular property they possess (greenness, roughness, etc.). This leads to serial ordering of object collections.

Material Objects - Part III: Experimenting with Material Objects

The child continues to investigate various objects and to observe changes in them. In one investigation they work with sugar cubes and rock candy, noting their properties. Then they grind them into a powder

and find that the objects are the same material. They discover that different forms of the same material may have some properties which are different.

In the treatment program the following Science Curriculum Improvement Study (SCIS) objectives were used.

Objective	Material Objects' Chapters which focused on the stated objective
"To understand that the word object refers to a piece of matter."	Chapters 1, 2, 3, 4, 5
"To describe objects by their properties."	Chapters 1, 2, 3, 4, 5, 12
"To identify objects present in the kit and the environment from given properties."	Chapters 1, 2, 3
"To sort objects into groups according to properties."	Chapters 3, 4, 5
"To identify examples of solids, liquids and gases as objects."	Chapters 7, 8, 10, 15
"To identify some of the materials of which objects are made."	Chapters 7, 14, 15, 17
"To realize that an object's form can change while its material remains the same."	Chapter 13
"To distinguish between objects composed of one material and objects made of several materials."	Chapters 10, 14
"To arrange collections of similar objects in serial order according to property."	Chapters 11, 17
"To experiment with various objects in order to observe changes in them."	Chapters 18, 19, 21
"To interpret differences in a set of pictures as changes occurring in a given object or objects over a period of time."	Chapters 18, 19, 21

In addition to the activities described in the teacher's guide for Material Objects for those chapters listed, the children in the treatment group were also engaged in two special activities which were designed during the study to reinforce certain goals and objectives of the program.

They were:

Special Activity A

In this activity with snails the children examined and described properties of large land snails. Purpose:

1) Presentation of additional concrete experiences in properties concept using living organisms.
2) Increased interactions and observations between child and materials.

Special Activity B

A game was used with the children to reinforce the concepts of property and materials. In the game a single object was placed in a grab-bag prior to the children entering the room and then a set of common objects (10-15), including a duplicate of the object in the grab-bag, were placed upon a table. One child would give one of the properties of the object in the bag and the other children would then select objects from the table with that property. When no objects were left on the table with the property given, the remaining objects would be removed and the selected objects would be returned to the table. A second property would be given and the process repeated. It would continue until only one object was left and then it was compared with the object in the grab-bag. Purpose:

1) The children apply the property and materials concepts.

2) Child-child interaction increases as children compare properties of the objects they select.

Instruments Selected

Visual perception. The Marianne Frostig Developmental Test of Visual Perception, was selected as a measure of visual perception. Austin, in her review of the Frostig Test in the Sixth Mental Measurements Yearbook (1965), expressed enthusiasm in the statements: "The Frostig test appears to be a significant one. It has proved useful as a screening tool with groups of nursery school, kindergarten and first grade children, primarily because it permits identification of those children who need special perceptual training in five important areas of visual perception (p. 857)." Test-retest reliability of the perceptual quotient is reported as 0.90. Subtest scale score test-retest correlations range from 0.42 to 0.80. Split-half reliability correlations range from 0.78 to 0.89. Validity correlations between scaled scores and teacher ratings of classroom adjustment were 0.44; motor coordination, 0.50; intellectual functioning, 0.50. Correlations between the Frostig and Goodenough scores range from 0.32 to 0.46. Both reviewers, Anderson (1965) and Austin, questioned the adequacy of the standardization population. Anderson stated that the present primary use of the Frostig test would be to predict learning success in the primary grades. The Frostig test offered promise as a predictor of reading problems when administered by classroom teachers to kindergarten children. It was, therefore, selected as the measure of visual perception.

Language development. The Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities, Experimental Edition, was selected as the measure of language facility. The test authors, McCarthy and Kirk (1961), described verbal expression as the ability to express one's ideas in spoken words. Verbal expression is assessed by asking the student to describe simple objects. The specific objects used in the Verbal Expression subtest were: a nail, ball, block, envelope, and a button. The descriptive terms used by the student are tallied to obtain the raw score. Reliability of the difference between test and retest scores, over a period of three months, has been determined by comparing the ranges obtained by using the standard error of measurement for the raw scores on both the test and the retest. If the range of one standard error of measurement on the retest overlaps the range of one standard error of measurement on the original test, no reliable difference between scores is inferred. If the ranges do not overlap, a reliable difference in scores is inferred. The standard for the raw scores reported on the Verbal Expression subtest for ages five years three months to five years nine months is $\pm$2.45, for ages five years nine months to six years three months is $\pm$1.92, and for ages six years three months to six years six months is $\pm$2.59.

Weener, Barritt and Semmel (1967) evaluated the Illinois Test of Psycholinguistic Abilities and reported a range of internal consistency coefficient for the Verbal Expression subtest from 0.54 to 0.82 with a median coefficient of 0.75. The split-half reliability coefficient ranges for age groups from 0.48 to 0.84 with a median of 0.72. The test-retest stability coefficient reported for the Verbal Expression subtest ranged from -0.25 to +0.48 with a median of -0.17 for a

twelve-month interval between testing periods. The internal consistency measures are moderately high but the test-retest stabilities are quite low, according to the evaluators' judgments.

Validity studies conducted by Weener, Barritt and Semmel using eighty-six children showed a median concurrent validity coefficient for the test battery of 0.15; the median predictive coefficient was 0.23. Results for the subtests were not reported.

Although the validity and reliability of the test battery and subtests are questioned due to an inadequate standardization sample, the Illinois Test of Psycholinguistic Abilities is considered a fruitful beginning as a diagnostic measure of the psycholinguistic abilities. The Verbal Expression subtest, which measures the spoken descriptive language, was chosen as a measure of language facility.

Metropolitan Readiness Test. The Metropolitan Readiness Test was selected as a partial measure of overall readiness and a measure of the factors related to each of the subtests.

Test 1 Verbal Concepts

Test 2 Knowledge of Words and Comprehension of Spoken Words

Test 3 Visual Perception

Test 4 Recognize Letters of Alphabet

Test 5 Number Concepts

Test 6 Visual Perception and Motor Coordination

Construct Validity

Murphy-Durrell Reading Readiness Analysis (Revised Edition) and Metropolitan Readiness subtests correlations range from 0.47 to 0.78 while the total correlation was 0.80. The correlation between total

score on the Metropolitan Readiness Test and the Lee-Clark Reading Readiness Test was 0.70.

Split-half Reliability Correlations - Kindergarten (administration May)

Correlations for Form A were 0.90 to 0.95 with subtest correlation ranging from 0.33 (Listening) to 0.89 (Alphabet). The authors indicate that the subtest's correlations are lower due to their brevity. Form B of the Metropolitan Readiness Test total scores ranged from 0.92 to 0.94 with subtest correlations ranging from 0.48 (Word Meaning) to 0.91 (Alphabet).

Material Objects Test. This test was first developed by the Science Curriculum Improvement Study (SCIS) staff to assess children's attainment of the concepts and process skills developed through the use of the Material Objects unit. The original test has been modified by the investigator to include some concepts not included in the Science Curriculum Improvement Study (SCIS) developed test and is also being used to measure the experience factor for reading readiness. The Science Curriculum Improvement Study (SCIS) staff has never claimed or implied that the Material Objects unit develops reading readiness when used with children. The test as used consisted of the following subtests. For the purpose of this study, the research modified this test and therefore there is no data on validity of the test.

Material Identification subtest was used to determine the child's knowledge of the materials concept and to assess his skill in sorting, based upon the material's concept.

The child is asked to sort a number of objects into two groups based upon material, objects of one material and the second group,

objects made of more than one material. Then the child was shown four of the items and asked the number of materials in each and to name the materials.

Sequence Discrimination subtest was used to determine the child's ability to sequence a series of pictures so that they appear in a logical order and to establish their relationships through describing the series of events (telling the story). The child is asked to arrange four sequence cards so that they tell a story. Once the child has arranged the cards in sequence to his satisfaction, he is then asked to tell the story.

Comparison subtest was used to assess the child's ability to make comparisons based upon degrees of difference among a set of three objects and to use the comparison signs > (greater than) < (less than) in a logical manner.

The child was asked to compare two then three objects in relation to some particular property such as texture, weight, shade, and size. He is asked to arrange them using the comparison sign (>) and to verbally describe the arrangement.

Property Sort subtest was used to assess the child's knowledge of the property concept and application of this concept in sorting objects.

The child was asked to find objects with specific properties such as a thin and silver-colored object and place them in compartments within a clear plastic container.

Tester Training

Three examiners each with either pre-school or primary school teaching experience (experience ranged from one to three years) were selected to administer and score the instruments used in the post-test phase of the study. During the initial training session the investigator discussed the format, testing procedures and special materials required for each instrument used. Each examiner then worked with from three to five kindergarten-aged children who were not involved in the study to familiarize themselves with the techniques of presentation of the testing. Sample tests were scored so that questions concerning scoring procedures would be resolved.

A special testing space for the use of the examiners was scheduled by the principal in each building to insure a minimum of interference during the testing.

Post-Testing Program

Post-testing was begun during the last two weeks in March and completed by the end of the first week of April, 1971. Examiners were provided student lists with names listed in alphabetical order and no identification as to the individual child being in a treatment, control or placebo group.

The Metropolitan Readiness Test was administered in small groups, ten to fifteen children. The tests were scored by the examiners and checked by the investigator.

The Frostig tests were administered by one of the examiners and scored by that individual to insure that judgmental decisions would not vary.

The Verbal Expression tests were administered individually and recorded using a tape recorder to insure accurate evaluation of each child's responses. The tapes were then transcribed and scored by one examiner to insure that the judgmental decisions would not vary.

Selection of the Statistical Analysis Procedure

The statistical analysis procedures selected for use in this study was Multivariate Analyses of Variance programmed by Jeremy Finn, State University of New York, Buffalo, New York.

The following statements provide the basis of reasoning for the selection of the Finn Multivariate Analyses of Variance.

1) The study includes seventeen dependent variables and seven covariates. This requires an analysis procedure which can examine multiple factors. Readiness is based upon the child's attainment of a number of factors, not just one.
2) There was a possibility of no univariate effects while there may be a multivariate difference.
3) These procedures provided evidence of the interaction of dependent variables. In the case of reading readiness we expect to find interaction among dependent variables due to the necessity of the child's attaining a number of readiness factors.

4) Three treatment groups were examined; a treatment, a placebo control and a control group. To examine these groups with the number of variables of interest requires an analysis procedure with the potential that is found in the Finn procedure.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

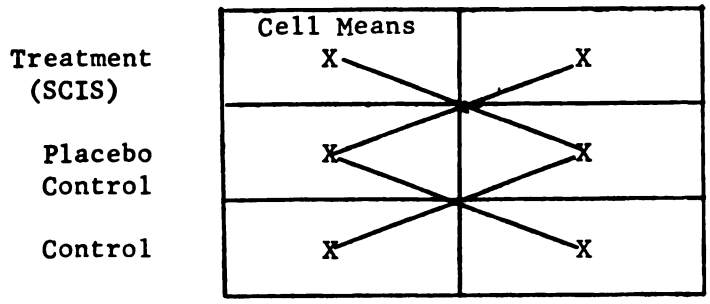
The data collected and analyzed by the procedures described in Chapter III are presented in this chapter. The data pertaining to each of the hypotheses will be presented followed by the data for the additional questions of interest. The cell means and their standard deviations for dependent variables for males and females in each of the groups is presented in the appendices (see Appendix E). The combined means for each of the study groups is presented in Appendix D. For the purposes of this study the level of significance for multivariate analyses is α p. ≤ 0.05 and for univariate analysis α p. ≤ 0.01 was selected. Cell sizes for each group were as follows: treatment, 42; placebo, 32; and control, 28.

Hypothesis I: Sex × Treatment Interaction

Null Hypothesis Tested: There will be no interaction between sex and treatment in readiness factors as measured by Metropolitan Form B, Frostig, Verbal Expression, and Material Objects tests in kindergarten children.

Multivariate analyses of covariance were used to determine whether a significant interaction existed between sex and treatment. If there are interactions between sex and treatment there will be a high

relationship between diagonal cell means. For example, there are possible interaction between the cell means of: treatment females and placebo males; control females and control males.



The Frostig, Metropolitan Form B, Material Objects Test, and the Verbal Expression subtest scores were used as dependent variables. The pre-test Metropolitan Form A score and age were the covariates. The results, as shown in Table 4-1, indicate no significance in sex treatment interaction. Therefore, the treatment × sex interaction can not be rejected.

TABLE 4-1

ANALYSES OF COVARIANCE FOR TREATMENT × SEX INTERACTION:

MULTIVARIATE ANALYSES
(8 and 182 degrees of freedom)

Variable	F Ratio	Alpha Level
Interaction	1.1520	0.3309

Covariates were Metropolitan A Test Score and Age

Table 4-2 showing the univariate analysis of each of the dependent variables used for examination of treatment × sex interaction indicates that none of the dependent variables showed a significant treatment × sex interaction.

TABLE 4-2

ANALYSES OF COVARIANCE FOR TREATMENT × SEX INTERACTION:

UNIVARIATE ANALYSIS
(2 and 94 degrees of freedom)

Variable	Between Mean Square	F Ratio	Alpha Level
Frostig	25.0795	0.3367	0.7150
Metropolitan B	104.9186	1.8707	0.1598
Material Objects Test	109.5812	0.6693	0.5145
Verbal Expression	53.5491	2.4563	0.0913

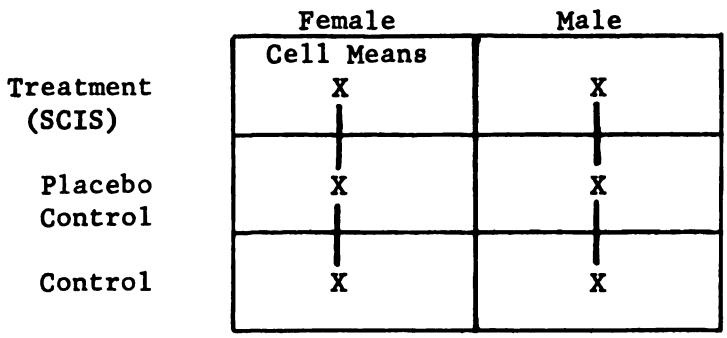
Covariates were Metropolitan A Test Score and Age

Hypothesis II: Sex Main Effects

Null Hypothesis Tested: There will be no differences in readiness as measured by Metropolitan Form B, Frostig, Verbal Expression, and Material Objects tests in relation to the sex of the subjects in kindergarten children.

Multivariate analyses of covariance were used to determine whether sex would have a significant effect on the treatment main effect. If

sex is having an effect upon the treatment effect there will be high relationships between cell means in columns.



The dependent variables used were the Frostig, Metropolitan Form B, Material Objects tests, and the Verbal Expression test scores. The pre-test Metropolitan Form Score and Age were the covariates. The results, as shown in Table 4-3, indicate no significance in sex main effect ($p. \leq 0.6949$). Therefore, the null hypothesis for sex main effect can not be rejected.

TABLE 4-3

ANALYSES OF COVARIANCE FOR SEX MAIN EFFECT:

MULTIVARIATE ANALYSES
(4 and 91 degrees of freedom)

Variable	F Ratio	Alpha Level
Sex	0.5564	0.6949

Covariates were Metropolitan A Test Score and Age

The univariate analysis of each of the dependent variables for sex main effect indicate no significance for any of the individual dependent variables (see Table 4-4).

TABLE 4-4

ANALYSES OF COVARIANCE FOR SEX MAIN EFFECT:

UNIVARIATE ANALYSIS
(1 and 94 degrees of freedom)

Variable	Between Mean Square	F Ratio	Alpha Level
Frostig	51.6610	0.6936	0.4071
Metropolitan B	51.7428	0.9226	0.3393
Material Objects Test	3.2806	0.0200	0.8878
Verbal Expression	0.5610	0.0257	0.8729

Covariates were Metropolitan A Test Score and Age

Since the null hypotheses I and II were not rejected the hypothesis for treatment main effect regarding readiness attainment may be inspected.

Hypothesis III: Readiness

Null Hypothesis Tested: Treatment will have no effect on the attainment of reading readiness in kindergarten children as measured by the Metropolitan Form B, Frostig, Verbal Expression and Material Objects Test.

The dependent variables selected as before were the Frostig, Metropolitan Form B, Material Objects Test and the Verbal Expression subtest scores. The pre-test Metropolitan Form A Score and Age were the covariates. The results, as shown in Table 4-5, indicate that there was a significant difference ($p. \leq 0.0001$) between the treatment group and the control and placebo control groups.

TABLE 4-5

ANALYSES OF COVARIANCE TREATMENT MAIN EFFECT:

MULTIVARIATE ANALYSES
(8 and 182 degrees of freedom)

Variable	Between Mean Square	F Ratio	Alpha Level
Reading Readiness		6.4400	0.0001

Covariates were Metropolitan A Test Score and Age

Examination of the univariate alpha levels reveals the relative contribution of each of the dependent variables to the treatment main effect (see Table 4-6). Two variables, the Material Objects Test and Verbal Expression, with univariate alpha levels of $p. \leq 0.0001$, support the rejection of the null hypothesis. The Frostig with a univariate alpha level of $p. \leq 0.0243$ approaches significance but for the purposes of this study is not significant.

TABLE 4-6

ANALYSES OF COVARIANCE TREATMENT MAIN EFFECT:

UNIVARIATE ANALYSIS
(2 and 94 degrees of freedom)

Variable	Between Mean Square	F Ratio	Alpha Level
Frostig	288.1887	3.8691	0.0243
Metropolitan B	49.0262	0.8741	0.4206
Material Objects Test	2093.5997	12.7875	0.0001
Verbal Expression	278.1154	12.7569	0.0001

Covariates were Metropolitan A Test Score and Age

Hypothesis IV: Visual Perception

Null Hypothesis Tested: Treatment will have no effect on the development of visual perceptual skills in kindergarten children as measured by the individual subtest scores of the Frostig test and Metropolitan Form B's subtests; subtest 3 Matching, and subtest 6 Copying.

Multivariate analyses of covariance was used to determine the effect of the treatment on the development of visual perceptual skills (Hypothesis IV). The five Frostig subtests: Eye-Motor, Figure Ground, Form Constancy, Position in Space, and Spatial Relationships plus two of the Metropolitan Form B subtests, Matching and Copying, were used as dependent variables. Metropolitan Form A Matching, A Copying and test scores and age were the covariates. The results, as shown in

Table 4-7, indicate that there was no significant difference ($p. \leq 0.1042$). We cannot therefore reject the null hypothesis.

TABLE 4-7

ANALYSES OF COVARIANCE FOR VISUAL PERCEPTION:

MULTIVARIATE ANALYSES
(14 and 174 degrees of freedom)

Variable	Between Mean Square	F Ratio	Alpha Level
Visual Perception		1.5315	0.1042

A Matching, A Copying Test Scores and Age were Covariates

The conclusions of no significance were further supported by inspection of the univariate alpha levels (see Table 4-8). None of the dependent variables was significant though there were some approaching significance: Figure Ground ($p. \leq 0.0451$), Eye-Motor ($p. \leq 0.0585$) and Position in Space ($p. \leq 0.0874$).

Hypothesis V: Language Facility

Null Hypothesis Tested: Treatment will have no effect on the development of language facility in kindergarten children as measured by the Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities.

To determine the effect of the treatment on the attainment of the language facility factor, the univariate F ratio for the Verbal

Expression (see Table 4-8) was used. Its contribution to the attainment of reading readiness was significant at the alpha level of $p. \leq 0.0001$. Therefore, the null hypothesis was rejected.

TABLE 4-8

ANALYSES OF COVARIANCE FOR VISUAL PERCEPTION:

UNIVARIATE ANALYSIS
(2 and 93 degrees of freedom)

Variable	Between Mean Square	F Ratio	Alpha Level
Eye-Motor	24.3054	2.9284	0.0585
Figure Ground	72.6960	3.2064	0.0451
Form Constancy	14.3682	0.8912	0.4137
Position in Space	5.5045	2.5024	0.0874
Spatial Relations	1.8408	0.7104	0.4942
B Matching	1.9115	0.2324	0.7931
B Copying	2.2164	0.3496	0.7059

A Matching, A Copying Test Scores and Age were Covariates

Hypothesis VI: Experience

Null Hypothesis Tested: Treatment will have no effect on acquisition of the experience for kindergarten children as measured by the Material Objects Test.

Multivariate analysis of covariance was used to determine the effect of the treatment on acquisition of the experience factor. The

five Material Objects subtest scores, Materials Identification, Sequential Discrimination, Object Comparison, Properties Sort, and Materials Sort were used as the dependent variables. The pre-test Metropolitan Form A test score and age were the covariates. The results, as shown in Table 4-9, indicate that there was a significant difference ($p. \leq 0.0001$). Therefore, the null hypothesis for experience can be rejected.

TABLE 4-9

ANALYSES OF COVARIANCE EXPERIENCE FACTOR:

MULTIVARIATE ANALYSES
(10 and 180 degrees of freedom)

Variable	Between Mean Square	F Ratio	Alpha Level
Experience		4.7368	0.0001

Covariates were Metropolitan A Test Score and Age

Inspection of the univariate analysis of the dependent variables (see Table 4-10) regarding their relative contributions to the significance reveals that Materials Identification ($p. \leq 0.0001$), Object Comparison ($p. \leq 0.0001$), and Property Sort ($p. \leq 0.0111$) made significant contributions.

TABLE 4-10

ANALYSES OF COVARIANCE EXPERIENCE FACTOR:

UNIVARIATE ANALYSIS
(2 and 94 degrees of freedom)

Variable	Between Mean Square	F Ratio	Alpha Level
Materials Identification	574.3331	11.1153	0.0001
Sequence Discrimination	19.0528	1.4635	0.2367
Object Comparison	593.6751	11.5825	0.0001
Property Sort	32.5662	4.6761	0.0111
Materials Sort	1.6562	0.5482	0.5799

Covariates were Metropolitan A Test Score and Age

Additional Questions Inspected

Inspection of the correlations (see Table 4-11), reveals the following high correlations between the science experiences as measured by the Material Objects Test and the subtests of the Metropolitan Form B: Materials Identification had a positive correlation with four of the Metropolitan Form B subtests.

They were:

Listening correlation coefficient of $r = 0.32450$ ($p. \leq 0.001$).

Visual Perception (Matching) correlation coefficient $r = 0.19543$ ($p. \leq 0.05$).

Alphabet correlation coefficient $r = 0.20533$ ($p. \leq 0.05$).

Mathematics correlation coefficient $r = 0.32304$ ($p. \leq 0.001$).

TABLE 4-11

SIMPLE CORRELATIONS - DEPENDENT VARIABLES*

Material Objects Subtests	Metropolitan Form B Subtests				Frostig Subtests		Verbal Expression Test
	Listening	Matching	Alphabet	Mathematics	Constancy	Relations	
Materials Identification	0.32450	0.19543	0.20533	0.32304	0.30208	0.20304	0.41150
Object Comparison			0.21445	0.23986	0.19726		0.23907

* For a complete breakdown of correlations see Appendix C.

Summary of Analysis

A summary of the hypothesis tested, significance level found and an indication of whether the hypothesis was rejected or not rejected is given in the following tabular form.

	Significance Level	Hypothesis Rejected or Not Rejected
1) There will be no interaction between sex and treatment in readiness factors as measured by Metropolitan Form B, Frostig, Verbal Expression, and Material Objects tests in kindergarten children.	0.3309	Not rejected
2) There will be no differences in readiness as measured by Metropolitan Form B, Frostig, Verbal Expression, and Material Objects tests in relation to the sex of the subjects in kindergarten children.	0.6949	Not rejected
3) Treatment will have no effect on the attainment of reading readiness in kindergarten children as measured by the Metropolitan Form B, Frostig, Verbal Expression, and Material Objects tests.	0.0001	Rejected
4) Treatment will have no effect on the development of visual perceptual skills in kindergarten children as measured by the individual subtest scores of the Frostig test and Metropolitan Form B's subtests; test 3 Matching, and test 6 Copying.	0.1042	Not rejected
5) Treatment will have no effect on the development of language facility in kindergarten children as measured by the Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities.	0.0001	Rejected
6) Treatment will have no effect on acquisition of the experience for kindergarten children as measured by the Material Objects Test.	0.0001	Rejected

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine whether science activities, which use concrete objects to develop science concepts and process skills, affect the attainment of reading readiness in Kindergarten children. The specific reading readiness factors of visual perception, language facility and experience were studied. Selected activities from the Science Curriculum Improvement Study's (SCIS) physical science unit Material Objects were used as the treatment. The effects were assessed by four measures: the Metropolitan Readiness Test Form B, The Marianne Frostig Developmental Test of Visual Perception, the Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities, and the Material Objects Test.

All of the tests were combined in determining the overall effect on reading readiness and certain subtest scores were examined to determine the treatment effect upon individual readiness factors.

The Metropolitan Readiness Test Form B was one of four tests used to measure the overall effect on reading readiness and its subtests Matching and Copying were used in part to determine the effect of the treatment on the visual perception factor.

The Marianne Frostig Developmental Test of Visual Perception was also used to measure the overall effect on reading readiness, and its subtests Eye-Motor, Figure Ground, Form Constancy, Position In Space,

and Spatial Relations were used in determining the treatment effect upon the visual perception factor.

The Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities was also used to measure the treatment effect upon overall reading readiness and to measure the treatment effect upon the language facility factor.

The Material Objects Test was used to measure in part the overall effect of treatment upon reading readiness and its subtests were used to measure the treatment effect upon the experience factor. In the material sort portion of the Material Objects Test, the children were asked to sort objects on a tray and then to place these sorted objects in a compartmentalized plastic box to preserve the sorted groups. The critical task for the child was to sort the objects on the tray. The examiners were instructed to insure that the children placed the objects in the plastic containers in the same groups and in the same order as they were on the tray. Upon completion of the testing program the examiners indicated that in many instances the children did not place the objects into the plastic containers in the same order they sorted them. Therefore, the data for this subtest were questionable and it may be that there was an effect which was lost in this study due to testing procedure error.

Analysis of the data indicated that science activities from the Science Curriculum Improvement Study's (SCIS) physical science unit Material Objects did significantly affect kindergarten children's reading readiness as measured by several factors. Specific factors of readiness affected in this study were language facility $p. \leq 0.0001$ and experience $p. \leq 0.0001$. While the factor in visual perception was

not statistically significant in this study, there were indications in the data that warrant further study of this factor. There were several correlations of interest noted.

Among those of interest were the Frostig Visual Perception subtest Form Constancy $r = 0.30208$ $p. \leq 0.01$ with the Material Objects subtest Materials Identification and Spatial Relations subtest and the Materials Identification subtest $r = 0.20304$ $p. \leq 0.05$. Positive correlations were also noted between the Material Objects subtest scores of Materials Identification $r = 0.41150$ $p. \leq 0.001$ and Object Comparison $r = 0.23907$ $p. \leq 0.02$ with the Verbal Expression subtest.

Summary of Rejected Hypotheses

Null Hypothesis Tested:	Multivariate Level of Significance
Treatment will have no effect on the attainment of reading readiness in kindergarten children as measured by the Metropolitan Readiness Test Form B, Marianne Frostig Developmental Test of Visual Perception, the Verbal Expression subtest, and the Material Objects Test.	0.0001
Treatment will have no effect on the development of language facility in kindergarten children as measured by the Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities.	0.0001
Treatment will have no effect upon the acquisition of the experience factor by kindergarten children as measured by the Material Objects Test.	0.0001

The population of interest in the study was the kindergarten children in two schools of the Waterford School District located in Waterford Township. Waterford Township is a predominately white suburban

community which is located close to the large industrial city of Detroit, Michigan. The community has little industry or agriculture with most of the adult working population being employed in industry outside the community proper. The socio-economic status of its inhabitants ranges from lower class to lower upper class. Average annual income according to the 1970 census was $13,583.00. The kindergarten children in the two selected schools are representative of the other twenty-seven elementary schools within the district. Each class in the study had a classroom teacher who had at least three years of teaching experience in the district. Those children in the study schools were all within walking distance of their school and approximately seventy-five percent had taken part in a twenty hour pre-kindergarten class the year before.

All kindergarten children (132) in two suburban schools were given the Metropolitan Readiness Test Form A in January, 1971. Based on the scores from this test, those students who fell in the C, D, and E categories were considered to be the population of interest (total of 102 subjects).

Students from the population were then assigned to one of three groups. The groups were the:

1) Treatment group which received science activities from Material Objects.
2) Placebo control group which received fine and gross motor activities instead of science activities, and
3) Control groups which received the normal kindergarten program.

A table of random numbers was used to assign children to groups.

After eight week of instruction consisting of twenty to twenty-five minutes each day for five days each week, the three groups were again observed using the following measures:

Metropolitan Readiness Test Form B

The Marianne Frostig Developmental Test of Visual Perception

Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities

Material Objects Test

The data were evaluated using multivariate analyses of variance programmed by Jeremy Finn, State University of New York at Buffalo. The use of multivariate analyses was made because of the number of variables examined for each of the factors under study and the need to determine their combined effects.

Conclusions

Analyses of the findings indicate that:

1) Kindergarten children who were actively engaged in a sequenced series of science activities with concrete objects made greater gains in the attainment of reading readiness than kindergarten children who received the traditional kindergarten program.
2) Kindergarten children who participated in a materials-oriented science program which stresses experience as does the Science Curriculum Improvement Study (SCIS) Material Objects unit made significant gains in the language facility over those kindergarten children who receive the traditional kindergarten

program. Concrete science experiences in kindergarten provided children with a broader vocabulary and skill in expressing themselves.

3) Kindergarten children who participated in a materials-oriented science program which stresses experience, as does the Science Curriculum Improvement Study (SCIS) Material Objects unit made significant gains in the experience factor over those kindergarten children who received the traditional kindergarten program.

4) Kindergarten children who participated in a science program such as the Science Curriculum Improvement Study (SCIS) Material Objects unit were able to apply the concepts and processes of science better than those kindergarten children who had a traditional kindergarten program.

5) Kindergarten children who were engaged in a materials-oriented science program which stresses experience as does the Science Curriculum Improvement Study (SCIS) Material Objects unit developed concepts and process skills which were highly correlated with some factors that were measured by visual perception and language facility measures.

Educational Implications

The significant growth in reading readiness observed in the treatment group in this study indicates that there should be greater emphasis placed upon kindergarten programs which encourage the child's interaction with concrete objects prior to his receiving instruction in

reading which is primarily representative and symbolic. Children in the group showed significant gains in both language facility and experience which have been identified as important readiness factors by reading experts.

Learning activities for kindergarten children should be developed logically and sequenced so that the child may proceed from simple to more complex concepts with meaning. The children who were in the placebo group were engaged in activities which utilized concrete objects but unlike the treatment group they were not sequenced to insure logical development of concepts or skills.

In planning for kindergarten instruction, science activities which stress concrete experiences such as those in the Science Curriculum Improvement Study (SCIS) Material Objects unit should be included. The child in such a program will not only benefit from the science instruction, but will also develop critical reading readiness factors.

An important part of the instructional mode in the treatment was a series of activities or segments of time during activities when the children were allowed to freely manipulate the objects being used. The results of this study indicate that allowing the children sufficient opportunities to have concrete experiences is important in developing reading readiness.

As children in the treatment group were engaged in activities, they were encouraged to interact with each other exchanging ideas and observations. Over the eight week period of treatment there was an increase in the frequency and quality of the child-child discussions. It, therefore, would be of value to encourage kindergarten children to interact with each other in meaningful discussions about their science

activities as it aids in the development of language facility. Further support for the use of science activities which stress concrete experiences to develop language facility can be found in Rowe's (1973) book Teaching Science as Continuous Inquiry:

> Early language development in the context of science comes about by the melding of three ingredients: concrete experiences combined with communication about these experiences in settings shared by others so that the common pool of referents will gradually enlarge. There need be no breakdown in the communication process in science if the starting point is a physical object or system which you or the child can point to and manipulate. No matter how abstract the conversation may eventually become, the requirement in science is that you be able to work your way back to the concrete stage when necessary (p. 15).

Another important factor which was observed in the treatment group was the high degree of motivation which was evident as the children were engaged in their science activities. The children had fun while learning and this in part was enhanced by the nature of the objects with which they were interacting. It is apparent, therefore, that the science materials and activities selected for use by kindergarten children should be of such a nature as to motivate the child's desire for learning.

Implications for Future Research

As indicated in the above paragraph the treatment group was highly motivated by the science activities. It would seem reasonable therefore to design a study to determine the affect of science activities of childrens' attitude toward school and science in early education. Such a study could be designed using a treatment, placebo, and control group similar to those used in this study.

Both the treatment and placebo groups received their instruction in small groups sessions (9-12 children). In the treatment group the children were involved in a program which had clearly defined goals and objectives which were understood by the instructors. The placebo on the other hand involved children in working in small groups but without clearly defined goals and objectives. From the observations made during the course of the study and in inspecting the data it appears that small group instruction alone may not be sufficient to insure educational progress. It may be that the combination of small group instruction with a carefully selected sequence of concept and skill development is more important. Using such a program with various sized groups in a controlled experiment could determine if group size is a critical factor.

The students in each of the three study groups were involved in readiness activities during their normal school day. These activities involved the use of worksheets for development of reading readiness. Upon inspection of the data it appears that use of worksheets in themselves do not promote readiness growth as well as their use in conjunction with concrete objects. Similarly, Church (1974) in her study found that use of Frostig workbooks or manipulative materials could both produce significant gains in visual perceptual skills over a six month period of time with kindergarten children. She did not however, use the combination of both workbooks and manipulative materials. Additional research is needed to determine the role of concrete objects either used alone or in conjunction with readiness workbooks in developing reading readiness.

Examination of the treatment cell means for the Verbal Expression subtest for males or females showed that the treatment males had a higher mean score than did the treatment females. In both placebo and control cell means for Verbal Expression subtest the female cell means were higher than those of the males. A future study might consider further investigation of the possible effect of science activities involving experience with concrete objects on males and on females in development of language facility.

The measure of the visual perception factor while not significant in this study did show a trend toward significance in both the Frostig total score, univariate alpha level of p. $\leq$ 0.0243, and in three of the five Frostig subtests, univariate alpha levels of p. $\leq$ 0.0451 for Figure Ground, p. $\leq$ 0.0585 for Eye-Motor and p. $\leq$ 0.874 for Position In Space. The relatively short length of time the children were involved in the treatment may have contributed to the lack of significance with the visual perception factor. Church (1974) found significant growth in visual perception when children were given opportunities to use concrete objects in informal gamelike situations over a six month period of time. Additional study of the potential relationship between science instruction, time, and their effect upon visual perception is merited.

During the sessions where the Verbal Expression subtest was administered, all dialogue was recorded and later a transcript for each individual was produced for evaluation. During the preparation of the transcripts it was observed that there appeared to be a marked difference in how the children from the three study groups responded to the testing procedures. Placebo and control children required more

coaxing to start describing the objects and to look for additional characteristics of the objects. The examiners would ask the child repeatedly if there was something else the child could tell them about the object. Many of the treatment children freely described the objects presented, and on several occasions, the examiners would move on to another object before the treatment child had completed his description of the object. A study to determine the effect of science programs such as the Science Curriculum Improvement Study (SCIS) Material Objects unit upon the child's self-confidence when speaking would be of value. This study could easily be expanded to include the treatment group's growth in self-concept compared to placebo and control groups. In addition, more detailed study of children's speech patterns may show greater growth in their use of more complex sentence structure.

The significant growth in language facility in the treatment group may be as a result of the children in small groups dealing with meaningful experience and having a greater opportunity to interact in the small group situation. More detailed examination of the children's individual speaking patterns in small group and large group settings should be a worthwhile study.

The number of readiness factors examined in this study was limited to language facility, experience, and visual perception being examined. Reading experts have identified many others such as following directions, listening, auditory perception, attitude toward reading, sex, and general intelligence. A future study should examine those factors omitted from this study to determine the effect of concrete science experiences on their attainment.

In this study the children worked with individuals other than their classroom teacher in the treatment sessions. A future study using the classroom teacher as the trainer working under similar conditions would be of value.

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APPENDICES

APPENDIX A

APPENDIX A

MATERIAL OBJECTS TEST

Student Data Sheet

Comments:

Student name _____

Age (yrs.) _____ (mos.) _____

Sex _____

School _____

Teacher _____

Examiner _____

Date testing began _____

Date testing completed _____

Identification of Materials	40 points
Sequence Discrimination	18 points
Comparison	16 points
Identification and Sorting by Property	12 points
Sorting by Material	8 points
Total	94 points

SCIS _____

Placebo _____

Control _____

Material Objects - Test 2

Identifying Objects of More Than One Material (Administered individually; average time, eight minutes)

Equipment:

Wood paintbrush
Small toy car
Porcelain light socket
Pencil
Clamp-type metal and wood clothespin
Wood clothespin
Green Scotchbrite
Brass fastener
Red plastic cap
Cloth-backed plastic
Cardboard lid
Emery board
Television lead-in wire
Cork
Green plastic
Brass chain
White styrofoam block

Instruction

The child is asked to group the objects as follows:

Look at all these objects. Sort them into two groups--those made of one material and those made of more than one material. (Examiner picks up red plastic cap.) This will start your pile of objects made of only one material. We'll put it over here. (Picks up pencil.) And this will start your pile of objects of more than one material. We'll put it over there. Now you finish sorting all the rest of the objects. Put all those made out of just one material in this pile (points to red cap) and all those made out of more than one material in this other pile (points to pencil). Do you understand? All right. Go ahead.

(If child does not understand or asks, "What is material?" Examiner should explain that material is the "stuff" an object is made of. Examiner should note that explanation was given. If child still does not understand, examiner notes this and test is stopped.)

Examiner will note grouping child uses for each object. When the child has finished sorting, examiner takes one of the four selected

items and asks the following questions recording the child's response. How many different materials is this made of? Tell me what materials they are. This is repeated for each of the items.

Record Sheet - Identifying Objects of More Than One Material

Date _____ Examiner _____

(1) Record classification of items by writing the appropriate code-letter after each object below as follows:

N = not sorted

O = one-material pile

M = more-than-one material pile

(2) For each of the four pre-selected items record the names of the materials given by the child.

Object	Classification	Score
Wood paintbrush		
Cloth-backed plastic		
Small toy car		
Cardboard lid		
Porcelain light socket		
Emery board		
Green plastic		
Green Scotchbrite		
Brass chain		

Object	Classification	Score
Pencil		
Television lead-in wire		
Clamp-type wood and mental clothespin		
Scissors		
Cork		
Wood clothespin		
Brass fastener		
White styrofoam block		
Red plastic cap		

Object	Number of Materials	Names of Materials
1. Pencil	_____	a. b. c. d. e.
2. Cardboard lid	_____	a. b. c. d. e.
3. Television lead-in wire	_____	a. b. c. d. e.
4. Clamp-type metal and wood clothespin	_____	a. b. c. d. e.

Material Objects - Test 4 - Discriminating Sequences

Equipment:

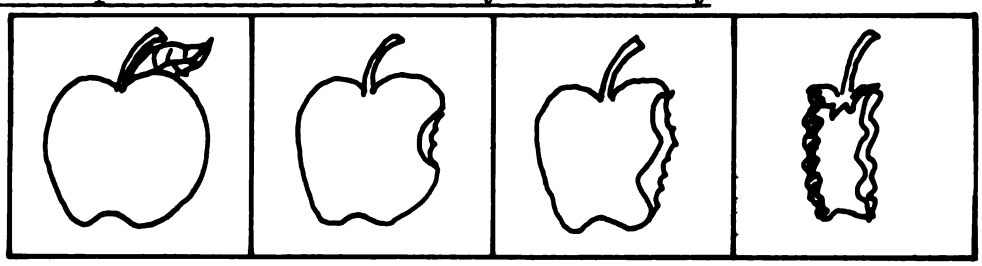
One set of sequence cards, four each of four sequences (lettered A practice), B, C, and F.

Cards should be set up in mixed order on rack of chalkboard. (If this is not possible, use large table.)

Instructions:

Examiner takes set A and lays them out in mixed sequence on chalkboard rack. Examiner:

Here are four pictures of an apple that somebody ate. Can you arrange the pictures in order so they tell a story?



If child's sequence is correct, the Examiner says, That's right: if incorrect, Examiner demonstrates correct order: You see, first there was a whole apple, then someone took a few bites, then they ate some more, and at the end, all that was left was the apple core.

Now I'll show you some more pictures and you put them in order so they tell a story. (Show each sequence of four cards separately, in alphabetical order. Record observed sequence for each.)

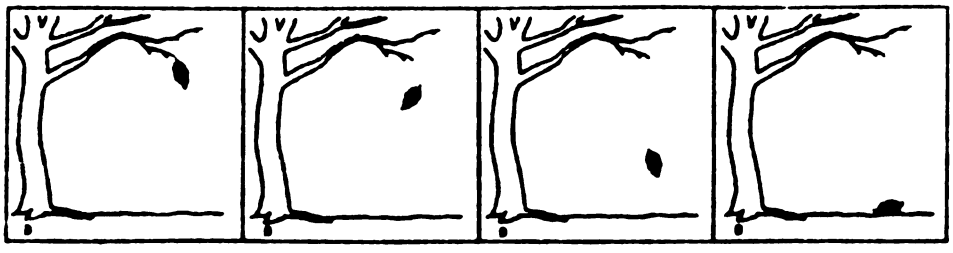
Once the child has sequenced the cards to his satisfaction, the Examiner states: Now tell me the story that the cards show. Note if the child then changes the sequence of cards.

____
Test 4

Record Sheet - Sequence Cards

Indicate the sequence from left to right by number. Note if the explanation is acceptable or not and if a change is made in the sequence.

Sequence Cards B



Sequence

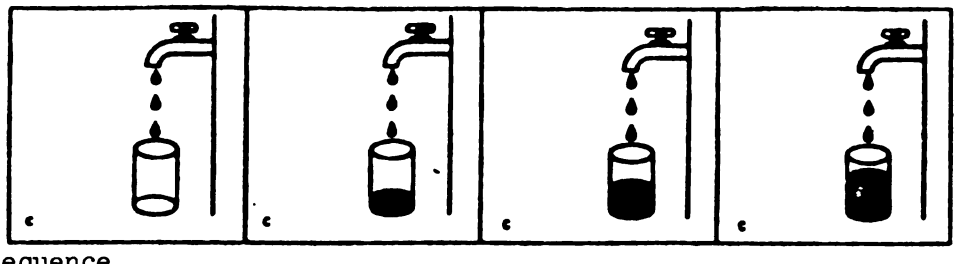
Acceptable explanation____
Unacceptable explanation____

____ ____ ____ ____

Sequence change during child's explanation
( ) ( ) ( ) ( )

(Explanation: leaf falls from tree to ground)

Sequence Cards C



Sequence

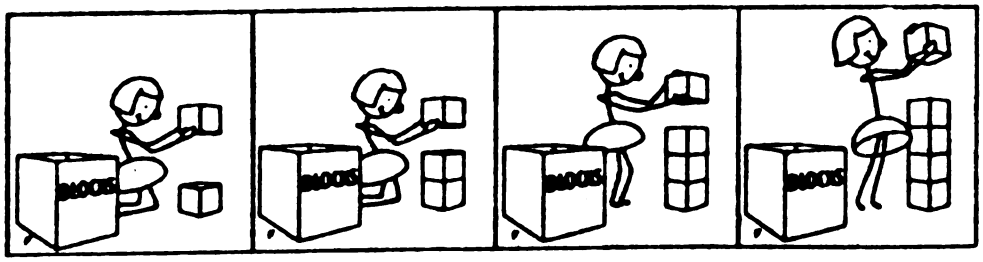
Acceptable explanation____
Unacceptable explanation____

____ ____ ____ ____

Sequence change during child's explanation
( ) ( ) ( ) ( )

(Explanation: water falls from faucet into glass filling it)

Sequence Cards F



Sequence

Acceptable explanation___
Unacceptable explanation___

___ ___ ___ ___

Sequence change during child's explanation
( ) ( ) ( ) ( )

(Explanation: 1, 2, 3, 4 girl playing with blocks, stacks them up.
4, 3, 2, 1 girl playing with blocks, takes them off the stack.)

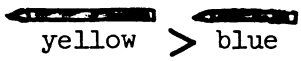
Comparison test

Equipment: Introduction

Three pencils (one each; yellow, blue, red)
Three sandpaper (one each; coarse, medium, fine)
Three boxes (red-heavy, yellow-medium, blue-light)
Three green squares (light green-large size, medium green-small size, dark green-medium size)

Introduction

Place the comparison sign on the table and then hand the child two pencils (yellow and blue), Examiner states, Would you put these pencils on each side of this comparison sign so that it tells something about the pencils length? Note how the child places the pencils. If the child is confused, places them incorrectly, or doesn't do anything ask, Which pencil is longer? We would place the longest pencil here because the sign shows us that it belongs here and the shorter one goes here. Either place objects in order or have the child do so.



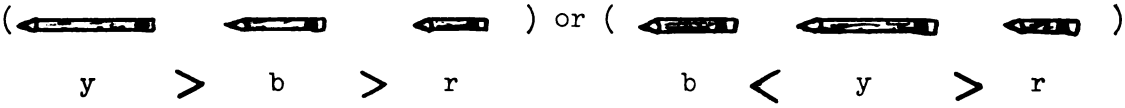
correct placement

If the child places objects in correct position ask, What does the sign tell us about the pencils? If child is confused go back to the previous statement. If child's explanation is correct the Examiner states, Yes, we would place the yellow pencil here because the sign tells us that it is longer than the blue pencil.

(After the proper comparison has been made proceed.)

Give the child the third pencil (red) and a second comparison sign and state, Now would you place this pencil and this comparison sign so that they tell us how all three pencils can be compared by length?

possible correct placements:



If the child does nothing, incorrectly places pencils, or is confused the Examiner asks, Which pencil is longest? Place it here... Which pencil is next longest? Place it here... Which pencil is the shortest? Place it here... (y, b, r order) After the subject has placed the objects in either of the possible correct comparisons or the Examiner has rearranged them the Examiner states, Now what do the signs tell us about the pencils? correct response Examiner states, Good, it tells us that... If the child gives an unacceptable response the Examiner states, No, the signs tell us that this pencil (yellow) is longer than this one (blue) and that this one (blue) is longer than

this one (red) (for arrangement y, b, r). The signs tell us that this one (yellow) is longer than this one (blue) and is also longer than this one (red) (for arrangement b, y, r).

The Test

Instructions:

(1) Sandpaper - (roughness)

Examiner hands the child two pieces of sandpaper coarse and medium and a comparison sign. Now, will you put these pieces of sandpaper on each side of this comparison sign so that it tells something about the sandpaper's roughness? Record what the child's response is. If the child is unable to do this, note it and proceed to the next set of items. If the child places the objects then state, What does the sign tell us about the sandpaper? Record response as either acceptable or unacceptable and indicate position of sandpaper and comparison sign. If the child changes comparison sign at this time, note this also.

Examiner gives the child the third piece of sandpaper (fine) and the second comparison sign and states, Would you place this piece of sandpaper and comparison sign so that they tell us how all three pieces of sandpaper can be compared by roughness?... Record child's response then Examiner states, Now, what does it tell us? Record if the child's response is acceptable or not.

(2) Boxes - weight (heaviness)

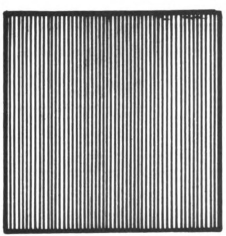
Use same format but substitute boxes and heaviness in appropriate places. Order of presentation of boxes - red and blue then yellow.

(3) Green Squares - shade (greenness)

Use same format but substitute green squares and greenness in appropriate places. Order of presentation - dark green, medium green then light green.

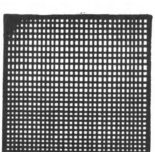
(4) Green Squares - size (bigness)

Use same format but substitute green squares and size in appropriate places. Order of presentation - light green and medium green then dark green.



(light green)

(dark green)



(medium green)

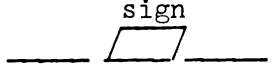
Record Sheet - Comparison of Objects

Example: pencil - length

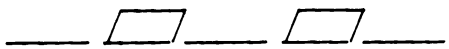
y = yellow
b = blue
r = red

Record child's response

sign



verbal response acceptable____
verbal response unacceptable____



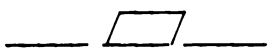
verbal response acceptable____
verbal response unacceptable____

Test

(1) Sandpaper - roughness

c = coarse
m = medium
f = fine

Record child's response



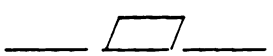
verbal response acceptable____
verbal response unacceptable____

verbal response acceptable____
verbal response unacceptable____

(2) Boxes - weight heaviness

R = red-heavy
B = blue-medium
Y = yellow-light

Record child's response



verbal response acceptable____
verbal response unacceptable____

verbal response acceptable____
verbal response unacceptable____

(3) Green Squares - shade (greenness)

L = light green
M = dark green
S = medium green

Record child's response

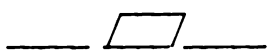
verbal response acceptable____
verbal response unacceptable____

verbal response acceptable____
verbal response unacceptable____

(4) Green Squares - size (bigness)

L = large
M = medium
S = small

Record child's response



verbal response acceptable____
verbal response unacceptable____

verbal response acceptable____
verbal response unacceptable____

Material Objects - Test 5

Parts A and B (Group Test) (administered to small groups of eight to ten children, total time about twenty minutes)

Equipment and Instructions for the Two Group Tests:

Each child will get:

Three plastic boxes with six compartments each; left compartment key -- colored red, white, and blue respectively.

One envelope containing an assortment of screws, washers, and nuts, made of plastic, brass, aluminum, and steel.

One paper plate

General instruction preceding the parts: (Give all instructions slowly and clearly.)

Today we are going to play some games and ask some questions about objects. Each one of you is going to get a paper plate, a couple of envelopes containing some objects, and some boxes we're going to use to sort the objects.

(Equipment is handed out.)

This envelope has objects in it that you may have seen before. Maybe you even know the names of some of the objects.

(Pull out a large screw.)

Does any one know what this is called? Wait until you hear the right answer. That's right, it's a screw. (Hold up display washer.) Does anyone know what this is called? (If no one knows, identify it as a washer. Hold up display nut.) Does anyone know what this is called? It's a nut. Remember, the screw is long, the washer is round like a penny with a hole in the middle, and the nut has six corners. Now take your envelope and open it very carefully onto the paper plate. Be sure

you empty everything out of the envelope. There are a lot of objects, aren't there? Can you remember which is the screw? Everyone hold up a screw. That's right. Now show me a washer... That's fine. And now a nut. Good. Each of them comes in different sizes and we're going to play some finding and sorting games with them.

In the two parts of the group test that follow, you will move among the children to check sources of confusion. Do not "hint" or approve/disapprove. The only help you can give is to restate instructions, but only when a child asks for help or does not know how to begin.

Examiner proceeds with Part B - Sorting by Material

Now we're going to play another finding game. Take the box that has the white space in it. Now I want you to look over all the objects left on your plate. Do you still remember what the screws look like? Hold up model screw. Pick out all the screws. (Allow time for this.) All right. Now put all the screws together in a pile on your plate. (Wait for children to do this.) Screws can be made out of different materials or stuff. I want you to sort the screws according to the materials or stuff they're made of. Put all the screws that are made of the same material or stuff together in the space with the white label. If you find another bunch of screws that are all made out of another material or stuff put them all together in the next space. Use as many spaces or as few spaces as you need. When you are finished, each space should have only screws that are made of the same material or stuff. (Wait until all the children have finished.) Fine. Now close your box up tightly and put it on the side of your desk. You can put all the objects that are left on your plate very carefully back into the envelope.

Procedure: The envelopes and red-and-white spaced boxes are collected, and then each child is given a small envelope containing nine washers.

NOTE: Before the sets of screws, washers, nuts are used again they should be rechecked against the inventory to be sure they are complete.

Material Objects - Test 5

Examiner now proceeds with Part A - Identification and Sorting by Property

Instructions:

The first game we're going to play with these objects is a finding game. Take the box that has a red space in it. I'm going to tell you to find something, and you're going to put it into its own space in the box with the red space in it. Are you ready? All right. (Wait for children to complete each part before going on with your instructions.)

First, find a white screw on your plate and put it into the red space. (Any white screw is all right.)

Now find a gold colored washer and put it in the next space.

Next, find a fat, thick black object, and put it in the next space. (Be sure to enunciate "fat" clearly so it won't be confused with "flat.")

Now find a thin silver-colored object and put it in the next space.

Make sure you give each object its own space. Don't put more than one object in each space.

Now find the smallest thin black object and put it in the next space. The smallest flat black object.

The next one is a little harder. Take out the very shortest screws you can find--the very shortest screws, and put them together on your plate. Now, just using these very shortest screws, find the one that feels the lightest (pause) and put it in the next space in the box. Remember, the one that feels the lightest.

Very good. Now close the box up tight, and we'll go on to another game.

Material Objects - Test 5 # _____

Record Sheet - Test 5 - Group Test

Date _____ Examiner _____

(1) Identification: Below each item put a check mark if the item is completely correct, and put a diagonal slash if the box is left blank. Write in the description of any incorrect item, e.g., "silver nut" if "silver washer" was requested.

white screw	gold washer	black nut	silver washer	smallest black washer	lightest smallest screw

SCORE _____

(2) Sorting by Material: Place a check mark in each box next to any material(s) that are represented in the box. Note in the boxes if objects other than screws are included.

___alum. ___steel ___plastic ___brass	___alum. ___steel ___plastic ___brass	___alum. ___steel ___plastic ___brass	___alum. ___steel ___plastic ___brass	___alum. ___steel ___plastic ___brass	___alum. ___steel ___plastic ___brass

SCORE _____

APPENDIX B

APPENDIX B

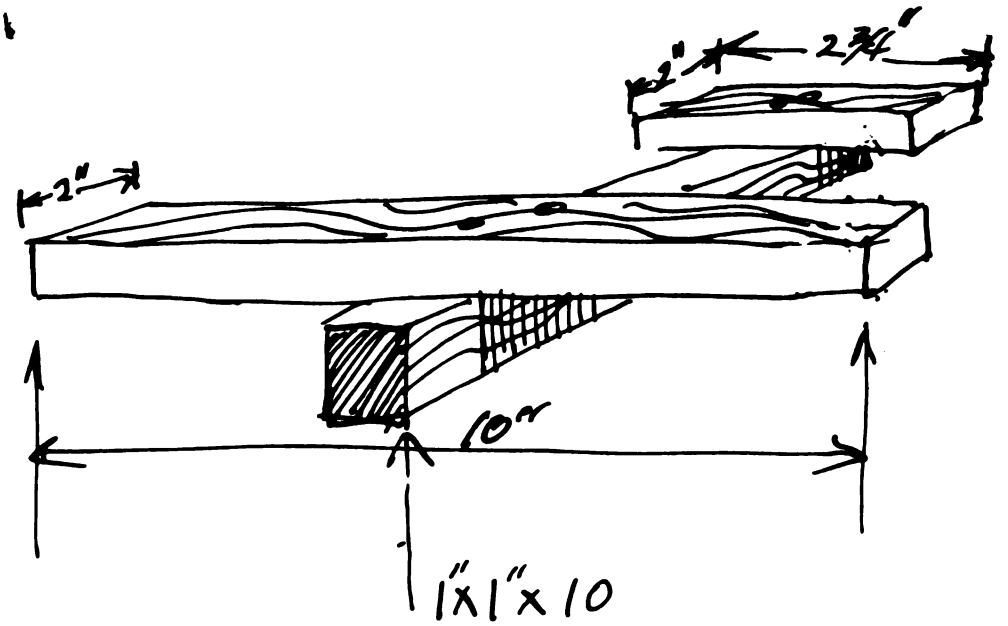
PLACEBO ACTIVITIES

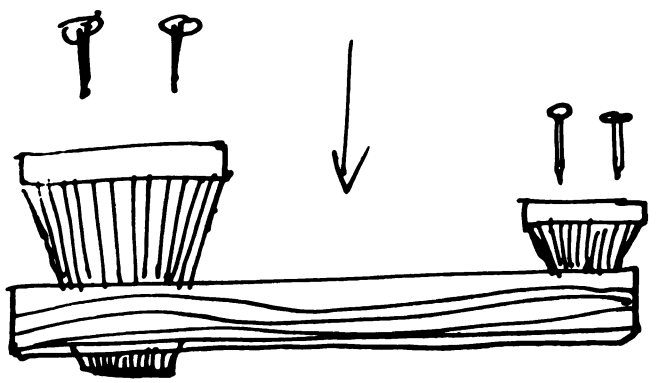
The following activities were used with the placebo groups during the course of this study. The activities were selected from Marjorie Latchou's book A Pocket Guide of Movement Activities for the Elementary School. It should be noted that the activities selected for use were not selected or organized by the investigator to develop any specific motor skills.

TYPE OF ACTIVITY	NAME OF ACTIVITY	BEHAVIORAL GOAL
Running and Chasing	Wild Horses	To run very fast from the "range" to the "valley."
Running and Chasing	Whistle Stop	To run on a signal and stop when the whistle blows; to solve the movement problems given by the teacher.
Running and Chasing	Beanbag Tag	To overtake and tag the player with the beanbag; to avoid being tagged if one is IT.
Running and Chasing	Frog in the Sea	To see how close one can get to the Frog without being tagged.
Running and Chasing	Walk, Walk, Run	To move quickly to tag another and to avoid being tagged.
Relays and Races	Walk-Run Race	To walk quickly and run fast in racing others.

TYPE OF ACTIVITY	NAME OF ACTIVITY	BEHAVIORAL GOAL
Relays and Races	Carry Home the Beanbag	To retrieve an object and carry it back across the line as fast as possible.
Throwing and Catching	Hot Ball	To push or roll the ball away from oneself quickly.
Throwing and Catching	I'll Roll the Ball to . . .	To roll the ball to another person, using one or two hands.
Throwing and Catching	Bounce and Catch	To bounce and catch a rubber playground ball.
Throwing and Catching	Moon Shot	To throw the bean bag and hit the "moon."
Throwing and Catching	Fox and Squirrel	To toss objects rapidly around the circle.
Classroom Games	Little Tommy Tiddlemouse	To guess who is knocking on one's "house."
Classroom Games	Lion Hunt	To mimic the action of a story; to make up a story for others.

Several modifications of the above relays and games were used. In addition to the activities above the placebo children were engaged in some activities where they used hand tools to construct wooden toys. The children spent three days driving 1" flat head nails into a 4 x 4 pine wood slab prior to constructing pre-cut wooden airplanes. Construction of the wooden airplanes took three days with the children having free play with planes during the construction period.





Another activity consisted of the children assembling pre-cut wooden cars. This activity took from eight to ten sessions for the children to complete. Each child sanded and painted (magic markers) his car.

APPENDIX C

APPENDIX C

SIMPLE CORRELATIONS

Dependent Variables

Lang Fac	1	1.00000									
B-Wrd Mn	2	0.10926	1.00000								
B-Lis	3	0.29267	0.52326	1.00000							
B-Match	4	0.10773	0.30630	0.31801	1.00000						
B-Alpha	5	0.07647	0.22765	0.33244	0.24767	1.00000					
B-Math	6	0.20593	0.36444	0.46307	0.41970	0.42608	1.00000				
B-Copy	7	0.03616	0.10025	0.13374	0.36873	0.19582	0.30206	1.00000			
B-Total	8	0.20242	0.60312	0.67344	0.68198	0.65555	0.75937	0.54606	1.00000		
Mater Id	9	0.41150	0.11151	0.32450	0.19543	0.20533	0.32304	0.09121	0.31881	1.00000	
Seq Disc	10	0.27048	0.22447	0.39678	0.33361	0.27387	0.43286	0.36316	0.51373	0.30412	1.00000
Obj Comp	11	0.23907	0.02119	0.11292	0.08838	0.21445	0.23986	0.13768	0.21992	0.43601	0.15779
Id Sort	12	0.08989	0.12676	0.18061	0.17763	0.14693	0.15308	0.04149	0.21119	0.06960	0.14395
Mat Sort	13	0.07081	0.18425	0.14133	0.03422	0.03221	0.14220	0.02049	0.13616	0.02074	0.19707
M.O. Sc Total	14	0.41840	0.16699	0.36798	0.26238	0.30865	0.43332	0.21721	0.45260	0.81294	0.53592
Eye-Motr	15	0.02195	0.05697	0.18270	0.32349	0.03271	0.14895	0.35952	0.27900	0.16440	0.14347
Fig-Grnd	16	0.07758	0.17479	0.10458	0.11903	0.17312	0.22516	0.36988	0.29539	0.08608	0.39024
Form Con	17	0.18556	0.10495	0.26259	0.18414	0.00717	0.25701	0.09314	0.22147	0.30208	0.28053
Spac Pos	18	0.11339	0.26845	0.38192	0.40191	0.27725	0.39652	0.40250	0.54536	0.14418	0.33349
Spal Rel	19	0.28291	0.23361	0.25142	0.47168	0.18134	0.33853	0.50921	0.50585	0.20304	0.46393
Fr Total	20	0.18958	0.23721	0.32585	0.38685	0.19083	0.40053	0.49005	0.51286	0.27350	0.49921

		1 Lang Fac	2 B-Wrd Mn	3 B-Lis	4 B-Match	5 B-Alpha	6 B-Math	7 B-Copy	8 B-Total	16 Mater Id	17 Seq Disc
Obj Comp	11	1.00000									
Id Sort	12	0.07231	1.00000								
Mat Sort	13	0.09848	0.06798	1.00000							
M.O. Sc Total	14	0.77157	0.28767	0.22307	1.00000						
Eye-Motr	15	0.10089	0.08441	0.00173	0.18501	1.00000					
Fig-Grnd	16	0.10155	-0.02761	0.10305	0.10051	0.23492	1.00000				
Form Con	17	0.19726	0.10468	0.17434	0.35885	0.06940	0.23529	1.00000			
Space Pos	18	0.07428	0.15055	0.07439	0.22828	0.16871	0.25426	0.24351	1.00000		
Spal Rel	19	0.05248	0.12193	0.03914	0.27519	0.26987	0.33292	0.17502	0.31909	1.00000	
Fr Total	20	0.08414	0.10251	0.14074	0.34149	0.53663	0.78586	0.61193	0.49762	0.54745	1.00000

		18 Obj Comp	19 Id Sort	20 Mat Sort	21 Sc Total	22 Eye-Motr	23 Fig-Grnd	24 Form Con	25 Spac Pos	26 Spal Rel	27 Fr Total

Language Facility - Lang Fac -- Verbal Expression subtest of the Illinois Test of Psycholinguistic Abilities

Metropolitan Readiness Test Form B

- Word Meaning - B-Wrd Mn
- Listening - B-Lis
- Matching - B-Match
- Alphabet - B-Alpha
- Copying - B-Copy
- Total - T-Total

Material Objects Science Test

- Materials Identification - Mater Id
- Sequential Discrimination - Seq Disc
- Object Comparison - Obj Comp
- Property Sort - Id Sort
- Materials Sort - Mat Sort
- Total - M.O. Sc Total

Marianne Frostig Developmental Test of Visual Perception

- Eye-Motor - Eye-Motr
- Figure Ground - Fig-Grnd
- Form Constancy - Form Con
- Position in Space - Spac Pos
- Spatial Relations - Spal Rel
- Total - Fr-Total

APPENDIX D

APPENDIX D

COMBINED MEANS

	Treatment N = 42	Placebo Control N = 32	Control N = 28
Verbal	17.93	13.91	12.11
B-Word Meaning	8.619	8.781	8.321
B-Listening	9.524	9.156	8.107
B-Matching	7.167	6.031	6.500
B-Alphabet	9.714	9.125	8.107
B-Math	9.381	9.719	8.536
B-Copying	6.381	5.187	5.821
B-Metro Total	50.86	48.16	45.39
Materials Identification	27.40	20.16	18.61
Sequential Discrimination	8.095	6.062	6.714
Object Comparison	13.29	6.844	4.321
Property Sort	5.333	6.062	6.786
Materials Sort	2.762	2.937	2.429
Science	56.90	42.06	38.86
Eye-Motor	10.81	8.844	10.36
Figure Ground	13.36	10.97	14.32
Form Constancy	7.214	6.156	6.071
Position in Space	5.976	5.937	5.286
Spatial Relations	4.214	3.000	3.750
Frostig Total	41.57	34.87	39.68
Covariates:			
Age	69.98	71.75	70.14
A-Word Meaning	7.762	7.281	7.429
A-Listening	7.857	7.625	7.250
A-Matching	4.595	3.219	4.857
A-Alphabet	6.429	6.094	5.321
A-Math	8.214	7.562	7.536
A-Copying	5.738	3.937	4.179
A-Metro Total	40.60	35.72	35.89

APPENDIX E

APPENDIX E

CELL MEANS AND STANDARD DEVIATIONS

Treatment

Variable	N = 23 $\bar{X}$ ♂	S.D.	N = 19 $\bar{X}$ ♀	S.D.
2. Verbal Expression	19.00000	5.16984	16.63158	3.96107
3. B-Word Meaning	8.73913	2.64948	8.47368	1.95415
4. B-Listening	9.60870	2.57151	9.42105	2.24390
5. B-Matching	6.73913	3.10743	7.68421	3.44887
6. B-Alphabet	8.60870	3.48685	11.05263	2.93397
7. B-Math	9.34783	3.22784	9.42105	2.79515
8. B-Copying	5.73913	2.71724	7.15789	2.29161
9. B-Metro Total	48.91304	12.18760	53.21053	9.36648
17. Materials Identification	27.34783	6.91250	27.47368	8.80889
18. Sequencial Discrimination	8.08696	3.64209	8.10526	3.60393
19. Object Comparison	12.78261	7.74571	13.89474	6.69904
20. Property Sort	5.91304	2.85901	4.63158	3.05888
21. Materials Sort	2.52174	1.72862	3.05263	1.39338
22. Material Objects Test	56.73913	15.57451	57.10526	12.38231
23. Eye-Motor	10.73913	3.30588	10.89474	2.96076
24. Figure Ground	13.43478	4.93435	13.26316	5.45529
25. Form Constancy	7.13043	2.89677	7.31579	4.17735
26. Position in Space	6.00000	1.44600	5.94737	1.47097
27. Spatial Relations	4.30435	1.39593	4.10526	1.52369
28. Frostig Total	41.60870	8.06079	41.52632	10.53760
Covariates:				
10. A-Word Meaning	8.00000	3.08957	7.47368	2.98828
11. A-Listening	7.65217	2.14495	8.10526	2.02470
12. A-Matching	3.69565	2.00986	5.68421	3.00097
13. A-Alphabet	5.60870	4.03101	7.42105	4.07316
14. A-Math	7.86957	3.36161	8.63158	2.73273
15. A-Copying	5.56522	3.53972	5.94737	3.11758
16. A-Metro Total	38.39130	12.81242	43.26316	9.83103
1. Age	70.21739		69.68421	

CELL MEANS AND STANDARD DEVIATIONS

Placebo

Variable	N = 19 $\bar{X}$ ♂	S.D.	N = 13 $\bar{X}$ ♀	S.D.
2. Verbal Expression	13.00000	3.69685	15.23077	6.94207
3. B-Word Meaning	8.10526	2.57972	9.76923	2.77350
4. B-Listening	8.73684	2.90291	9.76923	2.52170
5. B-Matching	5.57895	3.90606	6.69231	2.56205
6. B-Alphabet	8.31579	4.30829	10.30769	3.30113
7. B-Math	8.94737	3.56641	10.84615	2.91108
8. B-Copying	4.36842	3.13068	6.38462	2.50128
9. B-Metro Total	44.26316	13.64975	53.84615	9.19099
17. Materials Identification	19.89474	8.62100	20.53846	6.07749
18. Sequential Discrimination	4.94737	4.83590	7.69231	4.38529
19. Object Comparison	6.31579	7.58692	7.61538	8.15004
20. Property Sort	5.26316	2.51312	7.23077	3.41940
21. Materials Sort	2.63158	1.64014	3.38462	1.70970
22. Material Objects Test	39.05263	17.01135	46.46154	12.71230
23. Eye-Motor	9.15789	2.91096	8.38462	2.36426
24. Figure Ground	10.00000	5.62731	12.38462	5.82435
25. Form Constancy	6.00000	4.49691	6.38462	4.97558
26. Position in Space	5.73684	1.52177	6.23077	1.36344
27. Spatial Relations	2.89474	2.07885	3.15385	1.90815
28. Frostig Total	33.78947	11.40945	36.46154	9.01494
Covariates:				
10. A-Word Meaning	7.63158	3.09499	6.76923	1.73944
11. A-Listening	7.36842	2.43152	8.00000	3.60555
12. A-Matching	3.10526	2.78677	3.38462	2.36426
13. A-Alphabet	5.31579	4.50990	7.23077	3.63212
14. A-Math	7.36842	3.57787	7.84615	2.88231
15. A-Copying	3.00000	2.38048	5.30769	2.92645
16. A-Metro Total	33.78947	13.45601	38.53846	7.77405
1. Age	71.31579		72.38462	

CELL MEANS AND STANDARD DEVIATIONS

Control

Variable	N = 16 $\bar{X}$ ♂	S.D.	N = 12 $\bar{X}$ ♀	S.D.
2. Verbal Expression	11.43750	4.53091	13.00000	4.32750
3. B-Word Meaning	8.37500	2.30579	8.25000	3.33371
4. B-Listening	8.62500	2.12525	7.41667	3.08835
5. B-Matching	5.62500	3.44238	7.66667	2.18812
6. B-Alphabet	8.18750	4.03681	8.00000	4.28528
7. B-Math	8.31250	2.52240	8.83333	3.37998
8. B-Copying	5.81250	3.91950	5.83333	3.24271
9. B-Metro Total	44.93750	11.53816	46.00000	13.46376
17. Material Identification	18.12500	7.12624	19.25000	8.51870
18. Sequential Discrimination	7.12500	4.73110	6.16667	4.89589
19. Object Comparison	3.31250	6.01907	5.66667	7.60781
20. Property Sort	6.50000	2.47656	7.16667	2.88675
21. Materials Sort	2.12500	1.99583	2.8333	1.99241
22. Material Objects Test	37.18750	15.69806	41.08333	14.79839
23. Eye-Motor	10.06250	2.51578	10.75000	3.59608
24. Figure Ground	14.93750	3.41504	13.50000	4.79583
25. Form Constancy	6.50000	3.70585	5.50000	3.82575
26. Position in Space	5.37500	2.02896	5.16667	1.74946
27. Spatial Relations	3.81250	2.94887	3.66667	2.01509
28. Frostig Total	40.50000	9.52890	38.58333	9.77435
Covariates:				
10. A-Word Meaning	6.68750	2.41437	8.41667	2.23437
11. A-Listening	6.81250	2.73785	7.83333	2.75791
12. A-Matching	5.00000	4.14729	4.66667	2.77434
13. A-Alphabet	5.25000	3.19374	5.41667	3.28795
14. A-Math	6.93750	2.43499	8.33333	2.74138
15. A-Copying	4.37500	3.40343	3.91667	2.87492
16. A-Metro Total	34.18750	10.21906	38.16667	10.96136
1. Age	70.62500		69.50000	

APPENDIX F

APPENDIX F

KEY FOR THE DATA CARD PROGRAM

AND RAW DATA

Column Numbers	Number of Columns	Range of Valid Cards	Item Description
1-3	3	001-107	Subject Identification
4	1	1-3	Group 1 = T 2 = PC 3 = C
5-6	2	60-85	Age in Months
7	1	1-2	Sex 1 = ♂ 2 = ♀
8	1	-	Blank
9-10	2	01-35	Verbal Expression
11-12	2	-	Blank
13-14	2	00-16	Metro Form B Test 1 Word Meaning
15-16	2	00-16	Metro Form B Test 2 Listening
17-18	2	00-14	Metro Form B Test 3 Visual Perception
19-20	2	00-16	Metro Form B Test 4 Alphabet
21-22	2	00-26	Metro Form B Test 5 Numbers-Math
23-24	2	00-14	Metro Form B Test 6 Copying
25-26	2	00-99	Metro Form B Totals
27-38	2	-	Blank
29-30	2	00-16	Metro Form A Test 1
31-32	2	00-16	Metro Form A Test 2
33-34	2	00-14	Metro Form A Test 3

KEY FOR THE DATA CARD PROGRAM AND RAW DATA (continued)

Column Numbers	Number of Columns	Range of Valid Cards	Item Description
35-36	2	00-16	Metro Form A Test 4
37-38	2	00-14	Metro Form A Test 5
39-40	2	00-14	Metro Form A Test 6
41-42	2	00-99	Metro Form A Totals
43-44	2	-	Blank
45-46	2	00-41	Material Objects Science Test 1 Identification of Materials
47-48	2	00-18	Material Objects Science Test 2 Discrimination of Sequence
49-50	2	00-16	Material Objects Science Test 3 Comparison of Objects
51-52	2	00-12	Material Objects Science Test 4 Identifying and Sorting by Property
53-54	2	00-08	Material Objects Science Test 5 Sorting by Material
55-56	2	01-95	Material Objects Science Totals
57-58	2	-	Blank
59-60	2	00-16	Frostig Sub-test 1 Eye-Motor Word
61-62	2	00-08	Frostig Sub-test 2 Figure Ground
63-64	2	00-32	Frostig Sub-test 3 Form Constancy
65-66	2	00-08	Frostig Sub-test 4 Position in Space
67-68	2	00-08	Frostig Sub-test 5 Spatial Relations
69-70	2	00-72	Frostig Totals

KEY FOR THE DATA CARD PROGRAM AND RAW DATA (continued)

Column Numbers	Number of Columns	Range of Valid Cards	Item Description
71-72	2	-	Blank
73	1	1-2	School Identification 1 = School A 2 = School B
74	1	-	Blank
75	1	1-2	AM or PM Sessions 1 = AM 2 = PM
76	1	-	Blank
77	1	1-3	Teacher Identification 1 = Teacher 1 2 = Teacher 2 3 = Teacher 3
78-80	3	-	Blank

INDIVIDUAL DATA CARDS

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0721701 18  09080510070746  08080303030833  270720000258  121108050541  2 1 3
0731661 15  03040604050527  04070203060527  250215040248  131107040338  2 1 3
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INDIVIDUAL DATA CARDS (continued)

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0582762 15  12130915120667  07130613140356  191200100445  091604050438  1 1 2
0592712 10  04080807090945  05110502100740  161100060033  101805050543  1 1 2
0652752 12  13140212100657  08090005080333  140418020442  071002060025  1 1 2
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1072732 33  09101013120761  08110504051144  331200100257  071304070636  2 2 3
    16   3   1
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0273651 03  08090611080951  04050701090733  110200060019  151703060445  1 2 2
0293711 16  06110611100448  09080606080340  101200060028  101710080651  1 2 2
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0383731 08  06050912100850  07040006070529  250607060044  061405040433  1 2 2
0463731 16  09120014130755  10060309070944  231217100466  101501040232  1 1 2
0473741 14  09111011061259  10080908110743  251118080466  121608080751  1 1 2
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0643711 18  10080405080237  05080006100029  310800060449  101706040441  1 1 2
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