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An Investigation of what Relationships Exist Between a Child's Performance of Selected tasks of Conservation and Selected Factors in Reading Readiness

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AN INVESTIGATION OF WHAT RELATIONSHIPS EXIST BETWEEN A CHILD'S PERFORMANCE OF SELECTED TASKS OF CONSERVATION AND SELECTED FACTORS IN READING READINESS

by

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ABSTRACT

Problem

The purpose of this study was to determine what relationships exist between a child's performance of selected tasks of conservation and selected factors in reading readiness. Comparisons were also made between conservation and reading readiness to selected variables such as mental age, sex, chronological age, and teacher prediction.

Procedure

The research population for this study was comprised of 81 first grade subjects enrolled in four classrooms of the Grand Forks Public Schools during the 1970-1971 school year. The students were selected to be representative of the total Grand Forks, North Dakota school population. Due to changes in school populations between kindergarten, May, 1970 and first grade, September, 1970 only 63 of the 81 first grade students were ranked on their comparative readiness for reading by their kindergarten teachers during May, 1970. All of the 81 first grade children participating in the study received the following battery of tests in September, 1970: Gates-MacGinitie Reading Tests: Readiness Skills, SRA Primary Mental Abilities Test: Grades K - 1, and Procedures of Conservation of Number and Substance with First Grade Children.

The statistical procedure utilized in the investigation consisted of a multiple linear regression to find the multiple correlation

coefficients and the zero-order coefficients for all hypotheses. A stepwise regression was employed to find the variables which contributed most to prediction. Discriminant analysis by multiple linear regression was used to predict the number of conservers and nonconservers.

Conclusions

1. A child's performance of selected tasks of conservation is significantly related to selected factors in reading readiness.

2. Mental age is significantly related to conservation and reading readiness.

3. Sex differences are significantly related to conservation and reading readiness.

4. Chronological age is positively but not significantly related to conservation and reading readiness.

5. Teacher prediction is significantly related to reading readiness, but more closely related to mental age.

CHAPTER I

INTRODUCTION

Background and Significance of the Problem

A consideration of the school curriculum for young children often focuses upon the controversy of when beginning reading instruction should be initiated. Jean Piaget, a genetic epistemologist and authority on the structure and processes of the cognitive development of children, viewed the problem of time for learning in the following way:

> A few years ago Bruner made a claim which has always astounded me; namely, that you can teach anything in an intellectually honest way to any child at any age if you go about it in the right way. Well, . . . it's probably possible to accelerate, but maximum acceleration is not desirable. There seems to be an optimum time. When this optimum time is will surely depend on each individual and on the subject matter (Jennings, 1967, p. 82).

According to Piaget not only is there an optimum time for learning, but the stage of development can in part determine the nature of the learning. Jean Piaget (Almy, Chittenden, and Miller, 1967, p. v) made the following essential conclusions:

> Learning cannot explain development, but the stage of development can in part explain learning. Development follows its own laws . . . and although each stage in the development is accompanied by all sorts of new learning based upon experience, this learning is always relative to the developmental period during which it takes place, and to the intellectual structure, whether completely or partially formed, which the subject has at his disposal during this period.

Jean Piaget's theory and experimentation have shown that the cognitive development of children occurs in predictable sequential stages: sensorimotor, preoperational, concrete operational, and formal operational. His studies identified the characteristic thinking processes which comprise each stage. A child's acquisition of conservation of number and substance marked the entrance to the concrete operations stage. The child's attainment of conservation indicated an ability to differentiate logical reality from perceptual cues. Piaget has described conservation in terms of three stages as (1) no conservation, (2) transitional, and (3) conservation. Piaget's concept of conservation and the cognitive development of children was of particular interest in this study.

There has been scant research to relate Piaget's finding on the development of cognitive abilities during these stages to the abilities involved in learning to read. Furth (1970, p. 148) interpreted Piaget's theory of intelligence in regard to the decoding process of reading in the following: "Reading first requires the figurative ability to comprehend an arbitrary symbolic code, and this ability begins to be evident in the preoperational period of symbol formation."

The findings of Almy's et al. (1967) cross-sectional and longitudinal studies of kindergarten and primary children's concepts of conservation of quantity and number demonstrated a substantial correlation between conservation tasks of the concrete operational stage and progress in beginning reading.

The present study was an attempt to determine what relationships exist between conservation and reading readiness. It raises the question as to the extent conservation may be utilized as a predictor of readiness for beginning reading instruction. Can the stage of cognitive development help to explain the child's readiness for learning to read?

Statement of the Problem

This study was concerned with the process of the child's development of conservation in the concrete operational stage. The purpose of the study was to determine what relationships exist among the following: a child's performance of selected tasks of conservation as specified in the Procedures of Conservation of Number and Substance with First Grade Children, and selected factors in reading readiness as measured by the Gates-MacGinitie Reading Tests: Readiness Skills.

Hypotheses

The hypotheses were generated from this central question: is there a positive correlation between the performance of selected tasks of conservation and the performance of selected factors of reading readiness? The research hypotheses of which the first four are the most relevant to the present investigation are as follows:

1. There is a positive relationship between conservation and the reading readiness subtests.
2. There is a positive relationship between conservation and the primary mental abilities subtests.
3. There is a positive relationship between conservation and mental age.
4. There is a positive relationship between reading readiness and mental age.
5. There is a positive relationship between conservation and sex.

6. There is a positive relationship between reading readiness and sex.

7. There is a positive relationship between conservation and chronological age.

8. There is a positive relationship between reading readiness and chronological age.

9. There is a positive relationship in reading readiness among the children ranked by the kindergarten teachers on their comparative readiness for reading in the first grade.

Population and Procedures

The research population for this study was comprised of 81 first grade pupils. All of the children received the following battery of tests in September, 1970:

1. Gates-MacGinitie Reading Tests: Readiness Skills
2. SRA Primary Mental Abilities Test: Grades K-1
3. Procedures of Conservation of Number and Substance with First Grade Children

During May, 1970 the two kindergarten teachers of the first grade children ranked their classes on their comparative readiness for reading.

Delimitations of the Problem

The study was conducted within the framework of the following delimitations:

1. The subjects in this study were not randomly chosen. However, they were selected to be representative of the total Grand Forks, North Dakota school population. The difficulty in scheduling, coördinating, and collecting data on randomly

chosen subjects within the Grand Forks first grade school population was prohibitive. The study was concerned with first grade pupils enrolled in classes in West School and Wilder School, Grand Forks, North Dakota.

2. Only pupils for whom relevant data were available on all the instruments utilized in the study were included.

Limitations of the Problem

The study was conducted under the following limitations and assumptions:

1. It was assumed that the instruments employed in the study had sufficient reliability and validity for the purpose of the study.
2. It was assumed that the Procedures of Conservation of Number and Substance with First Grade Children developed by the investigator had sufficient validity and reliability for the purpose of this study.

Definition of Terms

The following terms are defined, when appropriate, nominally according to Piaget's theory as interpreted by Furth, and operationally as used in this study.

Conservation. Furth (1970, p. 158) defined conservation: "The maintenance of a structure as invariant during physical changes of some aspects." For conservation of number in Task I and Task II of the Procedures of Conservation of Number and Substance with First Grade Children, the child knows that rearranging the members of the two sets does not alter the numerical comparison of those sets, whether they are equal or unequal in number. For conservation of substance as used in the mentioned procedure for Task III, Task IV, and Task V, the child knows that changing the shape of the ball of play dough into a hot dog, pancake, or little pieces does not alter the amount of play dough. Conservation of equality and inequality of substance are included in these tasks.

Reversibility. Furth (1970, p. 162) constructed Piaget's definition of reversibility as: "The possibility of performing a given action in a reversed direction." In this study for all the five tasks in the conservation procedures a reversibility question followed the transformation question. A child attained reversibility when he realized that if the blocks or play dough were made into lines or a ball again, the criterion of equality or inequality of number or substance would be the same as before the transformation.

Concrete Operations. Furth (1970, p. 158) stated: "Characteristics of the first stage of operational intelligence. A concrete operation implies underlying systems or 'groupings' such as classification, seriation, number. Its applicability is limited to objects considered as real (concrete)." This stage begins around seven years. A child's entrance to this stage is indicated by the child's ability conserve number and substance.

Centration. Furth (1970, p. 158) explained this as: "In perception, the focusing on a specific part of a stimulus; in general, a subjective focusing on an aspect of a given situation leading to a deformation of objectivity." In this study a child might give a perceptual response in terms of the way the blocks or play dough appear after the transformation. For example, "Green play dough has more cause its got more pieces." This is characteristic of the preoperational stage.

Conserver. The investigator has operationally determined the conserver as the child who successfully conserved on all five conservation tasks.

Transitional Conserver. The investigator has defined the transitional conserver as the child who has attained reversibility, but not consistent conservation of number and substance.

Nonconserver. The investigator used this term to describe the child who is inconsistent and has not acquired reversibility of conservation.

Reading Readiness. The investigator has operationally defined reading readiness as the child's performance of selected factors of reading readiness as measured by the Gates-MacGinitie Reading Tests: Readiness Skills as follows: listening comprehension, auditory discrimination, visual discrimination, following directions, letter recognition, visual-motor coordination, auditory blending, and word recognition.

CHAPTER II

REVIEW OF LITERATURE

Introduction

The question as to when a child should begin to learn to read has been the subject of extensive research and interpretation. Reading readiness refers to the factors which are assumed necessary to achieve success in beginning reading. The review of the literature of reading readiness will be limited to the development of the concept and later to the relation of reading readiness to conservation, intelligence, sex, chronological age, and teacher prediction. These dimensions are most appropriate to the thrust of the study.

Gunderson (1963) reviewed reading readiness research and concluded that readiness for reading is determined by a constellation of factors. Harris (1961, p. 26) interpreted reading readiness factors in a descriptive summary as follows:

> Reading readiness may be defined as a state of general maturity which, when reached, allows a child to learn to read without excess difficulty. It is a composite of many interconnected traits. A child may be more advanced in some aspects of reading readiness than in others. The major characteristics which are important in reading readiness are age, sex, general intelligence, visual and auditory perception, physical health and maturity, freedom from directional confusion, background of experience, comprehension, and use of oral English, emotional and social adjustment, and interest in reading.

Schools have used various procedures to evaluate the child's reading readiness. According to De Hirsch, Jansky, and Langford (1966) the three most common measures are reading readiness tests, intelligence tests (usually a group test), and informal assessment of the child by the kindergarten teacher. They claimed that these measures have been proven useful, but each has limitations. Readiness tests do not suggest systematic educational strategies. Intelligence tests failed to consider certain aspects of perceptual functioning related to early reading. Informal assessment of the child by the kindergarten teacher represented subjective judgment. Differences in training and experience affected the reliability of teacher evaluation.

Development of Reading Readiness Concept

Although the term reading readiness appeared in professional publications in the 1920's, the concept of readiness had been evolving from the ideas of Rousseau, Pestalozzi, Froebel, Herbart, and particularly John Dewey. Maturation and sensory-motor activities were considered by these educators as the foundations of readiness.

Following this Gesell defined readiness as the development of maturational stages. Weber (1969, p. 200, 201) summarized Gesell's influence upon the research on reading readiness:

> Gesell extended the description of the active physiological process of maturation as equally applicable to mental processes. The belief became established that a mental age of six-and-a-half was essential before a child could profit from systematic reading instruction. This implied that the teacher must respect the individual readiness of each child; and there was little she could do to hurry it along.

During the 1920's and 1930's studies of first grade reading failures resulted in the application of reading readiness to beginning reading according to Smith (1967). The emphasis upon evaluation during the 1930's led to the development of group tests to determine reading readiness as reported by Weber (1969, p. 204):

> By 1936, Emmet Betts, Murray Lee and Willis Clark, Marion Monroe, M. J. Vanwagenen, Gertrude Hildreth, and others had developed readiness tests to be used at the kindergarten level. These tended to focus upon such reading mechanics as auditory discrimination, seeing likenesses and differences, ability to remember visual forms, and ocular-motor control.

These attempts to measure reading readiness evoked a concern for the ways in which children develop the skills necessary for beginning reading. A growing value was placed upon experiential readiness. The child's first-hand, concrete experiences with objects was believed necessary for understanding subsequent association with symbols in the reading process. Harrison (1936) clarified the concept of experiential readiness by identifying specific activities to develop readiness for reading.

During the following decades reading readiness became a composite of views which included experiential background together with physical, social, emotional, and intellectual maturation. In the 1960's the idea that the young child developed as a result of maturation rather than learning was further extended by the studies of Ilg and Ames (1965). They advocated that true readiness is based upon careful records of what a child does under normal circumstances. Ilg and Ames developed a battery of behavioral tests to assess readiness for school. Piaget's formulations of cognitive development of children have presented opportunities for establishing additional criteria of readiness. Piaget has demonstrated how the growth of the sequential stages of cognitive development is affected by experience.

Piaget and Cognitive Development

Piaget has systematically investigated the nature of intelligence and the source of knowledge. Furth (1969, p. 7) proposed, "Piaget's revolution removes knowledge and intelligence from philosophical assumptions and speculations and puts them in the totality of natural, biological life." As both a developmental psychologist and a biologist, Piaget (1963) viewed intelligence as an adaptation. In studying the origins of intelligence, Piaget (1963, p. 1) hypothesized:

> Verbal or cognitive intelligence is based upon practical or sensorimotor intelligence which in turn depends on acquired and recombined habits and associations. These presuppose, furthermore, the system of reflexes whose connection with the organisms anatomical and morphological structure is apparent. A certain continuity exists, therefore, between intelligence and the purely biological processes of morphogenesis and adaptation to the environment.

Adaptation is defined by Furth (1969, p. 260) as "A balanced state of biological organization within its environment." A living being exists to the extent that it functions. Each living being has a structure, which is affected by its functioning in the environment. Functioning relates the internal structure to the external environment. Knowledge is the active relation of the structure to the environment. Knowing means having information relevant to functioning. Psychological functioning has a structure which is dependent upon underlying structures. When functioning takes in external cues and incorporates them within the internal structure, the process is assimilation. When the functioning changes to cues in a particular, new external situation the outgoing process is accommodation. Piaget (1963, p. 6) stated, "Adaptation is an equilibrium between assimilation and accommodation." Equilibrium represents the state at which the processes of assimilation and accommodation are in balance.

Equilibration is the formative process for the equilibrium state. This process is described by Flavell (1963, p. 238).

> The mechanism of transition which Piaget proposes is an equilibration process. This process, continuously operating in all exchanges between the growing subject and his environment, is the propellant for change and transition. This continuous process of equilibration gives rise to successive, essentially discontinuous equilibrium states, that is, organized systems of actions (sensory-motor, perceptual, concrete-operation. . . .) whose attributes as systems are describable in equilibrium terms.

Equilibration proceeds through progressive assimilations and accommodations. Equilibration's directionality incorporates a sequence of higher states of equilibrium. The product of the unifying equilibration process is the formation of cognitive stages. Equilibration is the underlying continuity of the relation between sequential stages. Flavell (1963, p. 240) quoted Piaget, "In brief, no structure is ever radically new, but each one is limited to generalizing this or that form of action abstracted from the preceding one." The equilibration-equilibrium model is Piaget's interpretation of the developmental process of change and its successive structure.

Structure is analyzed by Furth (1970, p. 17) as " . . . a totality of interrelated substructures and Piaget calls schemes those substructures that underlie specific types of functioning." Furth (1969) differentiated between the terms schemes and schema. Schemes refer to internal structures and pertain to operativity, the action aspect of intelligence. Furth (1969, p. 264) wrote, "Piaget distinguishes scheme from the term 'schema,' which conveys a representational outline, a figurative model. Schema is related to a figurative accommodation or symbol; scheme, to operativity." An interpretation of schema is made by DeCecco (1968, p. 89), "Internally, it is the cognitive structures (or processes) which initiate and control the accommodations the child makes to his environment. Externally, it is a collection of cohesive behaviors or actions." Each stage has its schemas, which are named after the behaviors with which they are connected. For example, the schema of sucking is in the sensorimotor stage.

Functions remain constant but structures change. The distinction between function and structure is stated by DeCecco (1968, p. 86), "Function refers to those general characteristics of intelligent activity which virtually define the essence of intelligence itself. Structure refers to those organized aspects of intelligence which change with age." Development is the change in structures. Cognitive development is a continuous process of organization of structure. Earlier structures are incorporated in a progressive synthesis. Piaget classified intellectual development into hierarchically ordered stages. The sequence of the stages is invariant. The approximation of ages may vary within stages, but the order of the succession of the stages remains constant.

Summary of Stages of Cognitive Development

Piaget identified four operational structures in the cognitive development of the child. Each structure characterizes a major stage of the formation of the intellectual processes. In the sensorimotor stage, the child realizes that objects have permanence. The child learns that objects can be found when moved or placed out of his sight. The assimilation of the sensorimotor scheme results from the action of the child and from previous experience of accommodation to the object. This stage includes approximately the first eighteen months.

During the preoperational stage, the child's concrete thought processes are irreversible. Egocentrism and perceptual evaluation of the environment are characteristic of the child's intellectual functioning from the middle of the second year to the sixth year.

In the concrete operational stage, which emerges during the transitional ages of six to seven years, the child's concrete thought processes gradually become reversible. Subsequently the child forms incomplete systems of concrete operations as described by Inhelder (1970, p. 24).

> They are characterized by two forms of reversibility: (a) negation, as expressed in the plasticene experiment, in which a perceived change in form is canceled by its corresponding negative thought operation; and (b) reciprocity, as expressed in the child's discovery that "being a foreigner" is a reciprocal relationship, or that left-right, before-behind spatial relationships are relative. At the concrete level, these forms of reversibility are used independently of one another; in formal thought, they will form one unified system of operations.

According to Lavatelli (1970), a child can conserve number by six years and substance by six to seven years of age. Conservation of length, weight, and volume are attained at approximately eight, nine, and ten years of age. The child becomes able to conserve by constructing an internal system of logic to compensate for perceptual changes in the environment. Equilibrium within this stage is acquired by eleven to twelve years.

Then the child enters the formal operational stage. He becomes capable of hypothetical and propositional levels of thought. These abstract thought operations stabilize into structures by fourteen years or older.

Conservation

Piaget has proposed a four-step probabilistic model to explain conservation. Flavell (1963, p. 245) wrote,

> Piaget asserts that the evolution of conservation is a process of equilibration of cognitive actions which contains four major steps, each step comprising in itself an equilibrium state--an isolable "moment" in the continuous equilibration process.

For example, the child is shown two equal balls of clay. One ball is successively transformed into longer and thinner sausage shapes. The child is questioned about conservation of substance after each transformation. In the first step the child centrates on the width or the length of the sausage, but not both. The child may alternate his centration on width or length. The second step consists of a series of alternations of centrations between width and length. Though successive, the alternating centrations are isolated and lack coordination. The first and second steps result in nonconservation. During the third step the child begins to coordinate width and length, but is hesitant in his responses of more, less, or equal. It is in the fourth step that the child forms an understanding of the sausage transformations, which is that each increase in length is compensated by a decrease in width. He realizes that the amount of clay remains unchanged despite the transformation of shape. The child is then able to conserve substance and respond accordingly.

When asked why the amount of clay remains unchanged, the child may give one of several justifications according to Ginsburg and Opper (1969). The child may give the compensation or reciprocity argument that the amount of clay is the same because the increase in the length of the sausage is made up for by the decrease in the width. Therefore, the amount of clay in the sausage is equal to the amount of clay in the ball. The child may involve the negation argument that if the sausage were made back into a ball again, the two clay balls would have the same amount. The child may use the identity argument that the clay is the same. No clay has been added or taken away. These arguments of compensation, reciprocity, negation, and identity are cognitive elements that represent the development of conservation.

According to Flavell (1963) a similar sequence of steps is represented in the child's development of conservation of number. In the first step the child is able to replicate an approximation of a row of objects. During the second step the child is able to reproduce the same number of objects in a row without counting by using a one-to-one correspondence. The child is unable to retain the equivalence of the sets if the objects are rearranged. In the last step the child employs a one-to-one correspondence of objects to ascertain equality. This equality of sets is maintained despite rearrangements of the sets of objects. Thus the child develops conservation of number and equivalence. Conservation of difference involves the child's recognition of unequal sets regardless of how the sets are rearranged. Zimiles (1966, p. 24) stated, "Conservation of equivalence and conservation of difference appeared to be of equal difficulty and occurred equally often."

Replication studies have supported Piaget's formulative steps in the child's acquisition of conservation. The validation of conservation stages has been established in the studies of Dodwell (1960, 1961), Lovell and Ogilvie (1960), Elkind (1961b, 1961c), Hood (1962), Wohlwill and Lowe (1962), and Goldschmid (1967). The sequence of the stages was confirmed in the cross cultural studies of Goodnow and Bethon (1966), Etuk (1967), and Sams (1969).

Reversibility Preceding Conservation

Lovell and Ogilvie (1960) noted that children frequently show reversibility but not conservation. They defined reversibility as an awareness of the prior situation after a transformation of shape. Lovell and Ogilvie found reversibility present in 57 percent of the

83 children in the seven year old group studied. The results of testing for conservation of substance with this group indicated 30 conservers, 27 transitional conservers, and 26 nonconservers. Reversibility was shown by 21 of the transitional conservers and by 5 of the nonconservers. Lovell and Ogilvie concluded that reversibility may not necessarily produce conservation although reversibility is a criterion for justification of conservation.

A different interpretation of reversibility as an awareness of the possibility of return to the situation has been made by Wallach and Sprott (1964). They found that training in reversibility induced conservation of number with first grade children. Wallach and Sprott proposed that conservation results from experiences with reversibility. They have attempted to explain why a child can recognize reversibility and yet not conserve. The justifications for this, as stated by Wallach and Sprott (1964, p. 1068, 1069) are:

> Further, training in reversibility can hardly be expected to bring about knowledge of reversibility in subjects who already have such knowledge, and it will be recalled that the training procedure induced conservation in these subjects as well as the others. However, the possibility of a return to the original situation probably has not occurred, prior to their being asked, to those subjects who are able to answer correctly when asked about reversibility, but who have denied conservation. To think of this possibility, after all, involves going well beyond the immediate stimuli, and the children seem to be particularly likely to respond to immediate stimuli rather than to possible inferences from them, even when they are quite capable of the inferences. But conservation is probably caused by actually thinking of the inverse operation, and realizing that it would bring about again the situation implying equality, and not by the mere ability to answer correctly, if asked, that it would do so. The difference between such actual thinking and the mere (dispositional) ability thus explains how conservation can result from the recognition of reversibility, although reversibility may be "known" (in the dispositional sense) without conservation. It also explains how even nonconservation subjects who have such knowledge may be led to conservation by experience

> with reversibility, for although this experience will not provide them with new information, it will tend to induce them to think of the possibility of reversal without being prompted. The training in reversibility given in this experiment, then, probably contributed to conservation both by providing subjects who did not already have it with the information that rearrangements are reversible, and by inducing subject to think of reversal's possibility.

Wallach, Wall, and Anderson (1967) found that reversibility training facilitated number conservation. This concept did not transfer to discontinuous substances. Training procedures with addition and subtraction experiences had no effect in the same experiment. According to Wallach et al. recognition of reversibility as well as not using inappropriate perceptual cues would seem necessary for attainment of conservation. Blum (1967) confirmed that training children to disregard irrelevant perceptual cues hastened number conservation.

Piaget's position in regard to reversibility is stated by Elkind (1967, p. 20) as follows:

> Piaget often remarks on the fact that the preoperational child knows perfectly well that in the conservation problem nothing was added or taken away and that if it is returned to the starting point it will be the same. The latter judgment is in fact the criterion for the second or transition stage in the attainment of conservation. This knowledge, however, is of little value if the child is not already convinced of conservation.

Kamii (1968) used the term "renversabilité" to describe the child who believes that if objects are physically returned to the original position, numerical equivalence will be assumed again. This is an intermediary stage close to achieving conservation. When the child reaches conservation, his thought has reversibility, which is characterized by logic.

The intermediary stage close to reaching conservation was identified in the research of Sparks, Brown, and Bassler (1970). Their results indicated that training on reversibility tasks with clay balls and pennies induced conservation in children who were on the threshold of attaining conservation.

Piaget (1966) has contended that reversibility is the foundation of the development of conservation concepts. His position has been supported by the studies of Wallach and Sprott (1964), Wallach et al. (1967), and Sparks et al. (1970). These studies have demonstrated that conservation may be attained by experience with reversibility.

Review of Learning Studies

Learning studies have attempted to deal with the effect of experience upon inducing conservation concepts. These experimental studies have tested instructional procedures for facilitating the development of particular concepts. Piaget has asserted that the child's sequential development of conservation is gradually constructed through repeated, active experience with objects. The within-stage development of conservation has been confirmed by the studies of Dodwell (1960), Almy et al. (1967), and Uzgiris (1964). Piaget has not supported the view that limited training experiences would be enough to provide stable concepts of conservation. The learning studies of the early 1960's centered upon facilitating conservation through operational training. The effect of reinforcement and nonreinforcement procedures were demonstrated by Smedslund (1961a, 1961c) and Wohlwill and Lowe (1962). In an assessment of such studies, Flavell (1963, p. 377) wrote that almost all of the training methods "have had remarkably little success in producing cognitive change." Later attempts to induce conservation through various types of training have shown nonsignificant effects as in the studies of Fleischmann, Gilmore, and Ginsburg (1966), Mermelstein and Meyer (1967), and Winer (1968).

However, a number of studies have shown evidence of evoking conservation. Smedslund (1961b) concluded that cognitive conflict procedure was effective and consistent with Piaget's internal equilibration theory. Reversibility training was successful in eliciting conservation in the studies of Wallach and Sprott (1964) as well as that of Wallach et al. (1967). Beilin (1965) and Smith (1968) found verbal rule instruction produced more conservation than other training methods tested. This instruction provided a rule for the child to solve a problem after an unsuccessful response. Task analyses were used to derive a hierarchical order of subtasks by Kingsley and Hall (1967) and Lefrancois (1968). Training based upon an ordered number of learning tasks accelerated the development of conservation concepts.

Summarily, although experimental studies have not proven entirely successful in attempts to induce conservation, the training procedures involving cognitive conflict, reversibility, verbal rule instruction, and task analyses have demonstrated some effect in contributing to the attainment of conservation.

An evaluation of training in conservation was stated by Zimiles (1966, p. 43) as follows:

> The ability to conserve number, as it is measured in the conventional conservation paradigm, is the result of a set of cognitive attitudes involving the gathering and processing of information and an awareness of and sensitivity to their interconnections. Conservation should more properly be regarded as an index of a set of semi-interrelated cognitive attitudes than as a specific articulated concept. This was, in fact, the status assigned to it by Piaget (1952); conservation data were amassed to illustrate

operational thought, and conservation performance was used to exhibit and illustrate a form of cognitive orientation. It is for these reasons that the recent efforts to identify and devise methods for training in conservation appear misplaced. If it is true that conservation is a composite of cognitive and semicognitive factors, then various training procedures will succeed in overcoming different deterrents to conservation; and many training procedures will be successful, not because of the cognitive growth they foster, but because they succeed in removing artifactual barriers. Many of these attempts to achieve conservation seem to be based upon an erroneous evaluation of the concept and an over-evaluation of the cognitive significance of the specific behavior itself.

Relation of Intelligence to Conservation

Piaget and Inhelder (1947) advocated a qualitative analysis of operations of thought rather than observing immediate answers and assigning quantitative measures as in intelligence tests. The logical construction of developmental stages of conservation for normal children was used by Piaget and Inhelder to scale the reasoning of mentally deficient children. Inhelder found a relationship between the development of conservation and the intelligence levels of mentally deficient children. Piaget (1966, p. 154, 155) described Inhelder's research:

> She was able to show that the order acquiring concepts of conservation of substance, weight and volume recurs in its entirety in mental deficients; the last of these three constants (present only in slightly backward individuals and unknown in really deficient cases) is never found without the other two, nor the second without the first, while conservation of substance occurs without conservation of weight and volume and that of substance and weight without that of volume. She was able to distinguish moronism from imbecility by the presence of concrete groupings (of which the imbecile is not capable) and slight backwardness by an inability to reason formally, i.e., by incompleteness of operational construction. This is one of the first applications of a method which could be developed further for determining levels of intelligence in general.

A close relationship between mental age and Piaget's tasks was demonstrated by school children according to the findings of Goodnow and Bethon (1966). Tasks of conservation, weight, and volume differentiated between dull and normal children. The findings of Hood (1962) indicated that older children with a low mental age did not perform as well on Piagetian tasks as younger children with a matched low mental age.

Dodwell (1961) noted that intelligence as measured by a group standardized intelligence test was a factor in the development of number concepts. Hood (1962) also demonstrated a relationship between mental age and the stage of development of pre-number concepts. He showed that pre-number concepts are formed between the mental ages of 6-0 to 8-0. Elkind (1961c) compared the conservation of quantity scores with the Wechsler Intelligence Scale for Children scores of 62 children from five to seven years of age. The correlations of the scores were positive, low, and sometimes significant. Picture Arrangement had the highest correlation. This subtest involved conceptual organization similar to that of conservation of quantity.

Successive studies have analyzed the relationship between conservation of types of quantity and intelligence. Feigenbaum (1963) and Hermeier (1968) cited a positive relationship between intelligence quotient and conservation of discontinuous quantities and mass.

A comparison of total scores for different types of conservation has been made with the results of intelligence tests. Goldschmid (1967) found a positive correlation between mental age and the total conservation score. In a study with mentally retarded subjects Richards (1969) found a significant correlation of .91 between mental age and conservation pretest scores. Griffith, Shantz, and Sigel (1967) established a relationship between the Stanford-Binet scores and the total number of correct responses of the children studied. In conclusion, the correlations between intelligence and conservation have been modest, but positive with a range of .28 with normal children to .91 with retarded children.

Relation of Sex to Conservation

Sex differences were examined as incidental findings in the majority of experimental studies. No sex differences were reported by Braine (1959), Dodwell (1961), Uzgiris (1964), Pratoomraj and Johnson (1966), Almy et al. (1967), and Singh (1970).

Braine (1959) supported Piaget's conclusions that sex differences are insignificant. Dodwell (1961) compared number concept scores of boys and girls. The results evidenced no differences in favor of either sex. Uzgiris (1964) pointed out a lack of difference in the scores of boys and girls on the four materials used to test conservation. No sex differences were indicated for the ability to conserve substance for all age groups studied by Pratoomraj and Johnson (1966). Almy et al. (1967) found no sex differences related to acquisition of conservation. Singh (1970) concluded that there were no significant sex differences in the performance of an objective group Conservation of Volume Test.

On the other hand, sex differences were cited in the studies of Palmer (1966), Goldschmid (1967), and Sweetland (1969). Although the pretest of conservation of number revealed no sex differences, Palmer (1966) found that boys performed significantly higher than the girls in resolving cognitive conflicts in three different treatment groups as an outcome of his study. An examination of the relation of sex to types of conservation revealed a consistent sex difference in favor of the boys as confirmed by Goldschmid (1967). He found the boys performed on a higher level than the girls in all tasks of conservation as substance, weight, quantity, discontinuous quantity, number, area, distance, length, 2-dimensional space, and 3-dimensional space. There was a significant difference for conservation of substance and discontinuous quantity. Sweetland (1969) found indications of sex differences in the use of mental imagery to acquire conservation. Boys resisted extinction of conservation better when trained with concrete examples rather than with mental imagery. Girls used concrete examples equally well as mental imagery in acquiring conservation.

The results of studies investigating the relationship between sex and conservation seem to be inconclusive.

Relation of Chronological Age to Conservation

Chronological age may be described as a quantitative organismic variable. Studies have identified characteristic performance levels for different ages. An overlap between chronological age groups can be found in comparison of findings. However, the close relationship of chronological age to acquisition of conservation has been substantiated in the studies of Elkind (1961b), Elkind, Horn, and Schneider (1965), Dodwell (1960), Uzgiris (1964), Pratoomraj and Johnson (1966), Fleischmann et al. (1966), Goldschmid (1967), Hermeier (1968), and Richards (1969). Elkind (1961b) replicated Piaget's experiments investigating the age of attainment of conservation of mass, weight, and volume. His results agreed with Piaget's findings that conservation of mass was not usually acquired before 7-8 years; conservation of weight before 9-10 years; and conservation of volume before 11 years. In another study Elkind (1961c) reported an interaction of age with the type of quantity compared in the conservation task. He confirmed Piaget's findings that while the order of difficulty of types of quantity remained constant at each age, the difference in difficulty decreased with age. Elkind et al. (1965) indicated that the results of a later study were in keeping with Piaget's contentions that age is related to decentration of perception.

Dodwell (1960) found age trends in attainment of number concepts. Older children were more likely to give operational judgments. There was a variation of responses within age levels according to the task. Dodwell pointed out that children's responses were more task specific than age specific. Uzgiris (1964) found that the achievement of conservation of the three quantities of substance, weight, and volume increased with age. The findings of Pratoomraj and Johnson (1966) also support Piaget's observation that conservation concepts increased with age. Although it has been shown that age differentiated the level of conservation with normal children, Richards (1969) found a significant correlation of .66 between conservation pretest scores and chronological age of mentally retarded subjects.

The evidence collected by Fleischmann et al. (1966) indicated that young children were incapable of conserving continuous and discontinuous quantities. None of the methods evoked conservation in the majority of young children in their study. Goldschmid (1967) found that older children (mean age of 7.7 years) consistently performed tasks of conservation on a higher level than did the younger children (mean age of 6.7). The older children did significantly better on all but 3 of the 13 comparisons. A positive relationship of .48 between age and conservation of mass was established by Hermeier (1968). The results of these studies confirm Piaget's theory that cognitive development is dependent upon age.

However, Wallach and Sprott (1964) did not find a difference in age between conservers and nonconservers. Conservation may be expected to be found among older children. They attributed the lack of difference in age to a relatively homogenous sample from one grade level. The age of the children ranged from 6 years and 5 months to 7 years and 8 months. Wallach and Sprott suggested that a few of the older children may have repeated the grade and might be less intelligent than the others. A similar lack of increase in percentage of conservers with age was ascribed to errors of sampling by Singh (1970).

In summary the close relationship of chronological age to conservation has been verified in the majority of studies reviewed.

Relationship of Conservation to Reading Readiness and Beginning Reading

Almy (1964) used demonstrations and questions to determine conservation of number with 330 children from kindergarten, first grade, and second grade of two New York City schools. Scores of the reading readiness tests were obtained from school records. Almy found the ability to conserve present in 30 percent of middle class first grade children. The children who conserved did significantly better on the New York Tests of Reading Readiness than the nonconservers. In subsequent studies, Almy et al. (1967) confirmed a correlation between performance on conservation tasks and progress in beginning reading.

Lepper (1966) made a cross cultural investigation of the relationships between the development of conservation, social status, and reading readiness of Negro and white first grade children. The Piagetian tasks employed in the study were conservation of continuous substance, discontinuous substance, number, length, and area. Lepper established a positive relationship between success on these conservation tasks and scores on the Metropolitan Reading Readiness Test. The results were statistically significant and numerically low. The point biserial correlation coefficients ranged from .245 to .409.

Almy (1964) has indicated that the child's understanding of reciprocal relationships achieved in reversibility during the concrete operational stage may be related to his stability of perception. This is necessary for visual discrimination as well as directionality in beginning reading instruction. Elkind (1961a) found that a majority of children under the age of 7 years did not have a differentiated concept of left-right. In another study Elkind et al. (1965, p. 248) interpreted Piaget's model of perceptual development as implying:

> . . . the young child has difficulty in recognizing words he can ordinarily read if these words are presented in an unusual way, and that this difficulty is overcome with the development (with age) of perceptual regulations and the consequent decentration of perception. Our results are in keeping with this implication. For words that are recognized in standard form by more than 90 per cent of the children at each grade level, there is a regular increase with age in ability to recognize the words in modified form.

A correlation was found between reading achievement and recognition of modified words in scrambled or rotated form. De-centration is involved in the recognition of words in these modified forms. De-centration develops with conservation during the concrete operational stage.

Furth (1970, p. ix) has interpreted Piaget in relation to beginning reading in the following:

> Seriously, while the written word is the means par excellence for expanding a mature intelligence, the early pressure on reading must be exposed not merely as contributing little or nothing to

> intellectual development but, in many cases, as seriously interfering with it. . . . But if Piaget's theory of development has any validity, surely its first application should be in early education. If the formal teaching of reading turns out to be working against the development of the intelligent person, we should seriously consider whether, as educators, we have asked the proper questions. We are searching continually for new methods of teaching reading without ever asking whether reading is the appropriate focus of early education. Instead, I suggest that the spontaneously growing intelligence of the child should be the focus of grade school activities and that all else should be subordinated to this priority.

However, the views of Piaget (Hall, 1970, p. 30) on reading readiness seem to be inconclusive in his following remarks during an interview:

> The idea of reading readiness corresponds to the idea of competence in embryology. If a specific chemical inductor hits the developing embryo, it will produce an effect if the competence is there, and if it is not, the effect will not occur. So the concept of readiness is not bad but I am not sure that it can be applied to reading. Reading aptitude may not be related to mental age. There could easily be a difference of aptitude between children independent of mental age. But I can not state that as fact because I have not studied it closely.

In conclusion successful performance of conservation tasks has been shown to be positively correlated with scores on reading readiness and reading achievement tests.

Relationship of Intelligence to Reading Readiness and Beginning Reading

Intelligence is the most important factor related to reading readiness according to Harris (1961). In the studies reviewed the authors have expressed intelligence both as mental maturity and intelligence quotient. Heilman (1967, p. 31) pointed out,

> Research data appear to be in agreement that mental age is more closely related to success in reading than is chronological age or I.Q. Authorities do not agree as to the minimum mental age which should be attained before beginning reading.

The consideration of the necessary mental age for beginning reading was initiated by the research of Morphett and Washburne (1931). Two early experimental studies of Morphett and Washburne (1931) reported that children with a mental age of 6 years and 6 months made better progress in reading than children with lower mental ages. They advocated that beginning reading instruction be postponed until a child has reached a mental age of 6 years and 6 months. Morphett and Washburne (1931) found correlations ranging from .50 to .65 between mental age and the ability to learn to read.

Harris (1961) interpreted the effect of the study of Morphett and Washburne (1931) upon subsequent reading practices. He wrote (1961, p. 28),

> Many writers have since that time stated dogmatically that there is a minimum mental age necessary for success in first grade reading. Some have placed the lower limit at an MA of six years, and some at six and a half years. Nearly all have based their conclusions on the Morphett-Washburne study.

The practice of introducing reading instruction at the mental age of 6 years and 6 months was challenged by Gates' (1937) research. Gates (1937) investigated the mental age level at which reading could be successfully initiated. He compared four groups of children which were taught by different methods and materials. For these groups, the correlations between mental age and reading grade were .62, .55, .44, and .34. Gates (1937, p. 508) stated:

> Finally, it should be made clear that the results presented in this report do not answer the question: At what age is it best to introduce reading to pupils? Although the data seem to indicate that it is possible to organize materials and methods to teach children to learn to read at a mental age of 5.0 or higher, they do not, in any way, imply that it is desirable to do so. Decision on the optimum time of introducing reading to pupils must be based upon investigations of the value of this activity at different stages of development.

According to Dykstra (1967) intelligence is significantly related to reading readiness. Dykstra (1967) reporting on the twenty-seven first grade studies, cited several of the correlations between the Pintner-Cunningham Intelligence Test and the Metropolitan Readiness Tests as .56, .78, .73, and .64. Dykstra (1967, p. 46) concluded:

> A number of evaluation techniques predict first grade reading achievement just about as well as do reading readiness tests. The predictive validity of primary group intelligence tests, for example, is not substantially different from the predictive validity of readiness tests. Furthermore, the ability to deal with numbers is related to success in first grade reading to almost the same extent.

Children with high intelligence quotients of 130 and over started to read early and progressed rapidly according to Anderson, Hughes, and Dixon (1957). The authors reported that children with intelligence quotients of 100 or less usually started to read late and learned to read slowly.

Evaluative measures of intelligence have been as successful in predicting reading achievement as reading readiness tests. Olson (1968) found a significant predictive relationship at the .01 level between reading readiness scores and intelligence test scores. Olson (1968, p. 8, 9) stated, "The predictive power for intelligence of the reading readiness tests alone was nearly equal to the predictive power of the reading readiness tests in combination with age, sex, and age + sex."

The results of a study of the differences in predicting reading success for kindergarten and non-kindergarten children led Pratt (1949, p. 531) to the following inference: "One might conclude that the intelligence test, when used alone as a prediction of reading success, is more valid for the non-kindergarten group than for those pupils with previous attendance at kindergarten."

However, the findings of Hopkins and Sitkei (1967) indicated that the Lee-Clark Reading Readiness Test did at least as well as the

California Test of Mental Maturity in predicting first grade reading performance as correlated with the Lee-Clark Reading Test scores. This is consistent with the conclusions of Hahn's (1966) study, which compared the mean scores on the Metropolitan Readiness Test and the Pintner-Cunningham Intelligence Test.

On the other hand, several studies have shown reading readiness tests to be better predictors of reading achievement than intelligence tests. Mattick (1963) found the Metropolitan Readiness Test to be a more effective predictor of first grade success than the Lorge-Thorndike Intelligence Tests or the California Short-Form Test of Mental Maturity.

According to Barrett (1965) intelligence as measured by the Lorge-Thorndike Intelligence Test did not prove to be as valuable a predictor of first grade reading achievement as the visual discrimination task of reading letters and numbers. The study of Silberberg, Iversen, and Silberberg (1968) also confirmed that the reading readiness subtest of reading letters and numbers contributed more to prediction of success in reading than the intelligence quotient.

Although there has been a lack of altogether decisive evidence, the conclusions of the majority of studies have concurred in the substantial relationship between both mental age and intelligence quotient and reading readiness as well as beginning reading success. The interrelationship of other factors attributed to reading readiness makes the specification of a necessary mental age for beginning reading unfeasible.

The Relationship of Sex Differences to Reading Readiness and Beginning Reading

Sex differences have been compared in studies of reading readiness and beginning reading. The majority of studies reported sex differences in favor of the girls. Descriptive assessments of beginning reading problems associated with boys have indicated the necessity of accounting for sex differences in learning to read.

An early concern for sex differences in relation to reading readiness was expressed by Smith and Jenson (1936, p. 689) as follows:

> Studies of school progress show that in school more boys than girls fail, get low marks, are retained and retarded, need remedial reading instruction, and become problem children. All these findings emphasize the fact that school functions less effectively for boys than for girls. There are doubtless many reasons for this failure, but reading readiness is one that should be taken into account. It must become the business of the school to meet better the needs of boys by taking into consideration the maturation of psychological and physiological factors involved in reading readiness.

Robinson (1955, p. 266) speculated on the causes of sex differences in beginning reading success as:

> . . . whether just being a girl gives a young child a better chance for early reading success or whether something inherent in the school situation or the social setting mitigates against the progress of the boys. Until the answer to the question is found, we can continue to expect girls to make more rapid early progress in reading than boys.

Carroll (1948) examined sex differences in the results of several reading readiness tests given at the beginning of first grade. Her conclusions drawn from 1100 children in the study were that differences appeared in favor of the girls on numerous measures. Significant differences were observed for visual discrimination. A later study by Balow (1963) supported visual perception as accounting for sex differences. He found the Gates Reading Readiness Tests scores for word matching and word-card matching were significantly different between sexes. Furthermore, on all subtests, the mean scores of the girls were higher than those of the boys.

Lowell (1967) analyzed a composite of subtests from several reading readiness tests. Lowell (1967, p. 27) postulated, "The differences between sexes in factors measured and in achievement led to the conclusion that the readiness measures worked differently for boys than girls."

Prescott (1955) compared the performance of 14,959 beginning first grade girls and boys on the Metropolitan Readiness Test. He noted that the scores of the girls were somewhat superior to the boys. However, when chronological age was considered, there was not a consistent superiority of performance by girls.

Sex differences seemed to be related to both chronological age and intelligence in the initial stages of reading. In a study conducted by Anderson, Hughes, and Dixon (1956) sex differences were evidenced in the chronological age at which children began to read. Anderson et al. (1956, p. 453) stated, "Girls tended to learn to read earlier than boys and there were fewer extreme delays in reading among the girls than the boys." A following study of Anderson et al. (1957) attributed no significant differences to sex in the rate of reading development. The authors reported that the boys started to read later, but developed more rapidly in the low intelligence group. Sex differences were not shown in the high intelligence group, which began to read early and proceeded rapidly.

The United States Office of Education first grade studies included sex differences as an incidental variable. Comparisons of first grade reading achievement revealed differences favoring the girls. Hahn (1966) indicated that boys and girls had similar test scores on group data, but the girls were ahead of the boys in beginning reading achievement. Schneyer (1966) reported that girls scored significantly higher than the boys on five of the seven criterion measures. Spache, Andres, Curtis, Rowland, and Fields (1966, p. 584) noted, "Sex differences favored the girls at all levels in the white control population, and tended to favor girls at the lower levels in the experimental population." Tanyzer and Alpert (1966) concluded that girls achieved higher mean scores than the boys in each of three basal systems.

However, several of the first grade studies did not find sex differences in measures of reading. The posttest results of reading achievement suggested that girls did not score differently from the boys according to the first grade study of Sheldon and Lashinger (1966). Spencer (1966, p. 600) stated, "Boys and girls are served equally well by the individualized reading method." Manning (1966, p. 616) asserted, "The assumption that girls are superior to boys in first grade reading abilities is held invalid by the results of this study."

Other studies have demonstrated no differences which may be ascribed to sex. Kremenak (1966) indicated a lack of sex differences related to reading readiness, reading achievement, and the ability to match within and between the visual and auditory sensory modalities. Sex differences did not appear to be significantly related to first grade reading readiness and achievement scores in a study conducted by Hagenson (1968). Olson (1968) used a multivariate analysis and reported no significant difference between girls and boys on readiness performance when intelligence was the criterion variable. The findings of Barrett's (1965) study showed it was more difficult to predict first grade achievement for girls than for boys. Furthermore, it was evident that differences within sexes were greater than differences between sexes on test scores.

In summary, many reading studies have established differences in favor of the girls in measurements of reading readiness and beginning reading achievement. Despite some evidence to the contrary, the effect of sex differences upon early reading achievement has been recognized and generally accepted.

The Relationship of Chronological Age to Reading Readiness and Beginning Reading

Numerous studies have been concerned with the chronological age at which reading instruction should begin. There has been a correspondence among reading authorities that there is no particular age at which reading should commence. Traxler and Townsend (1955, p. 10) noted:

> Research during the last quarter of a century has dispelled the belief held years ago that readiness to read was determined mainly by chronological age and that when children reached the age of six they were ready to begin reading.

Preschool ability in reading was examined by Durkin (1961) in a longitudinal study of 49 children who learned to read at home. The conclusions were that one group who read at 3 years of age had a 2.6 reading grade score at the beginning of first grade and the other group that read at 5 years of age had a 1.7 reading level. The results of reading achievement tests at the end of second grade showed a continued lead by the group who read at 3 years, but also a reduction of 4 months between groups. The age at which a child begins to read appeared to be more related to intelligence than to chronological maturation. A correlation of .57 for the girls and .54 for the boys between intelligence and the age of learning to read was reported by Anderson *et al*. (1956).

The effect of age of entrance to first grade upon later achievement was studied by King (1955). She compared the six grade achievement of children who began first grade before 6 years of age with another group who began after 6 years of age. Although there was a small, significant difference in intelligence quotients in favor of the younger group, a significant difference in achievement was established in favor of the older group. Chronological age was indicated as a more important factor for the boys than the girls. King (1955) suggested that a few additional months of chronological age at the start of first grade was an important factor in a child's ability to meet school expectations.

However, chronological age was not shown to be a significant factor in reading readiness or beginning reading in the subsequent studies reviewed. The differences between performances of over age and underage matched beginning first grade girls and boys on the Metropolitan Readiness Test was insignificant according to Prescott (1955). Hampleman (1959) compared the reading achievements of 58 children who were classified by early or late entrance age for school. One group of children entered school at the age of 6 years and 3 months or younger and the other group was 6 years and 4 months or older. Although the mean reading achievement tests scores were higher for the older group, there was no significant difference in scores between the early or late entrance age groups.

Barrett (1965) pointed out that chronological age was negatively related to reading achievement when the reading readiness test results for the 724 boys and girls were combined. Kremenak (1966) found no age differences related to the tasks in reading achievement, reading readiness, and the ability to match within and between the visual and auditory sensory modalities.

Age differences were not of sufficient statistical significance to be relevant to first grade reading readiness and achievement scores according to Hagenson (1968). Olson (1968) did not find chronological age to be a significant predictive factor of readiness where intelligence was the criterion variable. Furthermore, age was found to have the least value for the prognosis of reading achievement in the research of Samuels (1943). Silberberg et al. (1968) reported no indications that chronological age increased the precision of predicting the end of first grade reading scores.

Summarily, there has been agreement among reading authorities that there is no particular age at which reading should be introduced.

The Relationship of Teacher Prediction to Reading Readiness and Beginning Reading

The evaluation of each child's readiness for first grade is one of the main responsibilities confronting the kindergarten teacher at the end of the school year. This assessment may be crucial in decisions affecting promotion, class placement, and within-class grouping for first grade. Dykstra (1967, p. 42) stated, "Teachers, after spending a few weeks with a group of children, can predict quite well how successful each pupil will be in learning to read."

According to Smith (1968) kindergarten teachers can assess reading readiness of kindergarten children as well standardized reading readiness tests. The judgment of kindergarten teachers appeared to be useful to first grade teachers for grouping children. Smith (1968, p. 2045) concluded:

> There is no clear evidence from this study, however, which supports one readiness assessment in kindergarten over another. It will be recalled that kindergarten teachers' reading

readiness estimates of their pupils have closer agreement with first grade teachers' reading achievements assigned to the same pupils, whereas the reading readiness test ratings showed a closer relationship to reading achievement test ratings. Since teachers' estimates of pupils' reading ability tend to be higher than the ratings the same pupils obtained from tests, there would seem to be some advantage for districts to use both measures.

The findings of Morgan (1960) suggest that specifically trained kindergarten teachers can make competent judgments in recommending first grade placements for potential low, average, and high achievers. First grade teachers also ranked the same children. The kindergarten and first grade teachers' estimations correlated with the Pintner-Cunningham Primary Test as well as the Full-Range Picture Vocabulary Test.

An investigation of 41 first grade teachers' informal estimates of 692 first grade childrens' reading readiness was conducted by Merrill (1969). He established a correlation of .563 between the teachers' prediction of reading readiness and the first grade reading achievement for the children.

According to Carr and Michaels (1941) first grade teachers' judgments may be relied upon for grouping children as well as prediction of difficulty in learning to read. Reading readiness test results should not supersede intelligent observation. Carr and Michaels (1941) cited a correlation of .79 between ratings of childrens' readiness by the first grade teacher after two months of informal observation and subsequent ranking on a criterion of reading success at the close of the year. Fourteen teachers and classrooms were included in the investigation. This relationship was confirmed by Henig's (1949, p. 46) conclusion, "So far as these children are concerned, their first-grade teachers were just as successful in predicting the degree of success their charges would meet in learning to read as was the standardized reading-readiness test." These strong relationships between teacher prediction and success of the children in reading need to be equated with the effects of teacher expectation, the self-fulfilling prophesy.

Kermoian (1962) reported a correlation of .77 between total readiness and teacher judgment. His study thus confirmed a significant relationship between 13 first grade teachers' appraisals of 276 childrens' readiness and their scores on the Metropolitan Readiness Test. Kermoian (1962, p. 201) advocated the following:

> Most teachers, however, can easily judge readiness status through non-test techniques. Therefore, it would seem more desirable and profitable for most teachers to use the time normally spent in administering, scoring, and interpreting these standardized tests for becoming better acquainted with the class, grouping the class for instruction, or beginning a developmental program of instruction.

On the other hand, Mattick (1963) claimed that a reading readiness test was a better predictor than the kindergarten teacher's judgment. Mattick (1963) compared kindergarten teacher prediction for success in first grade with the results of the Lorge-Thorndike Intelligence Tests, the California Short-Form Test of Mental Maturity, the Lee-Clark Reading Readiness Test, and the Metropolitan Readiness Test. Mattick reported the highest coefficient of correlation was .546 between the kindergarten teachers' judgments and the Metropolitan Readiness Test. Furthermore, he noted that the Metropolitan Readiness Test was more effective than the kindergarten teachers' ratings in forecasting the achievement of first grade children.

Readiness tests at the beginning of first grade can avert a delay in reading instruction according to the opinion of Traxler and Townsend (1955). A loss of time may result from teacher observation. This is necessary for rating the child's readiness for reading. Traxler and Townsend (1955, p. 12) asserted, "If tests have an advantage over teacher estimate, it is that prediction can be obtained on the basis of tests at the very beginning of the first grade or even before the children enter Grade 1."

In conclusion teacher prediction has positively correlated with the scores of reading readiness and reading achievement tests.

Summary

Successful performance of conservation tasks was positively related to scores on reading readiness tests and progress in beginning reading. Intelligence was moderately related to conservation, but substantially related to reading readiness, and beginning reading. Sex differences appeared to be more related to reading readiness and beginning reading than to conservation. Chronological age was closely related to conservation but less so to reading readiness or beginning reading. Kindergarten teacher prediction was positively related to the results of reading readiness tests and beginning reading.

CHAPTER III

DESIGN OF THE STUDY

Introduction

The procedures of the present research will be explained in this chapter. A discussion of the following topics will be included: sources of data, instruments, research population, and treatment of the data.

Planning the Investigation

Numerous studies have examined the factors which contribute to reading readiness on one hand and conservation on the other. A review of the literature disclosed that intelligence is positively related to both reading readiness and conservation. Consequently, this study was planned to determine what relationships exist among selected factors in reading readiness, intelligence, and the process of the child's development of conservation in the concrete operational stage.

Sources of Data

The data utilized in this study were collected during May, 1970 and September, 1970. The study included 2 kindergarten teachers and 81 first grade students. The first grade students were ranked on their comparative readiness for reading by their kindergarten teachers during May, 1970. All of the student participants in the study were administered the following battery of tests by the investigator in September, 1970:

1. Gates-MacGinitie Reading Tests: Readiness Skills

2. SRA Primary Mental Abilities Test: Grades K - 1

3. Procedures of Conservation of Number and Substance with First Grade Children

Instruments

Gates-MacGinitie Reading Tests: Readiness Skills

Selected factors of reading readiness were measured by the Gates-MacGinitie Reading Tests: Readiness Skills. The skills tested were listening comprehension, auditory discrimination, visual discrimination, following directions, letter recognition, visual-motor coordination, auditory blending, and word recognition.

Raw scores were obtained for the subtests. Corresponding stanines for the raw scores were obtained from a table of norms for first grade children. A relative weight which was taken from an analysis of the standardization data was given to each subtest according to the predictive value for later reading achievement. The weighted score was obtained by multiplying each stanine score by the corresponding weight. The Total Weighted Score was representative of the child's performance on the seven subtests and was the score usually used for evaluating reading readiness. The Word Recognition Subtest was not included in the total score norms. It measured the child's recognition of whole words. The readiness Standard Score was obtained from a table for first grade children. The mean was set at 50 and the standard deviation at 10.

The norms for the Gates-MacGinitie Reading Tests: Readiness Skills were developed from a national sample of 4500 children in 35 communities selected on the basis of geographic location, size, and socio-economic level. The reliability coefficients for each subtest were determined by use of the Kuder-Richardson formula 20 as follows:

	Subtest	Reliability Coefficient
I	Listening Comprehension	.69
II	Auditory Discrimination	.72
III	Visual Discrimination	.86
IV	Following Directions	.69
V	Letter Recognition	.85
VI	Visual-Motor Coordination	.67
VII	Auditory Blending	.65

The Gates-MacGinitie Reading Tests: Readiness Skills tests were administered by the investigator with the assistance of the classroom teachers to the first grade students during the first two weeks of school. This schedule was required to assure validity for the norms, since the first grade norms for the Readiness Skills test were established during the period of the first two weeks after the beginning of school.

SRA Primary Mental Abilities Test:
Grades K - 1

Intellectual ability was measured by the SRA Primary Mental Abilities Test: Grades K - 1. The four primary mental abilities measured were: Verbal Meaning, Number Facility, Perceptual Speed, and Spatial Relations. This battery provided multifactored scores as well as a general, all-inclusive intelligence rating. The scores obtained for the subtests and the total are expressed in terms of mental ages and ratio intelligence quotients.

The norms were drawn from a stratified sample on the basis of regional location and school size. The standardization sample was 2,429 students for first grade. The reliability estimates were obtained through test-retest studies. A battery overlap procedure was used to determine the reliability for the subtests and the total. The reliability coefficient for grade 1 was .83.

An SRA study of the SRA Primary Mental Abilities Test: Grades K - 1 as an indicator of reading readiness found a positive relationship between the PMA total scores of students completing kindergarten and their reaching achievement scores at the end of first grade. The SRA Technical Report for Primary Mental Abilities (1965, p. 24) listed the following guidelines for PMA K - 1 mental-age scores as predictors of reading achievement:

Mental Age	Observation
7-0 and over	Should be able to learn to read quickly.
6-1 to 6-11	Normal reading progress can be expected.
5-9 to 6-0	Some extra attention and special materials may be necessary, especially at early stages.
5-8 and under	To assure progress, special attention and remedial materials are essential. (The lower the score, the more important this recommendation will be.)

It is assumed in the foregoing observation that the mental-age scores are obtained by testing near the beginning of the first grade.

The SRA Primary Mental Abilities Test: Grades K - 1 was administered by the investigator with the assistance of the classroom teachers to the 81 first grade students during the first two weeks of school in September, 1970.

Procedure of Conservation of Number and
Substance with First Grade Children

Piaget's studies dealing with the developmental sequence of the child's acquisition of conservation have utilized the clinical method. Piaget's experimental technique flexibly probed at the process of the child's thought functioning in experimental tasks. The Procedures of Conservation of Number and Substance with First Grade Children used in this study differed from Piaget's clinical method in the standardization of procedures and the quantitative statistical treatment of data. These procedures were tested and video taped with first grade children prior to the study.

The child's performance of selected tasks of conservation was measured by the Procedures of Conservation of Number and Substance with First Grade Children (see Appendix). The procedures were organized into five tasks to assess the child's acquisition of conservation as follows:

Task I. Conservation of Inequality of Number with 17 white and 19 red wooden cubes. A transformation was made by pushing each set of cubes together into two bunches.

Task II. Conservation of Equality of Number with two sets of 18 black and pink wooden cubes. A transformation was made by pushing the black blocks close together and stretching the pink blocks out in lines.

Task III. Conservation of Equality of Substance with two equal-sized play dough balls. One ball was transformed into a hot dog shape.

Task IV. Conservation of Inequality of Substance with two unequal-sized balls. The smaller ball was transformed into a pancake shape. This was repeated with two additional unequal balls, and the larger ball was transformed into a pancake shape.

Task V. Conservation of Equality of Substance with two equal-sized balls, one ball was transformed into little pieces.

The Procedures of Conservation of Number and Substance with First Grade Children was administered by the investigator during the second half of September, 1970. Each first grade child was tested individually in a separate room at West and Wilder schools. The mean procedure time for the group was 18 minutes with a range of 9 to 38 minutes. The mean procedure time for the children who successfully conserved on all five tasks was 15 minutes. All procedures were audio taped and transcribed on record sheets for scoring.

For each task a conservation response was scored 1 and the total possible conservation score for each child was 5. Similarly for each task a reversibility response was scored 1 and the total possible reversibility score was 5. Both nonconservation and nonreversibility responses were scored 0. The child who succeeded on all five conservation tasks was defined as a conserver. The child who attained reversibility on all five tasks but not consistent conservation was termed a transitional conserver. The child who responded inconsistently and did not acquire conservation or reversibility was called a nonconserver.

Research Population

The 81 first grade subjects in this study were enrolled in four classrooms in West School and Wilder School. The students were selected to be representative of the total Grand Forks, North Dakota school population. West School and Wilder School were in the middle range of the 14 Grand Forks elementary schools as ranked by results of the Iowa Test of Basic Skills.

Only pupils for whom relevant data were available on all the instruments employed in this study were included. Due to changes in the West School and Wilder School populations between kindergarten, May, 1970 and first grade, September, 1970 only 63 of the 81 first grade students were ranked on their comparative readiness for reading by the kindergarten teachers during May, 1970.

There were a total of 81 first grade students involved in the study. Of these 81 students, 46 were male and 35 were female. The mean chronological age in months of the subjects was 77.3 with a range of 70 to 91. The mean mental age in months of the subjects was 80.3 with a range from 58 to 102.

Treatment of the Data

In investigating the relationships among the variables in this study a multiple linear regression was employed to find the multiple correlation coefficients and the zero-order correlation coefficients for hypotheses one through nine. A stepwise regression was utilized to find the variables which contribute most to prediction for hypotheses one, two, four, six, eight, and nine. Discriminant analysis by multiple linear regression was used to predict the number of conservers and nonconservers for hypothesis one.

CHAPTER IV

ANALYSIS OF THE DATA

The analysis of the data pertaining to each hypothesis is given in this chapter. The order of presentation for the findings follows that of Chapter I. A statement of the research hypothesis to be tested introduces each of the nine sections of the data analysis. In the nine sections the analysis is presented in this order:

1. Multiple linear regression procedure is utilized to find the multiple correlation between the criterion and the set of independent variables as well as the correlation coefficients for hypotheses one through nine.
2. Stepwise regression (backward elimination procedure) is employed to isolate the variables which contribute most to prediction for hypotheses one, two, four, six, eight, and nine.
3. Discriminant analysis by multiple linear regression is used for prediction of conservation or nonconservation for each child of the sample under consideration. Multiple regression techniques are applied as inferential statistics in this study.

Hypothesis Number One

There is a positive relationship between conservation and the reading readiness subtests.

Table 1 presents the correlation of the reading readiness subtests with a binary criterion on the conservation variable; one group is composed of those children who conserved on all tasks and the second group is composed of the remaining children. The independent variables' means, standard deviations, correlation coefficients (point biserial) with the criterion, and multiple correlation are given for the research group.

TABLE 1

MULTIPLE CORRELATION USING THE SUBTESTS OF THE GATES MACGINITIE READING TESTS: READINESS SKILLS AS PREDICTORS OF CONSERVATION

Variable	Mean	Standard Deviation	Correlation X vs Y	Regression Coefficient
Listening Comprehension	5.271	1.627	.285	.017
Auditory Discrimination	6.888	1.274	.278	.041
Visual Discrimination	5.938	1.886	.376	.037
Following Directions	6.469	1.761	.251	.008
Letter Recognition	6.926	1.149	.342	.062
Visual-Motor Coordination	6.025	1.739	.329	.055
Auditory Blending	4.951	1.816	.241	.012
Multiple Correlation			.516	
Intercept				-1.236

With 79 degrees of freedom a point biserial correlation coefficient of .218 is needed for significance at the .05 level. All of the reading readiness subtests were found to be significantly correlated with conservation. The implications drawn from these correlations are that all of the reading readiness subtests are significantly related to conservation. Since the multiple correlation was .516 and R^2 = .2663, 26.63 percent of the variance of the criterion variable is accounted for by this set of independent variables.

The stepwise regression (backward elimination procedure) was used for the variables related to the reading readiness subtests as predictors of conservation and is recorded in Table 2. This was employed to find which of the variables was most important toward predicting the criterion. The variables were excluded in reverse order according to their value for predicting the criterion. A resulting multiple correlation was found as a by-product for each step of the analysis process.

TABLE 2

STEPWISE BACKWARD ELIMINATION PROCEDURE FOR VARIABLES RELATED TO THE SUBTESTS OF THE GATES-MACGINITIE READING TESTS: READINESS SKILLS AND CONSERVATION

Step	Variable Eliminated	Multiple Correlation	Significance Level
1	None (Full Model)	.517	$p<.05$
2	Following Directions	.516	$p<.05$
3	Auditory Blending	.514	$p<.05$
4	Listening Comprehension	.510	$p<.05$
5	Visual Discrimination	.489	$p<.05$
6	Auditory Discrimination	.446	$p<.05$
7	Visual Motor-Coordination	.342	$p<.05$
8	Letter Recognition		

If Table 2 is read from the bottom to the top, the order of the predictors can be determined for the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills. Thus, Letter Recognition was the most important predictor of conservation and Following Directions was the least important (in the sense of being a predictor) variable. The multiple correlation of the set of variables had a significant multiple correlation with conservation in all steps.

Table 3 reports the results of discriminant analysis for the prediction of the number of conservers and nonconservers for the first grade children.

TABLE 3

DISCRIMINANT ANALYSIS BETWEEN CONSERVERS AND NONCONSERVERS

		ACTUAL GROUP	
		Conservers	Nonconservers
PREDICTED	Conservers	7	3
	Nonconservers	12	59
		F = 3.804	p<.01

Of the 19 conservers, 7 were correctly assigned to that group by the prediction equation formed by the regression. For the 62 nonconservers, 59 were predicted to be nonconservers. The discriminant analysis was found to be significant at the .01 level.

Hypothesis Number Two

There is a positive relationship between conservation and the primary mental abilities subtests.

Table 4 presents a listing of all the independent variables' means, standard deviations, and their point biserial correlation coefficients with the previously described binary criterion on conservation. The multiple correlation is also included.

TABLE 4

MULTIPLE CORRELATION USING PRIMARY MENTAL ABILITIES SUBTESTS AS PREDICTORS OF CONSERVATION

Variable	Mean	Standard Deviation	Correlation X vs Y	Regression Coefficient
Verbal Meaning	77.778	7.707	.343	.009
Perceptual Speed	83.457	13.161	.366	.005
Number Facility	82.494	9.282	.406	.008
Spatial Relations	78.889	10.305	.345	.006
Multiple Correlation			.479	
Intercept				-1.981

All of the point biserial correlation coefficients for the predictor variables with the criterion were significant at the .05 level. Since R = .479 and R^2 = .2294, 22.94 percent of the criterion variance is accounted for by this set of predictors.

Table 5 shows the findings of the stepwise regression (backward elimination procedure) when the subtests of the primary mental abilities test are used as predictors of conservation. The order of these predictors can be found by reading Table 5 from the bottom to the top. Number Facility was the most important variable and Perceptual Speed was the least important (in the sense of being a predictor variable). The full model and the set of variables were found to have a significant multiple correlation with the criterion in all steps.

TABLE 5

STEPWISE BACKWARD ELIMINATION PROCEDURE FOR VARIABLES RELATED TO THE SUBTESTS OF THE SRA PRIMARY MENTAL ABILITIES TEST AND CONSERVATION

Step	Variable Eliminated	Multiple Correlation	Significance Level
1	None (Full Model)	.479	$p<.05$
2	Perceptual Speed	.466	$p<.05$
3	Verbal Meaning	.448	$p<.05$
4	Spatial Relations	.406	$p<.05$
5	Number Facility		

Hypothesis Number Three

There is a positive relationship between conservation and mental age.

In answering the question on hypothesis number three, a point biserial correlation of .464 was found ($p<.01$). Correlations (point biserial) were also found for each task as reported in Table 6. Those correlations that exceed .218 are significant at the .05 level.

Hypothesis Number Four

There is a positive relationship between reading readiness and mental age.

Table 7 presents the independent variables' means, standard deviations, point biserial correlation coefficients with the criterion, and the

TABLE 6

CORRELATION OF FIVE CONSERVATION TASKS WITH MENTAL AGE

Variable	Correlation
Task I	-.158
Task II	.419
Task III	.353
Task IV	.279
Task V	.337
Conservation	.464

TABLE 7

MULTIPLE CORRELATION USING THE SUBTESTS OF THE GATES-MACGINITIE READING TESTS: READINESS SKILLS AS PREDICTORS OF MENTAL AGE

Variable	Mean	Standard Deviation	Correlation X vs Y	Regression Coefficient
Listening Comprehension	5.272	1.628	.600	1.687
Auditory Discrimination	6.889	1.275	.588	1.876
Visual Discrimination	5.938	1.886	.460	.695
Following Directions	6.469	1.761	.533	.845
Letter Recognition	6.926	1.149	.317	- .055
Visual-Motor Coordination	6.025	1.739	.273	.427
Auditory Blending	4.951	1.816	.347	.278
Multiple Correlation			.781	
Intercept				45.295

multiple correlation coefficient. All of the reading readiness subtests were found to be significantly correlated with mental age. Since $R = .781$ and $R^2 = .6100$, 61.00 percent of the criterion variance is accounted for by the factor of mental age.

Table 8 contains the steps in the stepwise regression (backward elimination procedure) when the reading readiness subtests are used as predictors of mental age. If the table is read from the bottom to the top, the most important predictor can be identified as Listening Comprehension. All of the reading readiness subtests were found to have a significant multiple correlation with the criterion for all steps.

TABLE 8

STEPWISE BACKWARD ELIMINATION PROCEDURE FOR VARIABLES RELATED TO THE SUBTESTS OF THE GATES-MACGINITIE READING TESTS: READINESS SKILLS AND MENTAL AGE

Step	Variable Eliminated	Multiple Correlation	Significance Level
1	None (Full Model)	.781	$p<.05$
2	Letter Recognition	.781	$p<.05$
3	Auditory Blending	.779	$p<.05$
4	Visual-Motor Coordination	.772	$p<.05$
5	Visual Discrimination	.754	$p<.05$
6	Following Directions	.729	$p<.05$
7	Auditory Discrimination	.600	$p<.05$
8	Listening Comprehension		

Hypothesis Number Five

There is a relationship between conservation and sex.

Table 9 gives the phi coefficients for the five conservation tasks with sex (male = 1, female = 0). The correlation for conservation with sex is included. Task IV and Task V are significant at the .01 level in favor of the girls. The correlation of conservation with sex is significant at the .01 level in favor of the girls.

TABLE 9

CORRELATION OF FIVE CONSERVATION TASKS WITH SEX

Variable	Correlation	Sex Favored
Task I	.167	Boys
Task II	-.135	Girls
Task III	-.129	Girls
Task IV	-.342	Girls
Task V	-.342	Girls
Conservation	-.282	Girls

Hypothesis Number Six

There is a relationship between reading readiness and sex.

Table 10 contains a listing of the reading readiness subtests' means, standard deviations, point biserial correlation coefficients with the criterion, and the multiple correlation. Three variables were found to be significantly correlated with sex differences. The implications drawn from these correlations are that of the seven subtests of reading readiness, Auditory Discrimination, Visual Discrimination, and Letter Recognition are more related to sex differences in favor of the girls. The other four reading readiness subtests showed the girls to score higher than the boys. Since R = .378 and R^2 = .1429, 14.29 percent of the variance of the criterion variable of sex (male = 1, female = 0) is accounted for by this set of independent variables.

TABLE 10

MULTIPLE CORRELATION USING THE SUBTESTS OF THE GATES-MACGINITIE READING TESTS: READINESS SKILLS AS PREDICTORS OF SEX

Variable	Mean	Standard Deviation	Correlation X vs Y	Regression Coefficient
Listening Comprehension	5.272	1.628	-.208	-.024
Auditory Discrimination	6.889	1.275	-.254	-.089
Visual Discrimination	5.938	1.886	-.281	-.041
Following Directions	6.469	1.761	-.094	.034
Letter Recognition	6.926	1.149	-.253	-.068
Visual-Motor Coordination	6.025	1.739	-.088	-.004
Auditory Blending	4.951	1.816	-.107	.012
Multiple Correlation			.378	
Intercept				1.769

Table 11 reports the results of the stepwise regression (backward elimination procedure). The independent variables are the reading readiness subtests. Visual Discrimination was found to be the most important predictor variable. The full model of the regression as well as Visual-Motor Coordination were not found to have a significant multiple correlation. After the second step, however, the set of variables was then found to have a significant multiple correlation with the criterion for all the remaining steps.

TABLE 11

STEPWISE BACKWARD ELIMINATION PROCEDURE FOR VARIABLES RELATED TO THE SUBTESTS OF THE GATES-MACGINITIE READING TESTS: READINESS SKILLS AND SEX

Step	Variable Eliminated	Multiple Correlation	Significance Level
1	None (Full Model)	.378	$p>.05$
2	Visual-Motor Coordination	.378	$p>.05$
3	Auditory Blending	.376	$p<.05$
4	Listening Comprehension	.369	$p<.05$
5	Following Directions	.358	$p<.05$
6	Letter Recognition	.334	$p<.05$
7	Auditory Discrimination	.281	$p<.05$
8	Visual Discrimination		

Hypothesis Number Seven

There is a positive relationship between conservation and chronological age.

A point biserial correlation of .071 ($p>.05$) was found between conservation and chronological age. Point biserial correlations were also found for each conservation task as presented in Table 12. Neither conservation nor any of the conservation tasks were significantly related to chronological age.

TABLE 12

CORRELATION OF FIVE CONSERVATION TASKS WITH CHRONOLOGICAL AGE

Variable	Correlation
Task I	-.049
Task II	.076
Task III	.090
Task IV	-.048
Task V	.135
Conservation	.071

Hypothesis Number 8

There is a positive relationship between reading readiness and chronological age.

Table 13 gives the independent variables' means, standard deviations, correlation coefficients with the criterion, and the multiple correlation coefficient. None of the reading readiness subtests were found to be significantly correlated with chronological age. Since $R = .301$ and $R^2 = .0906$, 9.06 percent of the criterion variance is accounted by the variable of chronological age.

The results of the stepwise regression (backward elimination procedure) are shown in Table 14. The independent variables are the reading readiness subtests. Listening Comprehension was found to be the most important predictor variable. However, neither the full model or any of the variables was found to have a significant correlation with the criterion.

TABLE 13

MULTIPLE CORRELATION USING THE SUBTESTS OF THE GATES-MACGINITIE READING TESTS: READINESS SKILLS AS PREDICTORS OF CHRONOLOGICAL AGE

Variable	Mean	Standard Deviation	Correlation X vs Y	Regression Coefficient
Listening Comprehension	5.272	1.628	-.173	-.579
Auditory Discrimination	6.889	1.275	.039	.752
Visual Discrimination	5.938	1.886	.013	.256
Following Directions	6.469	1.761	-.111	-.328
Letter Recognition	6.926	1.149	-.134	-.396
Visual-Motor Coordination	6.025	1.739	.047	.276
Auditory Blending	4.951	1.816	-.133	-.389
Multiple Correlation			.301	
Intercept				78.800

TABLE 14

STEPWISE BACKWARD ELIMINATION PROCEDURE FOR VARIABLES RELATED TO THE SUBTESTS OF THE GATES-MACGINITIE READING TESTS: READINESS SKILLS AND CHRONOLOGICAL AGE IN MONTHS

Step	Variable Eliminated	Multiple Correlation	Significance Level
1	None (Full Model)	.301	$p > .05$
2	Letter Recognition	.291	$p > .05$
3	Visual Discrimination	.286	$p > .05$
4	Following Directions	.269	$p > .05$
5	Visual-Motor Coordination	.248	$p > .05$
6	Auditory Blending	.200	$p > .05$
7	Auditory Discrimination	.172	$p > .05$
8	Listening Comprehension		

Hypothesis Number Nine

There is a positive relationship in reading readiness among the children ranked by the kindergarten teachers on their comparative readiness for reading in the first grade.

Table 15 contains a listing of all the independent variables' means, standard deviations, point biserial correlation coefficients with the criterion, and the multiple correlation. All of the reading readiness subtests were found to be significantly correlated with kindergarten teacher ranking. Since R = .558 and R^2 = .3114, 31.14 percent of the variance of the criterion variable is accounted for by this set of independent variables.

TABLE 15

MULTIPLE CORRELATION USING THE SUBTESTS OF THE GATES-MACGINITIE READING TESTS: READINESS SKILLS AS PREDICTORS OF KINDERGARTEN TEACHER RANKING

Variable	Mean	Standard Deviation	Correlation X vs Y	Regression Coefficient
Listening Comprehension	5.317	1.605	.352	.080
Auditory Discrimination	7.048	1.142	.381	.168
Visual Discrimination	6.095	1.802	.308	.056
Following Directions	6.683	1.644	.298	.059
Letter Recognition	6.921	1.052	.402	.145
Visual-Motor Coordination	6.032	1.750	.229	.051
Auditory Blending	4.937	1.795	.306	.020
Multiple Correlation			.558	
Intercept				5.583

While the above table would seem to indicate an ability on the part of the teacher to rank reading readiness, one additional finding disturbs this conclusion: the correlation between teacher ranking and mental age is .68. If appears as if the teachers were ranking the students more on the basis of mental age than on reading readiness.

Table 16 presents the results of the stepwise regression (backward elimination procedure). The independent variables are the reading readiness subtests. Letter Recognition was found to be the most important predictor variable. Both the full model and the set of variables were found to have a significant correlation with the criterion of teacher ranking.

TABLE 16

BACKWARD ELIMINATION PROCEDURE FOR VARIABLES RELATED TO THE SUBTESTS OF THE GATES-MACGINITIE READING TESTS: READINESS SKILLS AND TEACHER RANKING

Step	Variable Eliminated	Multiple Correlation	Significance Level
1	None (Full Model)	.558	$p<.05$
2	Auditory Blending	.557	$p<.05$
3	Visual Discrimination	.549	$p<.05$
4	Following Directions	.537	$p<.05$
5	Visual-Motor Coordination	.523	$p<.05$
6	Listening Comprehension	.497	$p<.05$
7	Auditory Discrimination	.402	$p<.05$
8	Letter Recognition		

Additional Findings Relating to Reversibility

While the direction of the study has been specifically concerned with conservation, similar hypotheses could have been made for reversibility. All of the same analyses have been used with the criterion being reversibility rather than conservation. The results were found to have no practical significance.

Table 17 shows the point biserial correlation coefficients with the criterion of reversibility as well as the multiple correlations for the predictor variables.

TABLE 17

RELATIONSHIP OF VARIABLES TO REVERSIBILITY

Variable	Correlation X vs Y
Reading Readiness Subtests	
Listening Comprehension	.046
Auditory Discrimination	.026
Visual Discrimination	-.108
Following Directions	.118
Letter Recognition	.003
Visual-Motor Coordination	.083
Auditory Blending	.085
Multiple Correlation	.227
Primary Mental Abilities Subtests	
Verbal Meaning	.071
Perceptual Speed	.173
Number Facility	.047
Spatial Relations	.027
Multiple Correlation	.202
Mental Age	.119
Chronological Age	.103
Sex	-.097

Chapter IV has presented an analysis of the data. Chapter V presents a summary of the investigation, a discussion of the findings, the conclusions from the results of the study, and the implications for further research.

CHAPTER V

SUMMARY, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine what relationships exist between a child's performance of selected tasks of conservation and selected factors in reading readiness. Comparisons were also made between conservation and reading readiness to selected variables such as age, sex, chronological age, and teacher prediction.

There has been a paucity of previous research directly relating Piaget's findings on the child's cognitive development to selected factors involved in readiness for learning to read. The time for beginning reading instruction usually coincides with the transition of the child's progression from the preoperational to the concrete operational stages. Piaget's studies have identified the child's acquisition of conservation of number and substance as marking the entrance to the concrete operational stage. The present study examined the relationships between conservation and reading readiness. It raised the possibility as to the extent conservation may be utilized as a predictor of readiness for learning to read.

The following hypotheses were tested.

1. There is a positive relationship between conservation and the reading readiness subtests.

2. There is a positive relationship between conservation and the primary mental abilities subtests.
3. There is a positive relationship between conservation and mental age.
4. There is a positive relationship between reading readiness and mental age.
5. There is a positive relationship between conservation and sex.
6. There is a positive relationship between reading readiness and sex.
7. There is a positive relationship between conservation and chronological age.
8. There is a positive relationship between reading readiness and chronological age.
9. There is a positive relationship in reading readiness among the children ranked by the kindergarten teachers on their comparative readiness for reading in the first grade.

The research population for this study was comprised of 81 first grade subjects enrolled in four classrooms of the Grand Forks Public Schools during the 1970-1971 school year. The students were selected to be representative of the total Grand Forks, North Dakota school population. Of the 81 first grade pupils, 46 were male and 35 were female. The mean chronological age of the subjects was 77.3 months. The mean mental age of the students was 80.3 months. Due to changes in school populations between kindergarten, May, 1970 and first grade, September, 1970 only 63 of the 81 first grade students were ranked on their comparative readiness for reading by their kindergarten teachers during May, 1970.

All of the 81 first grade children participating in the study received the following battery of tests in September, 1970:

1. Gates-MacGinitie Reading Tests: Readiness Skills

2. SRA Primary Mental Abilities Test: Grades K - 1

3. Procedures of Conservation of Number and Substance with First Grade Children.

The statistical procedure utilized in the investigation consisted of a multiple linear regression to find the multiple correlation coefficients and the zero-order coefficients for all hypotheses. A stepwise regression was employed to find the variables which contributed most to prediction. Discriminant analysis by multiple linear regression was used to predict the number of conservers and nonconservers.

Summary of Findings

The findings relative to conservation and the reading readiness subtests for the research population were the following:

1. Significant correlations were found between conserver scores and all of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills.

2. The multiple correlation for the set of predictors was significant past the .05 level. The independent variables accounted for approximately 26.63 percent of the criterion variance.

3. Letter Recognition was found to be the most important reading readiness subtest predictor of conserver scores. All of the variables contributed significantly to the multiple correlation of the set of predictors with the criterion.

4. The variables of reading readiness accounted for enough criterion variance to allow significant prediction of group membership in the dichotomous criterion relating to conservation by using discriminant analysis.

The findings relative to conservation and the primary mental abilities subtests for the research population were the following:

1. Significant correlations were found between conserver scores and all of the subtests of the SRA Primary Mental Abilities Test: Grades K - 1.

2. The set of predictors, which included the subtests of the SRA Primary Mental Abilities Test: Grades K - 1, had a significant correlation beyond the .05 level with the criterion. Approximately 22.94 percent of the criterion variance was accounted for by this set of predictors.

3. Number Facility was found to be the most important SRA Primary Mental Abilities subtest predictor of conserver scores. All of the variables contributed significantly to the multiple correlation of the set of predictors with the criterion.

The findings relative to mental age with conservation and reading readiness for the research population were the following:

1. A significant correlation was found between mental age and conserver scores.

2. Mental age was found to be significantly correlated to all of the conservation tasks except for Task I.

3. Significant correlations were found between mental age and all of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills.

4. The multiple correlation for the set of predictors was significant beyond the .05 level. The independent variables accounted for approximately 61 percent of the criterion variance.

5. Listening Comprehension was found to be the best reading readiness subtest predictor of mental age. All of the variables contributed significantly to the multiple correlation of the set of predictors with the criterion.

The findings pertinent to sex with conservation and reading readiness for the research population were the following:

1. A significant correlation was found between sex and conserver scores in favor of the girls.

2. Sex was found to be significantly correlated to conservation Task IV and Task V in favor of the girls.

3. Sex differences in favor of the girls were found to be significantly correlated with three of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills as follows: Auditory Discrimination, Visual Discrimination, and Letter Recognition.

4. The set of variables, which consisted of the reading readiness subtests, did not have a significant correlation with the criterion. Only 14.29 percent of the variance of the criterion variable of sex (male = 1, female = 0) is accounted for by this set of independent variables.

5. Visual Discrimination was found to be the most important predictor variable for sex differences. All of the reading readiness subtests except Visual-Motor Coordination made significant contributions to the multiple correlation of the set of predictors with the criterion.

The findings relative to chronological age with conservation and reading readiness for the research population were the following:

1. Chronological age was found to have a nonsignificant correlation with conserver scores and the conservation tasks.

2. Chronological age was found to have a nonsignificant correlation with all of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills.

3. The multiple correlation for the set of predictors was nonsignificant. The independent variables accounted for approximately 9.06 percent of the criterion variance.

4. Although Listening Comprehension was found to be the most important predictor variable, none of the variables were found to have a significant correlation with the criterion of chronological age.

The findings pertinent to kindergarten teacher prediction and reading readiness among first grade children for the research population were the following:

1. Significant correlations were found between teacher predictions and all of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills.

2. The multiple correlation for the set of predictors was significant beyond the .05 level. The independent variables accounted for approximately 31.14 percent of the criterion variance.

3. Letter Recognition was found to be the most important reading readiness subtest predictor of teacher ranking. All of the variables contributed significantly to the multiple correlation of the set of predictors with the criterion of teacher prediction.

4. Correlations between teacher prediction and mental age were found to be higher than for teacher prediction and reading readiness.

The findings pertinent to the best predictors of reading readiness for the research population were the following:

1. A significant multiple correlation of .78 was found between mental age and reading readiness.

2. A significant multiple correlation of .56 was found between teacher prediction and reading readiness.

3. A significant correlation of .52 was found between conservation and reading readiness.

All of the nine hypotheses have been supported by positive correlations. Only hypotheses seven and eight failed to reach the .05 level of significance.

Discussion and Conclusions

Based upon the data used to test the hypotheses, the present study found a positive relationship between conservation and reading readiness as well as the selected variables of mental age, sex, chronological age, and teacher prediction. Significant correlations beyond the .05 level were found for all of the variables except chronological age. This would indicate that chronological age is less related to conservation and reading readiness than the other variables. A restricted range was employed in regard to chronological age (70 months to 91 months).

Significant correlations were found between conserver scores and all of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills. This substantiates Lepper's (1966) findings of a significant relationship between success on conservation tasks and reading readiness test scores. Furthermore, Almy (1964) found the children who conserved did significantly better on the reading readiness test than the nonconservers.

The reading readiness subtest Letter Recognition was found to be the best predictor of conserver scores. Using the discriminant analysis technique, it was shown that conservers can be successfully differentiated from nonconservers.

There were significant correlations between conserver scores and all of the subtests of the SRA Primary Mental Abilities Test: Grades K-1. These were in agreement with previous research studies. Positive and sometimes significant correlations between conservation scores and intelligence test scores have been found by Elkind (1961c) and Griffith *et al.* (1967).

The finding that Number Facility, a subtest of the SRA Primary Mental Abilities Test: Grades K-1, was the most important predictor of conserver scores had been anticipated. It would appear that this subtest is the most closely related to conservation.

In this investigation the significant correlation between mental age and the conserver scores is consistent with other studies. Goldschmid (1967) found a positive relation between mental age and the total conservation score. Goodnow and Bethon (1966) demonstrated a close relationship between mental age and Piaget's tasks.

The significant correlations found between mental age and all of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills concur with the results of the twenty-seven first grade studies as cited by Dykstra (1967). The reading readiness subtest Listening Comprehension was found to be the best predictor of mental age.

An unexpected sex difference in favor of the girls was shown in a significant correlation between sex and conserver scores. However, sex differences in favor of the boys were noted in the studies of Palmer (1966), Goldschmid (1967), and Sweetland (1969). Goldschmid's (1967) examination of the relation of sex to types of conservation revealed that boys performed on a higher level than girls in all tasks of conservation. Also, a significant difference in favor of the boys was found for conservation of substance. This is in discord with the significant results in favor of the girls on Tasks IV and V, which involve conservation of substance in the present study. The contradictory findings of sex differences may be due to the interaction between the test administrator and the subjects. In contrast, no sex differences in relation to conservation were reported by Braine (1959), Dodwell (1961), Uzgiris (1964), Pratoomraj and Johnson (1966), Almy et al. (1967) and Singh (1970).

Sex differences in favor of the girls were significantly correlated with three of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills as follows: Auditory Discrimination, Letter Recognition, and Visual Discrimination. Furthermore, Visual Discrimination was found to be the most important predictor variable for sex differences. This corresponds with two other studies which noted sex differences were related to visual discrimination. Carroll (1948) observed significant differences in favor of the girls for the visual discrimination subtest. Subsequent research by Balow (1963) supported visual perception as accounting for sex differences in word matching readiness subtests.

In this study chronological age was not significantly related to conserver scores and the conservation tasks. This may be ascribed to the homogenous sample drawn from the first grade level. Wallach and Sprott (1964) did not find a difference in age between conservers and nonconservers. They attributed the lack of difference to a one grade level sample. Conversely, the close relationship of chronological age to conservation has been verified in the studies of Dodwell (1960), Uzgiris (1964), Pratoomraj and Johnson (1966), and Goldschmid (1967). Outcomes regarding chronological age seem to be directly related to the range of the chronological age.

Furthermore, there were no significant correlations between chronological age and all of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills. Similar insignificant differences were found in Prescott's (1955) investigation of the performances of overage and underage matched first grade girls and boys on a readiness test.

Teacher prediction was significantly related to all of the subtests of the Gates-MacGinitie Reading Tests: Readiness Skills. Letter Recognition was found to be the most important predictor of teacher ranking. This seems to be in keeping with Smith's (1968) conclusions that kindergarten teachers can assess reading readiness of kindergarten children as well as standardized reading readiness tests. However, an additional finding in the present study was that the correlation between teacher ranking and mental age was higher than that of teacher ranking and reading readiness. Thus, it appears as if the teachers were ranking the children more on the basis of mental age than on reading readiness.

The findings of Morgan (1960) demonstrated that kindergarten teachers' estimations correlated with intelligence test scores.

While mental age was shown to have the highest significant correlation to reading readiness, it was found that conservation related almost as well as teacher prediction to reading readiness.

The major conclusions which emerged from this study are as follows:

Conclusions

1. A child's performance of selected tasks of conservation is significantly related to selected factors in reading readiness.

2. Mental age is significantly related to conservation and reading readiness.

3. Sex differences are significantly related to conservation and reading readiness.

4. Chronological age is positively but not significantly related to conservation and reading readiness.

5. Teacher prediction is significantly related to reading readiness, but more closely related to mental age.

Recommendations

The findings of this study have generated seven recommendations. While the first four recommendations are concerned with school practices, the remaining three deal with implications for future research.

1. Conservation should be taken into account as an additional predictor of readiness for beginning reading.

2. The factors of mental age, reading readiness tests, teacher prediction, and sex should be considered when introducing reading instruction.

3. Although chronological age has been shown to be less closely related to reading readiness, age has regulated school practices for beginning reading in first grade. There seems to be a need to assess the child's development rather than rely solely upon the criteria of time.

4. The child's total readiness should determine when individualized reading instruction is introduced. There should be more flexibility for learning to read and less pressure for early achievement.

5. Additional research is needed to investigate the relationship of conservation to reading readiness and reading achievement in a longitudinal study.

6. Further research should be conducted on the relationship of sex differences to conservation.

7. It is recommended that research be conducted to determine what relationships exist between centration, conservation, and visual discrimination with first grade children.

APPENDIX

PROCEDURES OF PRETEST OF CONSERVATION OF NUMBER AND SUBSTANCE WITH FIRST GRADE CHILDREN

Task I. Conservation of Inequality of Number.

Materials: 17 white 3/4" solid wooden cubes
19 red 3/4" solid wooden cubes

Procedure: Before the experiment the blocks are lined up in a one to one correspondence spaced 3/4" apart. The red blocks are near the child, white blocks away from child.

```
   x x x x x x x x x x x x x x x x x      white blocks
 x x x x x x x x x x x x x x x x x x x      red blocks
```

A. Establishing starting position.

E. Look at the blocks. If you put one red block on each white block, would you have red ones left over, white ones left over, or would you come out even?

If child starts to do it--

E. Can you tell me without doing it?

If child answers correctly--
"Red ones left over" or "More red."

E. That's right, or repeat the child's words.

If the child gives an incorrect answer or says, "I'm not sure."

E. Is there anything you can do to find out? Go ahead, try to put one red block on each white block.

If the child does, E. puts blocks back and repeats first question. If the child starts to count, ask him to respond without counting.

B. Transformation.

The experimenter makes a bunch transformation by pushing the white blocks together into a one layer deep pile. The same procedure is repeated with the red blocks.

```
  xxxx                              xx
 xxxxxxx     white blocks          xxxx       red blocks
  xxxxxx                          xxxxxx
                                  xxxxxxx
```

E. Now if you put one red block on each white block, would you have red ones left over, white ones left over, or would you come out even?

If the child starts to do it--

E. Can you tell without doing it?

E. How do you know?

E. If you made the red blocks and the white blocks into lines again, as they were before, would there be red blocks left over, white blocks left over, or would you come out even?

E. How do you know?

E. Another child told me

1. the red and white blocks would not come out even. (If the child says come out even.) or
2. the number of red blocks and white blocks would come out even. (If the child says more red or more white blocks.)

What do you think?

Task II. Conservation of Equality of Number

Materials: 18 black 3/4" solid wooden cubes
18 pink 3/4" solid wooden cubes

Procedure: Before the experiment the blocks are lined up in a one to one correspondence spaced 3/4" apart. The pink blocks are near the child, black blocks away from child.

x x x x x x x x x x x x x x x x x x black blocks
x x x x x x x x x x x x x x x x x x pink blocks

A. Establishing starting position.

E. Look at the blocks. Are there more pink blocks, more black blocks, or the same number of pink and black blocks?

If the child begins to count--

E. Can you tell me without counting?

If the child answers correctly--

E. That's right.

If the child gives an incorrect answer to initial question or says, "I'm not sure," E. puts blocks back and repeats first question. If the child starts to count, ask him to respond without counting.

E. Is there anything you can do to find out? Go ahead, try to put one pink block on each black block.

B. Transformation.

The experimenter pushes the black blocks together and stretches the pink blocks out in the presence of the child.

xxxxxxxxxxxxxxxxxx	black blocks
x x x x x x x x x x x x x x x x x x	pink blocks

E. Look at the blocks. Are there more pink blocks, more black blocks or the same number of pink and black blocks?

E. How do you know?

E. If you made the pink blocks and the black blocks into lines again, as they were before, would there be more pink blocks, more black blocks, or the same number of pink and black blocks?

E. How do you know?

E. Another child told me

1. the number of pink and black blocks is not the same. (If the child says same number.) or
2. the number of pink and black blocks is the same. (If the child says more pink or more black blocks.)

What do you think?

Task III. Conservation of Equality of Substance

Materials: one ball white Play-Doh
one ball yellow Play-Doh
The balls are of equal-size and each is made from a full can of Play-Doh.
one hot dog made from a full can of yellow Play-Doh, 5 1/2" by 1 1/2"

Procedure: Place white Play-Doh ball near experimenter and yellow Play-Doh ball near the child. The child may lift the balls, but not change the shape.

A. Establishing starting position.

E. Here are two balls of Play-Doh. Which ball has more or do both balls have the same amount?

If the child answers correctly--

E. That's right. Both have the same amount, or repeat the child's words.

If the child answers "Different"--

E. Take a little from this one. Point to which ever ball the child has indicated as larger.

E. Make the balls the same. Remove the Play-Doh that the child takes away. Repeat the question--

E. Which ball has more or do both balls have the same amount?

If the child responds that the balls are different or unequal, say--

E. Take a little from this one. Point to which ever ball the child has indicated as larger.

E. Make the balls the same. Remove the Play-Doh that the child takes away.

E. Which ball has more or do both balls have the same amount? Two tries are allowed for establishing equality.

B. Transformation.

E. Make the yellow ball into a hot dog like this. Show a hot dog made from yellow Play-Doh, and then remove it.

E. Now which has more or do both have the same amount?

Whatever the child answers, ask--

E. How do you know?

E. If you made the yellow Play-Doh back into a ball again, which ball would have more, or would both balls have the same amount?

If the child starts to do it--

E. Can you tell me without doing it?

E. How do you know?

Whatever the child answers, say--

E. But another boy told me

1. the two balls would not have the same amount. (If the child says same.) or
2. the two balls would have the same amount. (If the child says not the same.)

What do you think?

Task IV. Conservation of Inequality of Substance, Part 1.

Materials: one ball white Play-Doh made from a full can of Play-Doh
one ball blue Play-Doh made from 3/4 can of Play-Doh
one pancake made from 3/4 can of blue Play-Doh, 3 1/2" by 1/2"

Procedure: Remove 1/4 of the amount of blue Play-Doh before the experiment.

A. Establishing starting position.

E. Here are two balls of Play-Doh, which ball has more or do both balls have the same amount?

If the child says "Blue has less" or "White has more"--

E. That's right, and repeat his words.

If the child says "Same", the experimenter removes a tablespoon of Play-Doh from the blue ball and puts it out of sight.

E. Now which ball has more or do both balls have the same amount?

If the child says "Blue has more", then remove a tablespoon of Play-Doh from the blue and repeat the question.

E. Now which ball has more or do both balls have the same amount? Two tries are allowed for establishing inequality.

B. Transformation.

E. Make the blue ball into a pancake like this. Show a pancake made from blue Play-Doh, and then remove it.

E. Now which has more or do both have the same amount?

Whatever the child answers, ask--

E. How do you know?

E. If you made the blue Play-Doh back into a ball again, which ball would have more, or would both balls have the same amount?

Whatever the child answers, ask--

E. How do you know?

E. Another child told me that

1. the two balls would not have the same amount. (If the child says same.) or
2. the two balls would have the same amount. (If the child says not the same.)

What do you think?

Task IV. Conservation of Inequality of Substance, Part 2.

Materials: one ball white Play-Doh made from 3/4 can of Play-Doh
one ball pink Play-Doh made from a full can of Play-Doh
one pancake made from a full can of pink Play-Doh, 4 1/4" by 1/2"

Procedure: Remove 1/4 of the amount of the white Play-Doh before the experiment.

A. Establishing a starting position.

E. Which ball has more or do both balls have the same amount.

If the child says "Pink has more" or "White has less"--

E. That's right, and repeat his words.

If the child says "Same", the experimenter removes one tablespoon of dough from the white ball.

E. Now which ball has more or do both balls have the same amount?

If the child says "White ball has more", then remove a tablespoon of Play-Doh from the white ball and ask--

E. Now which ball has more or do both balls have the same amount? Two tries are allowed for establishing inequality.

B. Transformation.

E. Make the pink ball into a pancake like this. Show a pancake made from pink Play-Doh, and then remove it.

E. Now which has more or do both have the same amount?

Whatever the child answers, the experimenter asks--

E. How do you know?

E. If you made the pink Play-Doh back into a ball again, which ball would have more or would both balls have the same amount?

Whatever the child answers, ask--

E. How do you know?

E. Another child told me that

1. the two balls would not have the same amount. (If the child says same.) or
2. the two balls would have the same amount. (If the child says not the same.)

What do you think?

Task V. Conservation of Equality of Substance.

Materials: one ball white Play-Doh made from a full can of Play-Doh
one ball of green Play-Doh made from a full can of Play-Doh
eight pieces of green Play-Doh, each made from 1/8 can of Play-Doh

Procedure: Place the white Play-Doh ball near the experimenter and the green Play-Doh ball near the child. The child may lift the balls, but not change the shape.

A. Establishing starting position.

E. Here are two balls of Play-Doh. Which ball has more or do both balls have the same amount?

If the child answers correctly--

E. That's right, both have the same amount, or repeat the child's words.

If the child answers, "Different"--

E. Take a little from this one. Point to which ever ball the child has indicated as larger.

E. Make the balls the same. Remove the Play-Doh the child takes away.

E. Which ball has more or do both balls have the same amount?

If the child responds that the balls are different or unequal, say--

E. Take a little from this one. Point to which ever ball the child has indicated as larger.

E. Make the balls the same. Remove the Play-Doh that the child takes away. Two tries are allowed for establishing equality.

E. Which ball has more or do both balls have the same amount?

B. Transformation.

E. Make the green ball into little pieces like this. Show little pieces made from green Play-Doh, and then remove them.

E. Now which has more or do both have the same amount?

E. How do you know?

E. If you made the green Play-Doh back into a ball again, which ball would have more or would both balls have the same amount?

E. How do you know?

E. Another child told me

1. the two balls would not have the same amount. (If the child says same.) or
2. the two balls would have the same amount. (If the child says not the same.)

What do you think?

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