INFORMATION TO USERS

73-6162

SCHENCK, Betsy Roberts, 1923-
TEACHING CORRELATES OF NUMBER CONSERVATION TO
VERY YOUNG CHILDREN.

University of North Carolina at Greensboro,
Ph.D., 1973
Psychology, experimental

University Microfilms, A XEROX Company, Ann Arbor, Michigan

TEACHING CORRELATES OF NUMBER CONSERVATION TO VERY YOUNG CHILDREN

by

Betsy Roberts Schenck

A Dissertation Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Greensboro
1973

Approved by

Helen Canaday
Dissertation Adviser

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

Dissertation Adviser: Helen Canaday

Oral Examination Committee Members:
Richard H. Klemer
Eunice M. Deemer
Mildred B. Johnson
Rebecca M. Smith

June 19, 1972
Date of Examination

SCHENCK, BETSY ROBERTS. Teaching Correlates of Number Conservation to Very Young Children. (1973) Directed by: Dr. Helen Canaday. Pp. 100.

The purposes of the experiment were to find out whether or not children under five years of age could conserve numbers and to ascertain if the ability to conserve numbers could be taught to three-, four-, and five-year-old children. It was hypothesized that two teaching sessions would be ineffective in teaching young children to conserve number; that there would be no difference in conservation of number scores by children according to sex; and that conservation of number scores would increase as the children increased in age. The subjects were 37 boys and 35 girls, ages 3 years 7 months to 6 years 9 months, from middle-class families.

Experimental and control groups were pretested on conservation of number. The test included a warm-up item and the following transformations: rotation, equal addition, collapsing, and expansion. The transformations were performed on arrays of 5 pairs of black checkers. Two questions were asked after each transformation. "Does this row have the same number of checkers as this row?" and "Does one row have more checkers than the other row?" Explanations of conserving responses were not required.

Subjects in the experimental condition were taught concepts prerequisite to number conservation on two successive days in individual 15 minute sessions. The standardized

teaching sessions involved practice in counting objects, in one-to-one correspondence with various objects, in addition-subtraction, and in the concepts of "row," "length," "more," and "same." Objects used in the teaching sessions were red checkers, small 1 inch wooden blocks, plastic cups and saucers from a tea set, small plastic farm animals, doll-house size chairs, and small wooden-peg painted children.

The data were analyzed statistically by analyses of covariance. Results supported the hypothesis that two teaching sessions would be ineffective in teaching young children to conserve number. The finding supported Piaget's contention that teaching has little influence on the development of number conservation, that instead number conservation develops through the processes of maturation, interaction with the physical and social environments, and equilibration.

Results revealed no differences in conservation of number scores by sex. There was a significant difference in number conservation scores between age-groups, with older groups scoring higher than younger groups. Only one child (48 months old) in the youngest age-group (mean age of 4.0) made a perfect score on the number conservation pretest. Thirty-one percent of Ss in the middle age-group (mean age of 5.0 years) made perfect scores on the pretest and 58 percent of the oldest age-group (mean age of 5.3 years) made perfect scores. From the results of this study, it would appear that the criteria of conservation (whether or not an explanation of conservation responses is required) and the difficulty level of the transformation tasks determine to a large extent whether young children are categorized as conservers or non-conservers of number.

ACKNOWLEDGMENTS

The researcher wishes to acknowledge the contributions of the many individuals who helped to make the study possible.

To Dr. Helen Canaday, committee chairman, a particular debt of appreciation is owed for her counsel and unfailing support.

To Dr. Richard Klemer, Dr. Rebecca Smith, Dr. Eunice Deemer, and Dr. Robert Eason, committee members, grateful acknowledgment is extended for their critical reading of the manuscript and their helpful criticisms.

To all the children who were subjects in the experiment, special appreciation is expressed; their warmth and interest made the experiment an enjoyable experience.

To Dr. Carl Cochrane, sincere appreciation is offered for his assistance in data-analysis.

To Miss Louise Lowe, grateful acknowledgment is given; she inspired the researcher to begin the long journey of which this volume is the culmination.

To Susan, John, Evelyn, Randolph, and Jim, her children, especial appreciation is expressed for their encouragement and moral support.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Piaget is one of the foremost cognitive theorists of the twentieth century. He has proposed the most complete and systematic theory of cognitive development. Probably Piaget's greatest impact has been on educators and other persons especially interested in the development of young children. The early years of children's development have been increasingly recognized as important influences in later cognitive development (Bloom, 1964; Bruner, 1960; Hunt, 1964). Piaget's (1950) theory of cognitive development has increased awareness of the cognitive growth which takes place during early childhood. Sigel (1968) noted,

> The inherent rationality of Piaget's position and his unique conceptualizations have added a dimension to our view of human development heretofore missing (p. 524).

Need for Research

The teacher of young children needs to be aware of the relevant aspects of learning situations in order to direct the child's attention to those aspects. The teacher also needs to understand the process of cognitive development in children in order to structure the environment for optimal growth. In discussing the educational implications of cognitive development, Tuddenham (1966) stated that "methods of education will be most effective when they are attuned to the patterns of thought which are natural to a child of the age concerned (p. 216)."

Educators have sought to devise teaching methods based on the cognitive processes underlying development as described by Piaget as a means of facilitating and sometimes accelerating the education of young children. Teachers need to understand the development of number conservation in young children and they need to know whether or not this ability can be taught or whether the ability develops with time. Such knowledge would enable teachers to arrange the curriculum and structure the environment of the preschool group to correspond to the level of development of the children.

Statement of the Problem

The basic problem for educators and child development specialists seeking to promote the cognitive development of young children is knowing which skills require specific teaching and which skills develop irrespective of specific teaching. More information is needed about the numerical conservation ability which may be expected of young children and whether this ability can or cannot be taught.

Piaget (1971) attributed the acquisition of the conservation of number to the processes of maturation, interaction with the total environment, and equilibration, with special emphasis on the latter. According to Piaget (1950) specific teaching plays little or no role in acquisition of the concept of conservation. He concluded that conservation is not usually present until age 6 or 7 years; therefore, most previous studies have been limited to children 5 years old and older.

The purpose of this experiment was to investigate conservation of number with very young children between the ages of 3 years 7 months and 6 years 9 months as subjects (Ss). Piaget's claim that children under 5 years of age were unable to conserve number aroused interest in determining if children under 5 years of age can conserve number and whether or not the ability to conserve number can be taught. The specific purpose of this study was to teach conservation of number to young children.

Rothenberg and Orost (1969a) successfully taught five-year-old children to conserve number. Rothenberg's (1969b) conservation of number task (Appendix A) and Rothenberg and Orost's (1969b) teaching methods (Appendix C) were adapted for use with nursery school children.

The children in this study were divided into three groups as follows: Group I, nursery school juniors whose ages ranged from 3 years 7 months (3-7) to 4-5; Group II, nursery school seniors whose ages ranged from 4-7 to 5-6; and Group III, kindergartners, whose ages ranged from 5-9 to 6-9.

Since Piaget concluded that specific teaching plays little role in the acquisition of conservation of number, it was hypothesized that direct instruction would not be effective in increasing the conservation of number task scores of young children, 3 years 7 months to 6 years 9 months. It was assumed from a review of the literature that sex was not a factor in the acquisition of conservation of number; however, age does play a role in the acquisition of conservation of number.

Another hypothesis was that the older the child the greater the possibility that he would make a perfect score on both pre- and posttests of conservation of number. The foregoing hypothesis was based on perfect scores on the conservation of number tests, whereas the effects of instruction on the conservation of number were assessed by examining increased scores on conservation of number tests.

For clarity, the null hypotheses were stated as follows:

Hypothesis I. There are no significant differences between conservation of number pre- and posttest scores of Ss who received two sessions of direct instruction in conservation of number skills and Ss who did not receive such direct instruction.

Hypothesis II. There are no significant differences between scores on conservation of number pre- and posttests by sex.

Hypothesis III. There are no significant differences between the number of Ss in Group I, Group II, and Group III who correctly respond to all items on the conservation of number pretest and posttests.

Hypothesis IV. There are no significant differences between conservation of number scores on Posttest I and Posttest II.

Piaget's Theory and Definitions

Piaget (1950) defined intelligence as continuous adaptation, that is, as constant interaction between the organism and the environment. Piaget's theory is a stage theory. The stages are characterized as appearing in an invariant order and each stage represents an incorporation and reorganization of structures of the previous stage. In discussions of stages, ages are given to define the beginning and end of the stages; however, all age ranges are approximations and it is understood that one can usually find evidence of more than one stage or period in any group of children of any age range.

Development, and movement from one stage to the next, according to Piaget (1967), is influenced by biological maturation, experience with the physical and social environment, and equilibration. Equilibration is a self-regulatory factor which coordinates the influences of maturation and the physical and social environments (Furth, 1969). In recent years Piaget has emphasized the importance of equilibration in the developmental process in relation to the influences of the other factors.

<u>The Periods of Cognitive Development</u>

The interpretation of Piaget's terminology as related to the various periods and stages of his theory varies from writer to writer. Because of its clarity, Baldwin's (1967) terms will be used throughout this discussion. Piaget's periods of cognitive development are outlined as follows:

I. Sensorimotor Period--birth to 2 years old

II. Preoperational Period--2 to 7 years old

   1. Preconceptual Stage--2 to 4 years old

   2. Intuitive Stage--4 to 7 years old

III. Period of Concrete Operations--7 to 12 years old

IV. Period of Formal Operations--over 12 years old

During the <u>sensorimotor period</u>, the first period of cognitive development, cognitive functioning is based on motor actions. Piaget concluded that the roots of intelligence are found in these motor actions. The second period, the <u>preoperational period</u>, begins at about 18 months or 2 years of age when language develops and the child is capable of manipulating symbols that represent the environment. Preoperational thought is inconsistent and lacks organization. This period is described more fully and the terms are defined in the next section.

During the <u>period of concrete operations</u> the child's thought is organized in an interrelated system. Concrete operations, in contrast with the operations of preoperational structures, are decentered and reversible. Decentration allows the child to attend to more than one attribute or dimension of a phenomenon at a time; this contrasts with the centered operations of the preoperational period in which the child attends to only one attribute of a phenomenon at a time. Centration, or centered operations, also involves a subjective focusing on a situation, i.e., an ignorance or unawareness of any point of view other than one's own. Reversibility of operations allows the child to see that a deformed object can be transformed back into its original state. These operations enable the child to extend his interaction with his environment because his representational thought is no longer tied to direct physical action. The period of formal operations is the highest level of cognitive development.

Preoperational Period

The preoperational period, the focus of this study, is divided into the preconceptual and intuitive stages. Piaget (1952) described the thought of the preconceptual child as being egocentric and syncretic. Egocentrism is the child's inability to realize another person's point of view. Egocentrism causes the child's judgment to be absolute, never relative. Since the child in the preoperational stage takes his immediate perception as absolute, he makes assertions without trying to support them with facts. The child's early thought is syncretic in that he deals with whole questions and ignores individual words. His thought is nonanalytical.

According to Piaget (1967), the child in the intuitive stage is prelogical; he substitutes intuition for logic. Intuition is thought carried out in action; it is the internalization of percepts and movements in the form of representational images and mental experiences. Piaget (1950) noted, "Intuition is still phenomenalist, because it copies outlines of reality without correcting them, and egocentric, because it is constantly related to present action (p. 138)."

The preoperational period is a transitional period. This period is also a time of disequilibrium. Furth (1969) declared, "The preoperational child lives in his own world, unaware of the disequilibrium that objectively exists between his own notions and the real world that he will come to know (p. 212)." The disequilibrium gradually decreases until a relative equilibrium is achieved when the period of concrete operations is reached.

Conservation of Number

One of the most widely investigated concepts related to Piaget's theory of cognitive development is conservation. Conservation is defined as the realization that a particular dimension of an object or situation may remain invariant despite changes in other irrelevant aspects of the object or situation (Piaget, 1950). Conservation is acquired when a child advances from pre-operational reasoning to reasoning at the concrete-operational level.

Piaget and Inhelder (1971) described the standard experimental conservation of number paradigm as follows: A row of eight or nine red counters are placed parallel to a row of equal length and number of blue counters. The child is asked if the rows are equal in number. Once equality of rows is established, the counters in one row are extended to a greater length than the other row. The child is then again asked if the rows are equal in number. The child of 4 to 5 years 6 months of age agrees to the equality of counters when the length of the rows is equal, but imagines that one row has more counters when that row is longer than the standard row. The child's difficulty is that he tends to estimate number in terms of space occupied (length of rows). He centers on length and ignores density--a characteristic of his developmental level.

Piaget (1952) delineates three stages in the development of the conservation of number. The first stage, "Absence of Conservation," appears to correspond with the preconceptual stage of development. During this stage the child evaluates quantity by global perceptual qualities, ignoring relationships between elements. Quantity is a logical concept which a child must be able to comprehend before it is possible for him to develop the concept of number (Piaget, 1952). Because the images of the child in the preconceptual stage are global and static, he is incapable of understanding transformations. He reasons on the basis of configuration (Piaget & Inhelder, 1971). The child at the preconceptual level centers on only one attribute of a problem at a time, thus he takes in objects one after another and not as a whole. Piaget (1952) declared, "Things are either conglomerated into a confused whole, or else considered one by one in a fragmentary manner (p. 220)." At this stage the child cannot synthesize what he sees. His thought is irreversible; i.e., after a transformation he cannot think back to the point of origin.

The second stage in the development of conservation of number, "Beginning of Construction of a Permanent Set," (Piaget, 1952) appears to correspond to the intuitive stage of development which begins at about 4 years of age and lasts until age 6 or 7 years. At this stage the child vacillates between believing that an alteration of the spatial arrangement of items alters its number and believing that an alteration does not alter the number. The child can conserve when alteration is slight but not when spatial alteration is considerable. There appears to be a conflict between the child's thinking and the configuration which he observes. The child begins to be aware of the principles of reversibility, identity, and compensation, factors necessary for the understanding of conservation. Baldwin (1967) described the intuitive child as follows: "He can frequently feel his way through a problem to a correct answer but he still does not have a clear conceptual representation (p. 245)."

In the third stage of the development of conservation of number, the child no longer needs to reflect in order to be certain of conservation. Piaget has indicated that this stage concurs at about 6 years of age.

Assumptions

It was assumed that the conservation of number tasks measured conservation of number and that the tasks were appropriate in degree of difficulty for children ages three and one-half through six and one-half years. It was also assumed that two teaching sessions were sufficient to teach conservation of number to young children. From the pilot study it was evident that young children would lose interest and cease to be challenged after two teaching sessions. Categorizing Ss as conservers on the basis of perfect scores on the conservation of number tasks was a purely arbitrary decision on the part of the researcher.

Limitations

The study was conducted with preschoolers in the University of North Carolina School of Home Economics Nursery School and kindergarten children in the First Presbyterian Church as Ss. Because of the characteristics of Ss, certain limitations were therefore relative to this study: (a) the Ss in the sample were not randomly selected because entire classes were studied; (b) Ss were white and primarily from middle-class families; (c) the children's ages were between 3-7 and 6-9; and (d) testing for the study was limited to a period of five weeks. A further limitation was that the discussions of number conservation referred to that ability as it could be measured by the instrument utilized in this study.

CHAPTER II

REVIEW OF LITERATURE

Literature reviewed included studies of the last eight years concerned with testing Piaget's theory about the concept of number conservation, or capabilities preparatory to number conservation. Next, attention was given to studies of conservation with very young children as subjects. Finally, methodological considerations in conservation experiments were reviewed.

Conservation Studies Involving Training

Piaget (1967) theorized that the developmental process was influenced by maturation, interaction between the organism and the physical and social environments, and equilibration, with an emphasis upon the latter as the most important factor. This aspect of Piaget's theory leads one to infer that the acquisition of conserving responses can not easily be accelerated or taught, but that they evolve over a long period of time. Much experimental attention has been directed toward training subjects (Ss) to conserve in order to test this aspect of the theory, as well as to isolate factors important in the conservation process which would result in a greater understanding of the process.

Braine and Shanks (1965) pretrained Ss to understand "more" in relation to the relevant experimental dimension by a reinforcement procedure. Correct responses to the question, "Which has more?" were rewarded with chips which could be exchanged for M&M candy at the end of the session. Feedback was not intended to teach the child how to conserve, but to teach him to deal with the relevant aspects of the task. Braine and Shanks found feedback effective in generating correct responses. The authors attributed the results to teaching the child to understand what was asked of him when tested. In studies in which children did not conserve until age six or seven, Braine and Shanks attributed the results to Ss' misunderstanding of instructions. The child may have interpreted questions about quantity as "Does it 'look' like it has more?" or "Does it 'really' have more?" Rothenberg and Courtney (1969a), however, criticized Braine and Shanks' results as reflecting lax criteria of conservation.

Fleischmann, Gilmore, and Ginsberg (1966), in a series of experiments, attempted unsuccessfully to train four- and five-year-old children to conserve continuous and discontinuous quantities. Training methods involved emphasis on (a) quantification, (b) feedback, (c) continuity of the transformation, and (d) continuity of the transformation combined with reduction of visual cues. Their results revealed that a non-repetition response set was not a significant determinant of failure to conserve. Their findings supported Piaget's view of conservation.

Gelman (1969) contended that young children fail to conserve because of inattention to relevant quantitative relationships and attention to irrelevant features in conservation tasks. She gave discrimination learning set training on length and number tasks to five-year-olds who then conserved on posttests. Her data, thus, did not support Piaget's theory.

Brison (1966) trained 12 of 24 kindergarten children to conserve substance by reversing Ss' expectations of an event; however, he accepted perceptual responses as adequate evidence of conservation. Gruen (1965) found pretraining on relational terms about as effective in inducing conservation as direct training or cognitive conflict.

Wallach, Wall, and Anderson (1967) induced Ss who were six and seven years old to conserve number by a procedure involving experience with reversibility. They concluded that the procedure may have led Ss to stop using misleading perceptual cues. They found that giving Ss experience with addition and subtraction did not lead to number conservation. Another interpretation might be that their Ss were at the age at which conservation usually appears and their manipulations merely brought out evidence of structures already present.

Mermelstein and Meyer (1969) attempted unsuccessfully to train children three and one-half to six years of age to conserve number. Training techniques included cognitive conflict, verbal rule instruction, language activation, and multiple classification. Their evidence supported the Piagetian concept of conservation.

Rothenberg and Orost (1969a) attempted to train kindergarten children to conserve number. Training methods involved: (a) rote counting, (b) counting attached to objects, (c) comprehension of "same" number, (d) comprehension of "same" versus "more" in terms of number, (e) addition and subtraction, (f) one-to-one correspondence, (g) reversibility, and (h) comprehension of "more" referring to number versus referring to "longer." Part of the instruction was presented by slightly older conserving peers who acted as "assistant teachers." Experimental Ss showed significant gains in conservation whereas control Ss exhibited no noticeable growth.

Inhelder, Benet, Sinclair, and Smock (1966) taught Ss (4 to 6 years of age) language expressions characteristic of children with conservation concepts. They found that all children could follow instructions using relational terms whether or not they were conservers. All conservers used highly differentiated language and mentioned both dimensional differences (size and number) in their explanations. The nonconservers centered successively on the dimension of number and then of size. The authors concluded that understanding relational terms was a necessary but not sufficient factor in conservation acquisition.

Studies with Very Young Children

Studies (Sigel, Saltz, and Roskind, 1967; Sonstroem, 1967; Wallach, Wall, and Anderson, 1966) testing Piaget's theory of conservation usually had children aged five years and older as Ss, since they generally sought to test Piaget's theory empirically and to check its universality. Results generally were equivocal. Experimental variables included ones such as culture, age, and socioeconomic status. More recently attention has focused on the thought processes of children younger than five years old.

Mehler and Bever (1967) investigated the discriminative abilities of very young children, 2-6 (two years six months) to 4-6 years old. The children were presented two tasks involving unequal numbers of objects in which the row with the most objects was the shortest row. Clay pellets were used in one task and M&Ms in the other. One task was verbal; i.e., in the task using arrays of clay pellets, the S was asked which row had "more." The other task was non-verbal; i.e., in the task using arrays of M&Ms the child was asked to "take the row you want to eat, and eat all the M&Ms in that row (Mehler & Bever, 1967, p. 141)." The authors discussed their results from a conservation theory frame of reference. Results showed that the youngest child made extremely high conserving responses and that the responses decreased with age, significantly so for clay pellets but not for M&Ms. After age 3-6, conserving scores increased.

Mehler and Bever (1967) concluded that the "discriminative ability of the younger children shows that the logical capacity for cognitive operations exists earlier than previously acknowledged (p. 141)."

Beilin (1968) replicated the Mehler-Bever (1967) study. Beilin's results did not confirm the Mehler-Bever finding that very young children conserved the concept of number, with a decline and then a rise in performance with age. Beilin found that Ss between the ages of 3-0 and 4-7 could recognize equality or inequality in static situations but not after transformations.

Bever, Mehler, and Epstein (1968) criticized Beilin's (1968) replication as not a replication in that he did not use Ss under three years of age nor the same experimental procedure. They conducted additional studies which supported their original findings.

Rothenberg and Courtney (1968) also replicated the Mehler-Bever (1967) study, but their results did not support the Mehler-Bever conclusions. Rothenberg and Courtney criticized Mehler and Bever's use of one biased question as a criterion of a conserving answer and cited the proximity of the correct array to S as influencing correct choices.

Piaget (1968) wrote, concerning Mehler and Bever (1967) findings, that although their results "have nothing to do with conservation, they yet are suggestive of a useful complement of information on the development of quantification

(p. 976)." Piaget found that whereas children at the operational level of conservation looked for one-to-one correspondence between elements in two arrays, younger children (ages 3 or 4 to 6 or 7) judged by length. The Ss that had not reached the stage of evaluation by length used an even more primitive mode of evaluation, i.e., topological evaluation based on a notion of "heaping" or "crowding." Piaget found that the answers of Ss from 2-3 to 3-0 years of age were inconsistent and that the youngest S who understood and expressed equality was 3.4 years old. Once equality was understood, at about 3-6 years, considerations of length began to dominate responses. Piaget concluded that nonconservation was explained by inadequacy of means of quantification.

Rothenberg (1969a) investigated the effects on conservation status of: (a) the structure and number of questions asked, (b) the use of various transformational tasks, and (c) the use of explanations of S's conservation responses in categorizing Ss as conservers or non-conservers. An 18" x 24" board, half painted yellow and half painted blue, was used to present arrays to Ss. A warm-up item (equal subtraction) and five transformations (lateral displacement, collapsing, resubgrouping, equal addition, and unequal addition) were presented to Ss. After each transformation, S was asked two questions and was requested to justify his responses. Effect of materials was tested using styrofoam blocks and toys. Subjects were categorized as conservers, consistent nonconservers, and inconsistent nonconservers. The two nonconserving groups were differentiated by ability to understand or not to understand the language of the questions. Explanations were categorized as symbolic, number, matching, perceptual, limited verbal, don't know, and magical. Symbolic, number, and matching responses were considered adequate evidence of conservation and responses in other categories were considered inadequate. The explanations, however, were not used in determining conservation status.

Rothenberg (1969a) found that 6 percent of Ss, children 4-3 to 6-0 years old, were conservers. Results indicated no effects for materials or sex. Conserving answers were infrequently consistant across transformations. No significant main effect for age was found among middle-class Ss, possibly because of similarity in language understanding as measured by the Peabody Preschool Vocabulary Test (PPVT).

Rothenberg (1969a) recommended assessing or teaching basic understanding of "same" and "more" in order to be certain that conservation, not an understanding of vocabulary, was being assessed. She also suggested varying the order of questions asked since children tend to answer "yes" when in doubt. She suggested that Piaget's (1952) stage of absence of conservation be divided into: (a) lack of understanding of conservation questions and (b) understanding of language but not conservers. Rothenberg concluded that Ss should not be considered conservers of number unless they were able to conserve on a variety of different problems. The ability to conserve on some but not all transformation tasks may indicate a transitional stage.

Rothenberg and Courtney (1969a) assessed number conservation in Ss 2-5 to 4-4 years old. Understanding of language was assessed during presentation of introductory items. The subject was asked to reproduce the experimenter's (E's) row of five blocks in order to evaluate his ability to make his blocks correspond numerically to E's blocks. The five test transformations involved collapsing, rotation, expansion, equal addition, and unequal addition.

Rothenberg and Courtney (1969a) found that 2 percent of Ss were conservers. Age and socioeconomic status differences in conservation attainment were found but no sex differences. They reported that a majority of very young Ss were unable to reproduce correctly a simple linear configuration and thus were probably in the stage of global comparison, as described by Piaget (1952); however, a majority of Ss 4-6 to 6 years old could correctly reproduce the configuration and were in the stage of intuitive correspondence. Rothenberg and Courtney found growth in skills associated with number conservation, i.e., growth in ability to reproduce a row, to understand language concepts of "same" and "more," and to explain judgments more adequately. Their findings supported Piaget's view that number conservation does not develop until nearer six years of age.

Rothenberg and Courtney (1969b) investigated the number conservation abilities of very young Ss. Four test transformations (rotation, collapsing, expansion, and equal addition) were used. Effects of proximity, length, density, and manipulation were studied. The researchers found that the responses of younger Ss (2-5 to 3-3 years) were based on proximity while the responses of older Ss (5-3 to 6-2 years) were based on length. The older Ss' responses were based on length, manipulation, closeness, and density, in that order. To determine the effects of density, Rothenberg and Courtney recommended the use of a transformation in which one row was manipulated to be closer and longer and the other row was made only more dense. They also suggested that the transformations be presented vertically rather than horizontally so as to eliminate proximity bias.

Rothenberg and Orost (1969a) successfully taught conservation of number concepts to kindergarten children through presentation of a logical sequence of component concepts. Control Ss showed no noticeable growth in conservation concepts. The effects of teaching were retained after three months and generalizability of effects to conservation of discontinuous quantity was demonstrated.

Methodological Considerations

Piaget's (1950) conservation experiments usually involved children five to seven years of age. He was particularly interested in the acquisition of the concepts, which he found to take place at the age of six or seven. Piaget's experiments were clinical. His testing procedures were unstandardized and his scoring procedures were arbitrary and inadequately detailed (Sigel, 1968). Many problems have been encountered in attempting to cast Piaget's experiments into a psychometric framework.

Experimenter Bias

Hall and Kingsley (1968) criticized verbal methods of assessing the presence or absence of conservation. They found that the responses of conservers extinguished when taped instructions were used to remove experimenter bias. They declared that many young children thought that the "correct answer" was the one which pleased the experimenter and suggested using interesting materials so that the child focused on the task rather than on possible vocal or facial cues of E.

Size of Aggregates

Feigenbaum (1963) found that the number in the aggregate in a conservation of quantity experiment had a bearing on the percentage of Ss categorized as conservers. He found that some Ss solved the problems when the aggregate consisted of two, three, or four pairs of beads, but failed when the number was increased. Baker and Sullivan (1970) also found that the aggregate size influenced results. In a conservation of number experiment with kindergarten children as Ss, they found more conservers with small aggregates and when the aggregates were high interest materials (candy).

Materials

Various materials have been used in conservation of number tasks. Piaget and Inhelder (1971) reported using blue and red discs. They discontinued use of red discs because the children's fondness of them confounded results. Baker and Sullivan (1970) found more conserving responses when the task involved high interest materials (candies) in conjunction with small aggregates. They suggested that high interest materials lessened distractability and inattention. Mehler and Bever's (1967) results varied slightly according to whether the task involved clay pellets or M&Ms. Siegal and Goldstein (1969) utilized pennies in their tasks and Rothenberg (1969) used styrofoam blocks.

Structure of Questions

Siegal and Goldstein (1969) found that the structure of the questions influenced results. Subjects, ages 2-7 to 6-1, significantly more often chose the last of the response alternatives offered them when asked, "Which row of pennies has more (less), this one or this one (Siegal & Goldstein, p. 129)?" The authors tested the understanding of relational terminology as well as conservation of number and found that most children under 4-7 years do not correctly respond to quantitative relational terms such as "more," "less," or "same."

Relational Terminology

The relational terms "same" and "more" have received much attention in number conservation experiments. Griffiths, Shantz, and Sigel (1967) tested children ages 4-1 to 5-2 years and found that responses to "same" were less often correct than responses to "more" or "less." To a child, "same" may mean identity or equivalence. The investigators suggested that there may be a close relation between the ability to use relational terms and the ability to conserve. They recommended that the ability to judge similarity and to use the term "same" correctly be determined prior to testing for conservation in order to minimize chances of confounding linguistic and conceptual abilities. Piaget's view, however, was that lack of comprehension of relational terms was an indication that the child had not assimilated this knowledge; thus lack of comprehension in itself was an indication of cognitive level (Sigel, 1968).

Explanation Categories and Scoring

The criteria of conservation used by some investigators required conservation responses and adequate explanations of conservation (Brison, 1966; Dodwell, 1960; Fiegenbaum, 1963; Gelman, 1969; Goldschmid, 1967; Piaget, 1968). Other studies have not required adequate explanations of conserving responses (Fleischmann, Gilmore, & Ginsburg, 1966; Mehler & Bever, 1967; Mermelstein & Shulman, 1969; Rothenberg, 1969a; Rothenberg & Courtney, 1969a; Uzgiris, 1964). The criteria of conservation may determine whether a S was categorized as a conserver or a nonconserver. Sigel (1968) noted that acceptance of responses as indicating conservation without adequate explanations would be considered insufficient evidence by Piaget and was probably not an adequate test of the theory.

Inhelder, et al., (1966) suggested that categories should be based on structural criteria of explanations. Conservation is dependent on thought-operation reversibility; therefore, explanations to be categorized as conserving should indicate the mechanisms underlying the structure of conservation concepts, i.e., identity, reversibility, and compensation. She found that nonconserving explanations mentioned only one dimensional difference or successively centered on dimensions of number and size. Language of conserving responses was differentiated, referring to a comparison between the standard and transformed object, e.g., long-short and fat-thin. Inhelder held that neither the availability of dimensional terms nor the use of them was a sufficient index of conservation. Evidence of the presence of conservation concepts was the differentiated structure of explanation responses.

Gelman (1969) categorized explanations as adequate evidence of conservation if the explanations referred to former equality, reversibility, compensation, addition and subtraction, irrelevancy of transformation, and partition or matching schema. Correct responses and logical explanations were required for Ss to be categorized as conservers.

Rothenberg and Orost (1969a) did not utilize explanations in categorizing Ss. Subjects were scored on each transformation, as a conserver if both questions were answered correctly and a non-conserver if both questions were not answered correctly. Effects of utilizing explanations and correct responses versus correct responses only were studied. The conclusion was that when a sufficient number of questions was asked, the measure of conservation was valid without including explanations in the scoring. This seems especially applicable when Ss are very young and explanations are largely in the "don't know," "limited verbal," or "no response" categories.

Goldschmid (1967) categorized explanations as follows: (a) abstract conceptual responses, e.g., "Nothing was added to or subtracted from"; (b) perceptual response, e.g., "It looks like they are the same"; and (c) magical or no response. The responses were scored 2 points, 1 point, and 0 points, in that order.

Sigel (1968) commented on the factor of language fluency in relation to conservation category criteria. He said that requirement of justification may result in categorizing young children as nonconservers when the children were aware, intuitively, of the invariance of attributes after transformations but were not able to verbalize adequate justifications.

Peabody Picture Vocabulary Test

The Peabody Picture Vocabulary Test (PPVT) is an individual test which can be administered in 15 minutes or less. Piers considered the test "probably now the best of its kind (Buros, 1965, p. 821)." The test has moderate reliability and unestablished validity, according to a review in Buros (1965). Anderson and Flax (1968), however, reported that the PPVT was quite comparable to the Wechsler Intelligence Scale for Children, and O'Connor, Shotwell, Gabet, and Dingman (1969) found a relatively strong relation between the PPVT and the Stanford-Benet. Deal and Wood (1968) noted that at the lower age range, the same raw score gave large IQ differences with only small differences in chronological age. They recommended using raw scores rather than IQ scores.

CHAPTER III

METHOD

The experimental design was a pretest-posttest control group design (Campbell & Stanley, 1963). The independent variable was instruction in number conservation given the experimental group, and the dependent variable was the conservation of number task scores. The subjects (Ss) were matched on age and the Peabody Picture Vocabulary Test (PPVT) score and were randomly assigned to experimental and control groups.

A multiple analysis of covariance was executed by computer on the data, the statistical treatment suggested as appropriate for this design by Campbell and Stanley (1963). The analysis of covariance eliminated that part of the variability of posttest scores which was accounted for (a) by variability in Ss existing prior to the experiment as measured on the pretest, (b) by sex, (c) by age, and (d) by PPVT score. The analysis of covariance was especially applicable since there was a wide variability in pretest scores on conservation of number between three-year-old and six-year-old children. The effectiveness of the covariance design in reducing error size depended on the degree of correlation between the dependent variable and the adjusting variable (Ray, 1960). Since scores on the same test served as dependent variable when used as a posttest and adjusting variable when used as a pretest in this experiment, the covariance design was particularly applicable. The level of significance was .05.

The percentage of children in Groups I, II, and III who correctly responded to each item on pretest and posttest was reported, as was any significant differences between them. The correlation between scores on Posttest I and Posttest II was computed. Raw scores may be found in Appendix D.

Subjects

The Ss were 72 children, 37 boys and 35 girls, from the University of North Carolina at Greensboro Nursery School and the First Presbyterian Church Kindergarten. All of the children were from middle-class homes. The 22 children from the junior class at the nursery school were called Age-Group I. The age range in Age-Group I was from 3-7 to 4-5 and the mean age was 4.0 years. The PPVT raw scores in this group ranged from 38 to 61 and the mean was 50.4. The 26 children from the senior class at the nursery school belonged to Age-Group II. The age range in Age-Group II was from 4-7 to 5-6 and the mean age was 5.0 years. The PPVT scores ranged from 49 to 97 and the mean was 60.1. The age range in Group III was from 5-9 to 6-9 and the mean age was

5.3 years. The PPVT scores ranged from 51 to 75 and the mean was 64.8.

Subjects were chosen from two kindergarten classes and experimental sessions occurred at times other than the out-door play period and juice periods which the children did not like to miss. The out-door play periods and juice periods were at different times for each class. The Ss who initially responded correctly to all five test items were retained in the study since the pilot study demonstrated that some children regressed on the conservation of number posttest.

Each S was tested individually by the experimenter (E), who spent several days becoming acquainted with Ss prior to testing sessions. Sessions took place during a regular school day in a quiet room apart from other children.

Apparatus

A plywood board 18" x 24" served as a surface on which to place arrays used in the number transformation tasks and in the teaching sessions. One-half of the board surface was painted blue and one-half was painted yellow. The yellow side of the board was faintly marked at 3 inch intervals along the length of the blue-yellow division. Black checkers were the materials used in the transformation tasks. Materials utilized in the teaching sessions were small 1 inch square wooden blocks, red checkers, plastic cups and saucers from a child's tea set, plastic chairs from a doll house, small wooden-peg painted children, and plastic barnyard animals.

Experimenter and S sat facing each other in child-size chairs at a child-size table. The plywood board was placed on the table with the blue side toward S and the yellow side toward E.

Pilot Study

A pilot study was carried out with a total of 10 children as Ss, ages three through five years. The children were from the Carter Child Care Center, on the University of North Carolina at Greensboro campus, and the West Market Street United Methodist Church Kindergarten located in Greensboro. The purposes of the pilot study were as follows: (a) to determine the children's reaction to the conservation of number task, (b) to determine the time required for the sessions, (c) to determine the children's reaction to the materials used in the conservation of number tests and to the teaching sessions, (d) to give E practice in administering the conservation of number task, (e) to allow E to gain experience in the teaching sessions, and (f) to determine the most feasible number of teaching sessions.

During the pilot study, the children appeared to enjoy the "number game" (conservation of number tasks) and willingly went to the experimental room with E for each session. Black checkers worked well as objects in the conservation of number tests. The checkers were easily manipulated, familiar to the children, and not so interesting in themselves as to be distracting. Blue poker chips were found to be difficult to manipulate. Other materials used in the teaching sessions (small plastic cups and saucers from a tea set, plastic farm animals, plastic doll-house-size chairs, small wooden peg-shaped children, and wooden counting blocks (1" x 1"), were found to be satisfactory, i.e., to hold the child's interest and keep his attention focused on the tasks. Fifteen minutes was the maximum time that a three-year-old child's attention and interest could be maintained in a teaching session. When a child tired of the task, his attention wandered. Two sessions seemed sufficient for teaching conservation of number to three-year-olds. Toward the end of the second teaching session, the three-year-olds seemed to have reached a plateau in their learnings and appeared to lack interest in the proceedings.

Experiences during the pilot study revealed the desirability of keeping all materials for the teaching sessions in a box in order to keep the child's attention on the task. Objects used in the sessions were removed from the box, manipulated according to the instructions, and then returned to the box before the next objects to be manipulated were removed from the box.

An analysis of variance on difference scores between conservation of number pre- and posttests revealed a significant difference at the .025 level between the young, the intermediate, and the older children. Further examination of the scores revealed that some children improved their scores between pre- and posttests, some children's pre- and posttest scores were the same, and some children regressed on their posttest scores.

Procedure

The procedure was as follows: (a) experimental and control groups were pretested for conservation of number, (b) the experimental group received instruction in conservation of number for two sessions, and (c) both groups received two posttests on conservation of number. Pretests, teaching sessions, and posttest I took place on successive days. Posttest II was administered one week after posttest I. Pretests and teaching sessions lasted approximately 15 minutes and posttests required 5 to 7 minutes. Control groups received no special instruction between pre- and posttests. Each S was given a small piece of candy at the end of each session and he was asked to eat the candy before he rejoined his classmates. Since all kindergarten children in a class did not have a chance to participate in the experiment, candy was given to the teacher to be distributed at juice-time to the entire class in order that none of the children felt slighted.

Conservation of Number Test

The conservation of number test was adapted for use with children aged three to six years from Rothenberg's (1969b) test (see Appendix A). The same test was used for pre- and posttests. The test included a warm-up item and the following four transformations: rotation, equal addition, expansion, and collapsing (Table 1). The warm-up item did not involve conservation, but served to acquaint Ss with the task format. Five black checkers were placed 3 inches apart on the yellow side of the testing surface and five checkers were placed on the blue surface parallel to them. Two questions were asked consecutively, regardless of the answer to the first question. The first question was, "Does this row have the same number of checkers as this row?" The E pointed to the appropriate side as the question was asked. The second question was, "Does one row have more checkers than the other row?" The format for one transformation is shown in Table 2. The same format was used for all transformations.

Transformations

The warm-up item involved equal subtraction. An array of five pairs of objects (checkers) was lined up in parallel fashion, each pair separated 3 inches from each other pair. The arrangement was linear, one object of each pair on the yellow side of the board and one object on the blue side of the board on which the presentation was made.

Table 1

Conservation of Number Transformations[a]

Tasks	Distinguishable Factors
Equal Subtraction[b] Blue: 0 0 0 0 0 Yellow: 0 0 0 0 0	Rows equal in length Rows equal in manipulation Rows equal in density
Rotation: 0 0 0 0 0 Blue: 0 0 0 0 0 Yellow: 0 0 0 0 0	Rows equal in length Rows equal in density Only blue row manipulated
Unequal Addition: Blue: 0 0 0 0 0 Yellow: 0 0 0 0 0	Rows equal in manipulation Yellow row longer Blue row more dense
Expansion: Blue: 0 0 0 0 0 Yellow: ←0 0 0 0 0→	Only yellow row manipulated Yellow row longer Blue row more dense
Collapsing: Blue: 0 0 0 0 0 Yellow: →0 0 0 0 0←	Only yellow row manipulated Blue row longer Yellow row more dense

a Adapted from Rothenberg & Courtney (1969b).

b Arrow shows objects which were manipulated to transform the array.

Table 2

Transformation Format[a]

Row Collapsing
Reposition objects on yellow side without removing them from board. Then remove the objects on the blue side and restore the formation

Blue:	0	0	0	0	0
Yellow:	0	0	0	0	0

E. "This row has the same number of checkers as this row. Now watch what I do."

Collapse the yellow row, producing:

Blue:	0	0	0	0	0
Yellow:			00000		

E. 1. "Does this row (point to blue) have the same number of checkers as this row (point to yellow)?"

2. "Does one row have more checkers than the other row?"

a Adapted from Rothenberg (1969a).

The E said, "This row has the same number of checkers as this row. Now watch what I do." One checker of an end pair was removed from the blue side and the corresponding checker was removed from the yellow side. The child was then questioned as to whether the number of checkers was the "same" or "more."

The second transformation, rotation, involved moving the checkers on the blue side from their initial arrangement parallel to the checkers on the yellow side to a linear arrangement at right angles to one end of the arrangement of checkers on the yellow side. Only one side was manipulated, whereas both rows were equal in length and density. The child was again questioned about the equality of number.

In the third transformation, equal addition, an array of four pairs of checkers arranged parallel to the blue-yellow division was presented S. One checker was then added to the blue side and one checker to the yellow side, not parallel to each other but in a manner in which the two rows of checkers were no longer in a paired arrangement. Both rows were manipulated, but following the transformation the row on the yellow side was longer and the row on the blue side was more dense. Questions about equality followed the manipulation.

The fourth transformation, expansion, involved extending the row of blocks to cover a greater space, lengthwise, from an initially equivalent position. The row on the yellow side was manipulated and thus longer, whereas the row on the blue side was more dense. In the last transformation, one row of checkers was collapsed, thus more dense and shorter than the unmanipulated row.

Questions and Scoring

The use of two questions after each transformation allowed differentiation between Ss who understood the language of the question but who could not conserve number, those who neither understood the language of the questions nor conserved number, and those who conserved number on the test items. Scores were weighted. Correct responses to both questions on an item were scored 4 points. Consistent but incorrect responses were scored 2 points. Consistent but incorrect responses gave evidence of comprehension of "some" and "more" but not of conservation of number; e.g., S responded "No" to the question, "Does this row have the same number of checkers as this row?" and responded "Yes" to the question, "Does one row have more checkers than the other row?" Inconsistent responses were scored 0 points. Inconsistent responses indicated that the S did not comprehend the meaning of "same" and "more" and did not conserve; e.g., S responded "Yes" to the question, "Does this row have the same number of checkers as this row?" and "Yes" to the question, "Does one row have more checkers than the other row?" Highest possible total score on each test was 16. The higher the score was, the greater the comprehension of conservation of number was. A sample score sheet is in Appendix B.

Teaching Sessions

Teaching sessions were modifications of Rothenberg and Orost's (1969b) procedure. (See Appendix C.) Standardized instructions were worded so as to be understood by the youngest child. The procedure for the teaching sessions was typed on 5" x 8" index cards. The procedure for the teaching sessions is in Appendix C.

Each S in the experimental condition received two individual sessions of instruction from E on two successive days. Sessions lasted approximately 15 minutes and took place in a quiet room apart from the other children.

Concepts relating to the acquisition of number were taught. The Ss were given practice in counting to ten verbally and in counting objects. Practice was given in one-to-one correspondence. Different objects were utilized in one-to-one correspondence practice; i.e., one-to-one correspondence was practiced with blocks, toy cups and saucers, and with toy children and chairs. Practice was also given in addition-subtraction and in the concepts of "row," "length," "more," and "same." The child's correct responses were verbally reinforced and the child was given a piece of candy at the end of each session.

CHAPTER IV

RESULTS

The conservation performance of young children who received instruction in concepts prerequisite to number conservation was compared with the performance of young children who did not receive instruction. Scores on conservation of number tasks, the dependent variable, were analyzed to ascertain whether there were any significant effects due to instruction. Data on subjects' (Ss') ages by months and Peabody Picture Vocabulary Test (PPVT) scores, as well as raw scores on the Conservation of Number Pretest, Posttest I, and Posttest II, are in Appendix D.

Tests of Hypotheses I, II, and IV involved analyses of covariance, whereas the test of Hypothesis III involved a chi-square analysis. Therefore, a discussion of the test of Hypothesis III follows examination of the analyses of covariance results.

Hypothesis I stated that instruction in conservation of number skills would have no effect. Two analyses of covariance were computed to test Hypothesis I. First, an analysis of covariance was run on the Posttest I-Posttest II difference scores. The analysis revealed that random error accounted for most of the variability between experimental and control groups. The covariates were age and PPVT scores. The analysis of these results is shown in Table 3, the means by condition in Table 4, and the adjusted means in Table 5.

An analysis of covariance on Posttest I scores, with pretest, age, and PPVT scores as the adjusting variables, was also computed as a test of Hypothesis I. The results, as shown in Table 6, indicated that there were no significant differences in treatment effects. The effects of age and pretest, however, were highly significant.

The effect of age-groups is shown in Table 7. An analysis of covariance on Posttest I scores was computed with age-groups, pretest, and PPVT scores as covariates. The age-group effect was significant at the .0001 level. The means for Ss by age-group are shown in Table 8. The results thus support Hypothesis I which stated that there would be no difference between the conservation of number pre- and posttest scores of children who received instruction in conservation of number skills and those who did not receive instruction.

Results also support Hypothesis II. This hypothesis stated that there would be no difference in conservation of number scores by sex. The means for Ss by sex are in Table 9. As seen in Table 3, variations due to sex were not significant.

Table 3

Analysis of Covariance on Difference Between Pretest and Posttest I

Source	SS	df	MS	F	Prob< F
Total	782.611	71			
Treatment	4.500	1	4.500	0.38	.54
Sex	0.198	1	0.198	0.02	.89
Treatment x Sex	7.869	1	7.869	0.68	.58
Age	1.894	1	1.894	0.16	.69
PPVT	0.0003	1	0.0003	0.0001	0.99
Error	768.15	66	11.638		

Table 4

Age, PPVT, Pretest, and Posttest I Means for Subjects by Condition

N	Treatment	Age in Months	PPVT Raw Score	Pre-test Score	Post-test I Score	Pretest-Post-test I Score Differences
36	Control	61.67	59.08	10.50	11.61	1.11
36	Experimental	60.92	58.31	10.44	11.06	.62

Table 5

Means Adjusted for Pretest, Age, PPVT

N	Treatment	Posttest I
36	Control	11.53
36	Experimental	11.14

Table 6

Analysis of Covariance for Dependent Variable Posttest I

Source of Variation	SS	df	MS	F	Prob < F
Total	2024.00	71			
Error	598.42	67	8.93		
Treatment	5.55	1	5.55	0.62	.5610
Pretest	1318.05	1	1318.05	147.57	.0001
Age	81.52	1	81.52	9.13	.0039
PPVT	20.46	1	20.46	2.29	.1310

Table 7

Analysis of Covariance on Dependent Variable Posttest I

Source	SS	df	MS	F	Prob < F
Total	2024.00	71			
Error	575.47	66	8.72		
Treatment	5.55	1	5.55	0.74	.57
Age-Group	1003.00	2	501.50	57.52	.0001
Pretest	420.26	1	420.26	48.20	.0001
PPVT	19.71	1	19.71	2.26	.13

Table 8

Means for Experimental and Control Subjects by Age-Group

N	Group	Age in Months	PPVT Score	Pretest Score	Post-test I Score	Pretest-Post-test I Score Differences
22	I	48.00	50.36	5.64	6.09	.45
26	II	60.19	60.11	10.92	12.08	1.16
24	III	74.67	64.79	14.42	15.33	.91

Table 9

Means for Experimental and Control Subjects by Sex

N	Sex	Age	PPVT	Pretest	Posttest I	Differences
35	Female	61.20	56.74	10.46	11.26	.80
37	Male	61.38	60.54	10.49	11.41	.92

As a test of Hypothesis IV, that there would be no difference between scores on Posttest I and Posttest II, an analysis of covariance was computed on the Posttest II scores, with Posttest I as the adjusting variable. The results, shown in Table 10, indicated a correlation (r) of .83 between Posttest I and Posttest II scores. Thus practically 70 percent of the variance in Posttest II scores was accounted for by Posttest I. The means of Posttest II, however, were lower than the means of Posttest I. A t-test indicated a significant difference between the means of Posttest I and Posttest II. Hypothesis IV, therefore, was rejected. Results demonstrated a significant difference between scores on Posttest I and Posttest II.

Two chi-square tests of significance were computed as a test of Hypothesis III (Walker & Lev, 1953). The hypothesis stated that there would be no difference between the number of Ss in Age-Groups I, II, and III who responded correctly to all items on the Conservation of Number Pretest

Table 10

Analysis of Covariance on Dependent Variable Posttest II

Source	SS	df	MS	F	Prob < F	r
Total	2199.50					
Posttest I	1516.55	1	1516.55	155.44	.0001	.830
Error	682.95	70	9.756			

and Posttest. The frequency of perfect scores on the pretest, by age-groups, is shown in Table 11. The chi-square value was significant at the .001 level. The results of the computation revealed an observed chi-square value of 15.33.

Table 11

Frequency of Perfect Scores on Pretest by Age-Group

	Perfect Scores	Not Perfect Scores	Total
Group I	1 (5)*	21 (95)	22
Group II	8 (31)	18 (69)	26
Group III	14 (58)	10 (42)	24
Total	23 (32)	49 (68)	72

* Percentage values are shown in parentheses.

A chi-square test of significance was also computed on frequencies of perfect scores on Posttest I. The results indicated a highly significant difference between age-groups. These frequencies are shown in Table 12. An observed chi-square value of 28.71 was obtained; a chi-square value at the .001 level is only 13.8. Thus it was clear that Hypothesis III must be rejected; there was a significant difference between the number of Ss in Age-Groups I, II, and III who made perfect scores on the pretest and the posttest.

Table 12

Frequency of Perfect Scores on Posttest I by Age-Groups

	Perfect Scores	Not Perfect Scores	Total
Group I	1 (5)*	21 (95)	22
Group II	13 (50)	13 (50)	26
Group III	20 (82)	4 (18)	24
Total	34 (47)	38 (53)	72

* Percentage values are in parentheses.

CHAPTER V

DISCUSSION AND CONCLUSIONS

An investigation was made of the number conservation ability of young children and whether this ability can or cannot be taught. Piaget (1950) theorized that teaching played no role in the development of conservation of number; however, other studies included in the review of literature on previous conservation research indicated equivocal evidence on the results of instruction. Subjects in those studies who were taught to conserve were usually at least five years old.

Subjects (Ss) in the experimental condition were instructed in concepts of number conservation. Their performance on the Conservation of Number Tasks Posttest I was compared with the performance of Ss in the control group who did not receive instruction. Statistical analysis of the data revealed that Ss who had received instruction in conservation of number concepts scored no higher on the posttest than Ss who had received no instruction.

The non-significance of treatment effect necessitated consideration of the validity of the instument of measurement. Previous studies, as seen in the review of literature, in which Ss were successfully taught to conserve were criticized for various reasons by researchers who were unsuccessful in teaching conservation. Lax criteria of conservation were factors cited as responsible for successful results. For example, Ss were categorized as conservers on the basis of one or two tasks. Subjects also were categorized as conservers without requiring correct explanations of conserving responses.

The Conservation of Number Task was adapted from an instrument developed by Rothenberg (1969b). The following factors were considered by Rothenberg and Courtney (1969b) in their validation of the instrument: (a) the number of tasks in the test; (b) the degree of difficulty of each item; (c) clarity of instructions and format; (d) number of questions in each item; (e) construction of questions so that neither a "yes-set" nor a "no-set" produced conserving answers; (f) variation of the side manipulated; and (g) variation of density and length of objects in the arrays.

Rothenberg's instrument was developed for use with five-year-old children. The instrument, therefore, was adapted for use with Ss whose ages ranged from 3-7 to 6-9 years. The test needed to be not so difficult as to be completely beyond the comprehension of the three-year-old child and yet not so easy as to be uninteresting and unchallenging to the six-year-old child. The test proved easy for the kindergarten children; yet the results of treatment remained valid since the pretest and age were used as covariates. Four conservation of number tasks were presented to Ss; therefore, it was doubtful that the results included "false positives." The use of more than one question after each transformation task also contributed to the validity of the results.

The operational definition of conservation was an important consideration. Explanations of conserving responses were not required because very young children, three- to four-years-old, were known to give largely inadequate or no explanations. Had such explanations been required, it seemed reasonable to speculate that fewer Ss in Age-Group III would have been judged conservers (responded correctly to all items) on the pretest and consequently would have shown increased scores on the posttest as a result of instruction. Another consideration was that requiring explanations may result in "false negatives." Bruner (1966) suggested that "conservation-in-action occurs far earlier than does conservation as a linguistic judgment (p. 325)." He contended that children may be able to handle conservation problems in life even though they are unable to verbalize what happens. The Conservation of Number Task was designed to take into consideration and account for factors which were criticized as producing invalid results in other studies.

A consideration of factors which may have contributed to nonsignificant results necessitated an examination of the sessions of instruction. It is possible that an increased number of instruction sessions would have produced significant results. The longer the period of time over which experimental sessions are spaced, however, the greater the possibility of extraneous factors entering into the results. It would be very difficult, for example to parcel out the effects of maturation if sessions extended over long periods of time.

Age was an important factor in considering conservation problems. The fact that kindergarten-age children in previous studies had been taught to conserve may have been a product of the age factor rather than instruction. Most five-year-olds, according to Piaget's theory, are in the intuitive stage of cognitive development, i.e., a transition stage between examining phenomena perceptually in the preconceptual stage and judging phenomena logically in the period of concrete operations. If conservation is analogous to insight learning, the usual interpretation of the phenomenon, it is plausible to consider age, which is representative of developmental level, more responsible for conservation acquisition than instruction. It may be that children who acquired conservation after instruction were already on the brink of conservation. Examination of the data using the analysis of covariance allowed the effect of age to be parceled out.

An examination was made of informal observations noted by E on the individual score sheets. In Age-Group I few Ss were observed counting the objects before responding to the item questions. Of the few Ss who counted, those who counted correctly gave correct responses; those who counted incorrectly gave incorrect responses. In Age-Group III most Ss were observed to count before responding, usually correctly. Observations of children's actions during testing sessions appeared to agree with Piaget's theory that nonconservers attempt to solve transformation problems on the basis of perception. The children in Age-Group I, 3-7 to 4-5 years of age, responded to questions without counting. This mode of behavior was representative of behavior in the preconceptual stage.

The fact that the older children counted objects in the arrays before responding, even though they responded correctly, might be an indication that they were in the intuitive or transitional stage. Had these children reached the period of concrete operations, they would have recognized that the transformations did not alter the number of objects without counting. It seemed reasonable to speculate that some of the 5 to 6 year-old-children would have been unable to conserve on tests which involved larger aggregates and more extensive transformations.

The comments and expressions of some of the children in Age-Group III were consistent with the contention that kindergarten-age children are in a stage of transition or are on the brink of conservation. One child, when asked after a transformation, "Does this row have the same number of checkers as this row?", counted both rows of checkers and responded correctly to the question. With a look of incredulity on her face, she said, "It sure doesn't look like it!" Another child counted both rows of checkers and responded correctly to the question, but his facial expression indicated that he could hardly believe what the facts indicated. This interpretation is consistent with the interpretations of Wohlwill (1960), Elkind (1964), and Dodwell (1960).

The decision was arbitrarily made to categorize as conservers all subjects who responded correctly to each item on the Conservation of Number Tasks. Results revealed that 5 percent of Ss in Age-Group I (3-7 to 4-5 years) were conservers of number. The percentage of conserving Ss in Age-Group I was thus essentially in agreement with the results of Rothenberg and Courtney's (1969a) study. Rothenberg and Courtney reported as conservers 2 percent of Ss who were 2-5 to 4-4 years of age.

As was expected, boys and girls did not differ in their scores on the Conservation of Number Task. This finding was in agreement with previous research results reported in the literature. Also, as expected, there was a significant difference by age-group. "Age-group" is practically synonymous with "age." The effect of age was discussed earlier.

It was expected that there would be no significant difference between Posttest I and Posttest II which was administered one week later. Although there was a correlation of .83 between Posttest I and Posttest II, there were differences between the means of the two tests. The mean of Posttest II was lower than the mean of Posttest I. It was the observation of the experimenter that this difference in means was due to the children's loss of interest in the proceedings and consequent decreased motivation. Several Ss were extremely uncooperative during the Posttest II session due to loss of interest during the testing sessions.

Conclusions

The results of this study demonstrated that two teaching sessions were ineffective in increasing Ss' Conservation of Number Task scores. The finding supports Piaget's contention that teaching has little influence on the acquisition of conservation of number, that conservation develops in the individual by the processes of maturation, interaction with the physical and social environments, and equilibration.

The ability to conserve number is rare among children as young as 3 years 7 months to 4 years 5 months. Only 5 percent of Ss who were that young made perfect scores on the conservation tasks. The youngest child to make a perfect score was 48 months old. There was, however, a noticeable increase from the younger to the older Ss in their total scores on the Conservation of Number Task.

The difference between the results of this study and those studies reported earlier (Brison, 1966; Gelman, 1969; Rothenberg & Orost, 1969a; Wallach, et al., 1969) in which younger Ss were alleged to be conservers, appears to be due to differences in methodology and criteria for conservation. It is possible that fewer Ss would have made perfect scores if the transformations had involved greater distortion and if justifications for correct responses had been required for perfect scores. This interpretation supports Braine and Shanks' (1965) suggestion that transformations with more complex attributes are conserved at a later age than transformations involving simple attributes. The findings, also, are in agreement with Goldschmid's (1967) declaration that the level of conservation is dependent on the particular task and particular transformations used to measure conservation. It appears from the results of this study that the age at which a child is categorized as a conserver of number is dependent on the criteria of conservation and the difficulty level of the measuring instrument.

The findings may be regarded as a challenge to studies reporting success in teaching children to conserve. It may be that the children who were "taught" to conserve were at an age and a state of maturational readiness which made conservation acquisition possible, or the claimed success may have been an artifact of the criteria of conservation and the difficulty level of the instrument used to measure conservation ability.

CHAPTER VI

SUMMARY

An experimental investigation was made to study the effects of instruction on young children's ability to conserve numbers. According to Piaget (1950), number conservation is a product of the processes of maturation, interaction with the total environment, and equilibration. More recently, Piaget (1967) emphasized the influence of equilibration on the developmental process. Equilibration is a self-regulatory factor which coordinates the influences of maturation and the physical and social environments. From research and observation he concluded that conservation did not usually develop until age six or seven years.

Professionals and paraprofessionals working with very young children need to know which cognitive skills develop regardless of specific teaching. Further, information dealing with young children's ability to conserve numbers may be helpful to educators responsible for designing preschool curriculums.

A review of literature indicated that the results of previous studies concerned with teaching conservation skills were equivocal (Flavell, 1963; Sigel, 1968). Since the studies reporting success in teaching conservation usually involved children five years of age or older, it seemed important to study the conservation ability of children under five years of age and fill the void in the research reported.

The following hypotheses were tested: (a) there are no significant differences between conservation of number pre- and posttest scores of Ss who receive direct instruction in conservation of number skills and Ss who do not receive such direct instruction; (b) there are no significant differences between scores on conservation of number pre- and posttests by sex; (c) there are no significant differences between the number of Ss in Group I (3-7 to 4-5), Group II (4-7 to 5-6), and Group III (5-9 to 6-9) who correctly respond to all items on the conservation of number pretest and posttests; and (d) there are no significant differences between conservation of number scores on Posttest I and Posttest II.

The subjects (Ss) were 72 children whose ages ranged from three years seven months (3-7) to six years nine months (6-9). All Ss were from families considered to be in the middle-class socioeconomic level. The distribution of Ss by sex was 37 males and 35 females. Subjects were matched by age and scores on the Peabody Picture Vocabulary Test (PPVT). They were assigned randomly to experimental and control groups.

A Conservation of Number Task was devised to measure the number conservation ability of young children. The instrument was a modification of Rothenberg's (1969b) test. Since her test measured the ability of five-year-old children, it was necessary to adapt the test for use with children as young as three and one-half years of age. Fewer objects were used in the transformation arrays.

A pilot study, using children in a newly opened day care center on campus, produced the following information: (a) the instrument was appropriate for children as young as 3-7; (b) the materials used in the testing and instruction sessions (checkers, blocks, plastic animals, small wooden blocks, plastic cups and saucers from a child's tea set, plastic chairs from a doll house, and small wooden-peg children) were satisfactory, (c) a teaching session of 15 minutes seemed feasible; and (d) two teaching sessions were sufficient.

The procedure involved pretests for all Ss, two sessions of instruction in concepts of number conservation for the experimental group, and two posttests for all Ss. Posttest I was administered the day following the last teaching session and Posttest II followed one week later. The teaching sessions were adapted from the Rothenberg and Orost (1969) study. Only two of Rothenberg and Orost's three sessions were used; the third session, which involved older children assisting in the teaching sessions, was deleted as not practicable with Ss as young as 3-7.

The experimental design was a pretest-posttest control group design. The results were analyzed statistically by the analysis of covariance and chi-square tests.

An analysis of the results indicated that two sessions of instruction in number conservation concepts were not effective in increasing Ss' scores on the Conservation of Number Tasks. No difference was found between Conservation of Number Task scores of boys and the scores of girls.

There was a significant difference between the number of Ss in Age-Groups I, II, and III who made perfect scores on the Conservation of Number Tasks pretest and posttest I. As was expected, the number of Ss who made perfect scores increased from youngest Ss to oldest Ss. An unexpected finding was a decrease in scores on Posttest II as compared to scores on Posttest I.

The validity of the measuring instrument was examined as a source of non-significant results; this supposition, however, was rejected. The number of instruction sessions was discussed; however, the question of the most feasible number of instruction sessions remained a moot one.

Essentially, results and observations were in agreement with Piaget's theory. The behavior of the children appeared to correspond to behavior described as representative of the preconceptual and intuitive stages. The Ss in the youngest age group (3-7 to 4-5) appeared to rely on their perceptions to solve the transformation problems. The Ss in the oldest age-group (5-9 to 6-9) generally were not certain of conservation without counting. The results supported Piaget's concept of number conservation in that instruction was not effective in increasing the scores on the Conservation of Number Tasks.

Implications for Further Research

1. The possibility of using different but comparable number conservation tasks for different age-levels needs to be investigated. For example, greater number of objects in transformation arrays could be utilized with older children and fewer objects with younger children.

2. The feasibility of using different but comparable pre- and posttests deserves consideration. The use of different transformations and different materials in conservation of number pretests and all consequent posttests may alievate Ss' loss of interest and decreased motivation on posttests.

3. An investigation of the effects of instruction in number conservation over a period of months would be of interest. A comparison of treatment and no treatment with intact preschool classes would be possible.

4. The video-taping of testing sessions should be most profitable. This procedure would make possible the

study of facial expressions, verbalizations, and counting behavior of Ss confronted with transformation problems.

5. A study of differences in number conservation ability of children involved in structured preschool programs with children not involved in such programs would be of interest.

BIBLIOGRAPHY

Anderson, D. E. & Flax, M. L. A comparison of the Peabody Picture Vocabulary Test with the Weschsler Intelligence Scale for Children. Journal of Education Research, 1968, 62, 114-116.

Baker, N. E., & Sullivan, E. V. The influence of some task variables and of socioeconomic class on the manifestation of conservation of number. Journal of Genetic Psychology, 1970, 116, 21-30.

Baldwin, A. L. Theories of child development. New York: Wiley, 1967.

Beilin, H. Cognitive capacities of young children: A replication. Science, 1968, 62, 920-921.

Bever, T. G., Mehler, J., & Epstein, J. What children do in spite of what they know. Science, 1968, 162, 921-924.

Bloom, B. Stability and change in human characteristics. New York: Wiley, 1964.

Braine, M. C., & Shanks, B. L. The development of conservation of size. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 227-242.

Brison, D. W. Acceleration of conservation of substance. Journal of Genetic Psychology, 1966, 109, 311-322.

Bruner, J. The process of education. Cambridge, Mass.: Harvard University Press, 1960.

Bruner, J. S. Studies in cognitive growth. New York: Wiley, 1966.

Buros, O. K. The sixth mental measurement yearbook. Highland Park, N. J.: Gryphen Press, 1965.

Campbell, D. T., & Stanley, J. C. Experimental and quasi-experimental designs for research. Chicago: Rand-McNally, 1963.

Deal, T. N. & Wood, P. L. Testing the early educational and psychological development of children--ages 3-6. Review of Educational Research, 1968, 38, 12-18.

Dodwell, P. C. Children's understanding of number and related concepts. Canadian Journal of Psychology, 1960, 14, 191-205.

Elkind, D. Children's discovery of the conservation of mass, weight, and volume: Piaget Replication Study II. Journal of Genetic Psychology, 1961, 98, 219-227.

Elkind D. Discrimination, seriation, and numberation of size and dimensional differences in young children. Piaget Replication Study VI. Journal of Genetic Psychology, 1964, 104, 275-296.

Feigenbaum, K. D. Task complexity and IQ as variables in Piaget's problem of conservation. Child Development, 1963, 34, 423-432.

Flavell, J. H. The developmental psychology of Jean Piaget. New York: Van Nostrand, 1963.

Fleischmann, B., Gilmore, S., & Ginsburg, H. The strength of non-conservation. Journal of Experimental Child Psychology, 1966, 4, 353-368.

Furth, H. G. Piaget and knowledge. Englewood Cliffs, N. J.: Prentice-Hall, 1969.

Gelman, R. Conservation acquisition: A problem of learning to attend to relevant attributes. Journal of Experimental Child Psychology, 1969, 7, 167-187.

Goldschmid, M. L. Different types of conservation and non-conservation and their relation to age, sex, IQ, MA, and vocabulary. Child Development, 1967, 38, 1220-1246.

Griffiths, J. A., Shantz, C. A., & Sigel, I. E. A methodological problem in conservation studies: The use of relational terms. Child Development, 1967, 38, 841-848.

Gruen, G. E. Experiences affecting the development of number conservation in children. Child Development, 1965, 36, 963-979.

Hall, V. C. & Kingsley, R. Conservation and equilibration theory. Journal of Genetic Psychology, 1968, 113, 195-213.

Hunt, J. McV. The psychological basis for using pre-school education as an antidote for cultural deprivation. Merrill Palmer Quarterly, 1964, 10, 209-248.

Inhelder, B., Bonet, M., Sinclair, H., & Smock, C. C. On cognitive development. American Psychologist, 1966, 21, 160-165.

Kohlberg, L. Early education: A cognitive-developmental view. Child Development, 1968, 39, 1013-1062.

Mehler, J. & Bever, T. G. Cognitive capacity of very young children. Science, 1967, 158, 141-142.

Mermelstein, E. & Meyer, E. Conservation training techniques and their effects on different populations. Child Development, 1969, 40, 453-470.

Mermelstein, E. & Shulman, L. S. Lack of formal schooling and the acquisition of conservation. Child Development, 1969, 40, 471-490.

O'Connor, G., Shotwell, A. M., Gabet, Y., & Dingman, H. F. Relation of the Peabody Picture Vocabulary Test IQ to the Stanford-Binet IQ. American Journal of Mental Deficiency, 1969, 74, 39-42.

Piaget, J. The psychology of intelligence. London: Routledge & Kegan Paul, 1950.

Piaget, J. The child's conception of number. New York: Humanities Press, 1952.

Piaget, J. Six psychological studies. New York: Random House, 1967.

Piaget, J. Quantification, conservation, and nativism. Science, 1968, 162, 976-979.

Piaget, J. & Inhelder, B. Mental imagery in the child. New York: Basic Books, 1971.

Ray, W. S. An introduction to experimental design. New York: Macmillan, 1960.

Rothenberg, B. B. Conservation of number among four- and five-year-old children: Some methodological considerations. Child Development, 1969a, 40, 383-406.

Rothenberg, B. B. Material accompanying Conservation of number among four and five year old children: Some methodological considerations. ASIS National Auxiliary Publications Service, c/o CCM Information Sciences, Inc., 22 West 34th Street, New York, N.Y., 10001, 1969b. Document No. 00277.

Rothenberg, B. B. & Courtney, R. G. Conservation of number in very young children: A replication of and comparison with Mehler & Bever's study. Journal of Psychology, 1968, 70, 205-212.

Rothenburg, B. B. & Courtney, R. G. Conservation of number in very young children. Developmental Psychology, 1969a, 5, 493-502.

Rothenberg, B. B. & Courtney, R. G. A developmental study of nonconservation choices in young children. Merrill-Palmer Quarterly, 1969b, 15, 363-373.

Rothenberg, B. B. & Orost, J. H. The training of conservation of number in young children. Child Development, 1969a, 40, 707-726.

Rothenberg, B. B. & Orost, J. H. Material accompanying the training of conservation of number in young children. ASIS National Auxiliary Publications Service, c/o CCM Information Sciences, Inc. 22 West 34Th Street, New York, N.Y. 10001. 1969b. NAPS Document 00376.

Siegel, L. S. & Goldstein, A. G. Conservation of number in young children: Recency versus relational response strategies. Developmental Psychology, 1969, 1, 128-130.

Sigel, I. E. Reflections. In I. E. Sigel & F. H. Hooper (Eds.), Logical thinking in children. New York: Holt, Rinehart & Winston, 1968. Pp. 503-528.

Sigel, I. E., Saltz, E. E. & Roskind, W. Variables determining concept conservation in children. Journal of Experimental Psychology, 1967, 74, 471-475.

Smedslund, J. Patterns of experience and the acquisition of conservation of length. Scandinavian Journal of Psychology, 1963, 4, 257-264.

Sonstroem, A. McK. On the conservation of solids. In J. S. Bruner, R. R. Oliver, P. M. Greenwald (Eds.), Studies in cognitive growth. New York: Wiley, 1966.

Tuddenham, R. D. Piaget and the world of the child. American Psychologist, 1966, 21, 207-217.

Uzgiris, I. E. Situational generality of conservation. Child Development, 1964, 35, 831-841.

Walker, H. M. & Lev, J. *Statistical inference*. New York: Holt, Rinehart & Winston, 1953.

Wallach, L, Wall, A. J., & Anderson, L. Number conservation: The roles of reversibility, addition-subtraction, and misleading perceptual cues. *Child Development*, 1967, *38*, 425-442.

Wohlwill, J. F. Absolute versus relational discrimination on the dimension of number. *Journal of Genetic Psychology*, 1960, *96*, 353-363.

APPENDIX A

CONSERVATION OF NUMBER TEST ADAPTED FROM ROTHENBERG (1969b)

General Instructions

1. The yellow side of the board is always toward E, the blue side toward S.
2. Part I is entirely for instructional purposes so E may help child learn "yellow," "blue," and "row." Part II is assessment and instruction is not given.
3. Places for five objects at 3 inch intervals are marked on the yellow side of the board.
4. Establish rapport with child before beginning session. Instruct child as follows: "Hello, (child's name), we are going to play a number game. The rules for the game are on these white cards and I will read the rules for us. I will keep score on this sheet (indicate sheet). Let's begin."
5. Statements which E makes in administering the tasks were typed in capital letters and directions for E were typed in lower case letters. Instructions were typed on 5" x 8" index cards.

Part I. Introduction

1. Side (yellow vs. blue)

   Place the board with the yellow side toward the interviewer.

   I'LL PUT SOME CHECKERS ON THE YELLOW SIDE.

   Put 4 checkers on the yellow side.

   NOW I'LL PUT SOME CHECKERS ON THE BLUE SIDE.

   Put 4 checkers on the blue side.

NOW POINT TO THE BLUE SIDE.

Assist if necessary.

POINT TO THE YELLOW SIDE.

Assist.

NOW TAKE THE CHECKERS OFF THE BLUE SIDE. Assist.

NOW TAKE THE CHECKERS OFF THE YELLOW SIDE. Assist

2. Row

NOW I'LL PUT A ROW OF CHECKERS ON THE YELLOW SIDE.

Put 5 checkers on as follows:

```
S:  ________________________
E:  0    0    0    0    0
```

THIS IS ONE BIG ROW. Make a gesture that covers all 5 objects.

THIS IS ALL ONE ROW. SHOW ME THE ROW.

Encourage child to include all the objects in his designation of row.

NOW I'LL MAKE A ROW ON THE BLUE SIDE.

Use 5 more checkers to produce:

```
S:  0    0    0    0    0
    ________________________
E:  0    0    0    0    0
```

THIS IS ALL ONE ROW. Point to objects on blue side.

NOW YOU SHOW ME THE ROW ON THE BLUE SIDE.

Make sure he realizes the row contains all the objects on the blue side; if he does not understand, try to convey this in any way you can during this initial demonstration.

Part II. Tasks

1. <u>Row Duplication--Fives</u>

Clear the board.

NOW WATCH WHAT I DO WITH THE CHECKERS. Make a row of 5 checkers on the yellow side using the marked 3-inch intervals.

NOW YOU MAKE A ROW ON THE BLUE SIDE (draw line with finger) JUST LIKE THIS ONE (point to constructed row).

a. If S's row does not have 5 checkers, clear table and begin again. This time, after <u>each</u> placing of a checker say:

NOW YOU PUT A CHECKER ON THE BLUE SIDE, ACROSS FROM THIS ONE.

Help S if necessary.

If S's row has 5 checkers incorrectly placed, reposition them and go on to next E-statement.

If S's row has 5 blocks correctly placed, go on to next E-statement.

DOES THIS ROW (on blue side) HAVE THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow)?

If <u>yes</u>: THIS ROW (on blue) HAS THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow). Then go on to 2.

If <u>no</u>, or if there is no clear response, use procedure 1b.

b. Clear the table, and begin again. After each checker say:

NOW YOU PUT A CHECKER ON THE BLUE SIDE, ACROSS FROM THIS ONE.

Help S if necessay.

The first time S places a matching checker, say:

NOW THIS ROW (on blue) HAS THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow).

As each subsequent pair is placed, say:

NOW THEY ARE STILL THE SAME.

2. Equal Subtraction

THIS ROW (on blue) HAS THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow). NOW WATCH WHAT I DO.

Remove one checker from each row, as indicated:

S:	0 ↗	0	0	0	0
E:	0 ↘	0	0	0	0

DOES THIS ROW (on blue) HAVE THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow)?

Whether yes or no, go on:

DOES ONE ROW HAVE MORE CHECKERS THAN THE OTHER ROW?

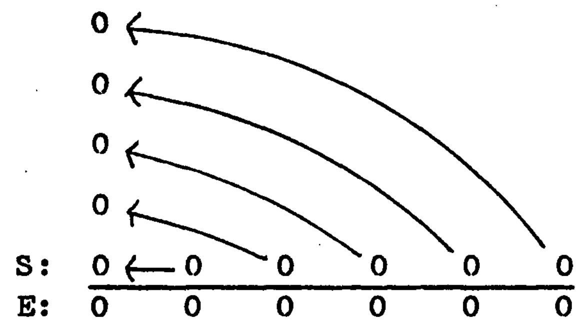
3. Row--Rotation

Restore the formation:

S:	0	0	0	0	0
E:	0	0	0	0	0

THIS ROW (on blue) HAS THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow). NOW WATCH WHAT I DO.

Rotate checkers as indicated:



DOES THIS ROW (on blue) HAVE THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow)?

DOES ONE ROW HAVE MORE CHECKERS THAN THE OTHER ROW?

4. <u>Row--Equal Addition</u>

Remove all checkers and reposition as follows:

S: 0 0 0 0
E: 0 0 0 0

THIS ROW (on blue) HAS THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow). NOW WATCH WHAT I DO.

Take one checker in each hand and add simultaneously as indicated: S: 0 0 0 0 0
0 0 0 0 0

DOES THIS ROW (on blue) HAVE THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow)?

DOES ONE ROW HAVE MORE CHECKERS THAN THE OTHER ROW?

5. <u>Row--Expansion</u>

Remove all checkers and reposition checkers as follows:

S: 0 0 0 0 0
E: 0 0 0 0 0

THIS ROW (on blue) HAS THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow). NOW WATCH WHAT I DO.

Using both hands, slide the two end checkers 3 inches out and then slide the two checkers on either side of the middle checker to positions halfway between middle checkers and end checkers, as indicated in the following diagram:

```
S:            0    0    0    0    0
   ____________________________________
E: 0          0         0         0          0
```

DOES THIS ROW (on blue) HAVE THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow)?

DOES ONE ROW HAVE MORE CHECKERS THAN THE OTHER ROW?

6. Row--Collapsing:

Let S-row checkers remain in position.

Remove E-row blocks, and restore formation:

```
S: 0    0    0    0    0
   ______________________
E: 0    0    0    0    0
```

THIS ROW (on blue) HAS THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow). NOW WATCH WHAT I DO.

Push checkers in E-row together using one hand at each end of the row.

```
S:   0    0    0    0    0
     ______________________
 --> 0    0    0    0    0 <--
```

DOES THIS ROW (on blue) HAVE THE SAME NUMBER OF CHECKERS AS THIS ROW (on yellow)?

DOES ONE ROW HAVE MORE CHECKERS THAN THE OTHER ROW?

APPENDIX B

CONSERVATION OF NUMBER TASK SCORE SHEET

CONSERVATION TASK

Date____________________ Pretest ___ Group I Score_____

Name____________________ Posttest I ___ II

School____________________ Posttest II___ III

		Part	E's Question	S's Answer					Remarks
I.	1.	Side (yellow vs. blue		OK	?	DK			
	2.	Row		OK	?	DK			
	3.	Row Duplication		S: __________					
				E: 0	0	0	0	0	
II.	1.	Equal Subtraction	Same number?	yes	no	DK	other		
			More?	yes	no	DK	other		
	2.	Rotation	Same number	yes	no	DK	other		
			More?	yes	no	DK	other		
	3.	Equal Addition	Same number?	yes	no	DK	other		
			More?	yes	no	DK	other		
	4.	Expansion	Same number?	yes	no	DK	other		
			More?	yes	no	DK	other		
	5.	Collapsing	Same number?	yes	no	DK	other		
			More?	yes	no	DK	other		

APPENDIX C

TEACHING SESSIONS ADAPTED FROM ROTHENBERG AND OROST (1969b)

General Instructions

The yellow side of the board is always toward E, the blue side toward S. Statements which E makes were typed in capital letters and directions for E were typed in lower case letters. Instructions were typed on 5" x 8" index cards. Abbreviations for toys used in teaching sessions are as follows:

c	cup	Dg	dog
S	saucer	Pg	pig
C	child	Ch	chicken
ch	chair	Ro	rooster

Teaching Session 1

1. Counting (blocks)

   a. HOW OLD ARE YOU, (name)?

      If child holds up fingers, encourage him to count his fingers. If he says 3, 4, 5, ask:

   DO YOU KNOW HOW TO COUNT? CAN YOU COUNT FOR ME?

      If child has some trouble, practice with him for awhile, bearing in mind he may only be able to get as far as 1, 2, 3 in any competent fashion. Try to get him to count carefully to 10. For the capable child, listen to his counting up to about 20, or until he begins to stumble. He may need to be cut off with some complimentary comment.

b. Put out a row of blocks on blue side of board = 2.

COUNT THESE AND TELL ME HOW MANY THERE ARE.

Put out a second row of blocks on yellow side of board = 3.

COUNT THESE AND TELL ME HOW MANY THERE ARE.

Make sure he starts counting with the number 1 again.

c. NOW, IF I PUT ANOTHER BLOCK WITH THIS ROW (add 1 block to the row that has 2) BOTH ROWS WILL HAVE THE SAME NUMBER.

LET'S COUNT THEM AND SEE IF THAT'S RIGHT.

Get him to count each row separately.

YES, THEY BOTH HAVE THE SAME NUMBER OF 3. THREE (point to one pile) IS THE SAME NUMBER AS ___ (point to other pile and let child say 3).

SO THEY BOTH HAVE THE SAME NUMBER OF ___ (let child say 3).

NOW IF I PUT 1 MORE BLOCK IN EACH ROW, CAN YOU TELL ME HOW MANY BLOCKS ARE IN EACH ROW?

He may have to count each row separately. Line them up if necessary to facilitate counting. Make sure he finds out by himself or from you that the rows have the same number of 4.

Skip 1. d, e, f, g for children who count well.

d. <u>One-to-one correspondence</u> (for children who have difficulty counting)

Put out a row of 4 cups and another row of 4 saucers. Have child identify them.

LET'S SEE IF THERE ARE ENOUGH SAUCERS FOR THESE CUPS. YOU PUT EACH CUP ON A SAUCER. GOOD. YOU SEE, EACH CUP HAS ONE SAUCER. ARE THERE ANY CUPS LEFT OVER WITHOUT A SAUCER? ARE THERE ANY SAUCERS LEFT OVER WITHOUT A CUP? SO IF EVERY CUP HAS A SAUCER AND THERE ARE NONE LEFT OVER, THEN WE COULD SAY THAT THEY BOTH HAVE THE SAME NUMBER.

Leaving pairs together ask:

ARE THERE THE SAME NUMBER OF CUPS AS THERE ARE SAUCERS?

HOW CAN YOU TELL?

Encourage child to state that every cup has a saucer and there are none left over.

e. Row

Set up toys as follows:

S:	c	c	c	c
E:	S	S	S	S

SHOW ME THE ROW ON THE YELLOW SIDE, THE WHOLE ROW.

ARE THERE THE SAME NUMBER OF CUPS AS SAUCERS?

HOW CAN WE FIND OUT?

Encourage child to associate pairs without actually putting one <u>on</u> the other, e.g. this one goes with that one, etc. and there are none left over.

f. Set up children and chairs as follows:

S:	C	C	C	C
E:	ch	ch	ch	ch

LET'S SEE IF THESE ROWS (indicate each) HAVE THE SAME NUMBER. LET'S PUT A CHILD JUST ACROSS FROM EACH CHAIR. (help child if necessary)

DOES EVERY CHILD HAVE A CHAIR?

ARE THERE ANY CHILDREN OR CHAIRS LEFT OVER?

SO, DOES THIS ROW (point) HAVE THE SAME NUMBER OF TOYS AS THIS ROW (point)?

HOW CAN YOU TELL?

Help child to state that every child has a chair and every chair has a child and there are no toys left over.

g. Set up toys as follows:

S:	C	C		C
E:	ch	ch	ch	ch

LET'S SEE IF THESE TWO ROWS BOTH HAVE THE SAME NUMBER OF TOYS.

Help child to match up pairs, child with chair.

ARE THERE ANY LEFT OVER? YES, ONE CHAIR IS LEFT OVER, SO THIS ROW (point) AND THAT ROW (point) DO NOT HAVE THE SAME NUMBER.

DO THIS ROW AND THAT ROW HAVE THE SAME NUMBER?

If child says yes, redo matching and repeat conclusions.

If no,

NOW, IF THERE IS A CHAIR LEFT OVER ON THIS SIDE (point), IT MEANS THAT THIS SIDE HAS MORE.

Repeat and/or regroup if necessary until child can reach these conclusions.

2. Task concepts

a. yellow-blue board

Using the empty yellow-blue board, say:

POINT TO THE YELLOW SIDE OF THIS (designate whole board).

NOW POINT TO THE BLUE SIDE.

If child has trouble, redo Part I. 1. of the pretest.

b. Row (toys)

Help child to identify each as it is presented. Set up toys as follows:

S:	Dg	Pg	Ch	Ro
E:	Dg	Pg	Ch	Ro

SHOW ME THE ROW ON THE BLUE SIDE. SHOW ME THE WHOLE ROW.

NOW SHOW ME THE ROW ON THE YELLOW SIDE, THE WHOLE ROW.

If child has trouble, redo Part I. 2. of the pretest.

DOES THIS ROW HAVE THE SAME NUMBER AS THIS ROW?

HOW CAN YOU TELL?

Assist child to state that he can tell by counting.

3. Same/More (Candy-Checkers)

a. LET'S PRETEND THAT THESE RED CHECKERS ARE CANDIES. ONE DAY I CAME TO SCHOOL WITH SOME CANDIES AND I GAVE SOME TO YOU (put 2 candies in front of child) AND SOME TO (name of child's classmate--put 4 on yellow side of board). LET'S FIND OUT IF YOU AND (name) BOTH HAVE THE SAME NUMBER OF CANDIES.

DO YOU BOTH HAVE THE SAME NUMBER?

WHO HAS MORE CANDIES?

Correct S if necessary. Explain 4 is more than 2.

b. NOW I'M GOING TO PICK UP SOME CANDIES FROM (name's) ROW, THE ONE WITH MORE IN IT. YOU TELL ME WHEN (name's) ROW AND YOUR ROW BOTH HAVE THE SAME NUMBER IN IT.

Take 1 away.

NOW DO THEY HAVE THE SAME NUMBER?

Always allow child to correct a wrong answer by counting and E interpreting what the two numbers mean.

Take a second away.

NOW DO THEY HAVE THE SAME NUMBER?

Help child to recognize that both rows have same number.

Take 1 more away from friend's row.

NOW DO YOU BOTH HAVE THE SAME NUMBER OF CANDIES?

WHO HAS MORE?

Help child recognize that the row of 2 > the row of 1.

c. Leaving the rows of two and of one, say:

NOW YOU USE THESE CANDIES TO MAKE THE TWO ROWS HAVE THE SAME NUMBER OF CANDIES.

Allow child to work with as many of the remaining 3 candies as he wants to. Help if necessary, using matching or counting.

NOW DO YOU AND (name) BOTH HAVE THE SAME NUMBER?

HOW DO YOU KNOW?

Encourage child to count rows or to match and repeat conclusions verbally.

d. Remove 6 and put 8 checkers together in a heap and say:

USE AS MANY OF THESE AS YOU LIKE TO MAKE TWO ROWS (indicate yellow & blue sides of board) THAT EACH HAVE THE SAME NUMBER OF CANDIES.

When he is finished, say:

HOW CAN WE TELL IF THESE TWO ROWS REALLY HAVE THE SAME NUMBER?

Encourage child to count or match and verbalize conclusion. If he discovers that they are not equal, ask which row has more and how can we change the rows so they both have the same number.

4. Addition/Subtraction

a. Remove one checker from yellow side clearly within the child's view.

NOW DOES THIS ROW (yellow side) HAVE THE SAME NUMBER AS THIS ROW (blue side)?

If no: DOES ONE ROW HAVE MORE CHECKERS? Assist child to agree.

WHICH ROW?

HOW CAN YOU TELL?

Get him to count or match. If he counts, E should say that there is one left over. Have child repeat this or complete your sentence, and the conclusion:

SO THIS ROW (point) HAS MORE THAN THIS ROW.

If yes: Have child count or match checkers. E should say that 4 is more than 3 or there is one left over. Have child repeat this or complete your sentence. Then ask:

DOES ONE ROW HAVE MORE?

WHICH ROW?

HOW CAN YOU TELL?

b. Replace the checker back in its row.

DOES THIS ROW (point) HAVE THE SAME NUMBER OF CHECKERS AS THIS ROW (point)?

HOW CAN YOU TELL?

If necessary get him to count or match again--4 is the same number as 4. Have child repeat "same number" section or complete your sentence, concluding that they both have the same number. Whenever S needs to count 2 rows, it will help him remember if E repeats each total as he counts, and if necessary, repeats both totals when he is finished.

IF BOTH ROWS HAVE THE SAME NUMBER, CAN ONE ROW HAVE MORE THAN THE OTHER?

Assist child to disagree here showing him that 4 is the same number as 4 or that the two sets match and repeat question if his first reply was incorrect. If necessary say:

DO YOU HAVE MORE CHECKERS THAN (classmate's name)?

DOES (name) HAVE MORE CHECKERS THAN YOU?

NO, YOU BOTH HAVE THE SAME NUMBER, SO NOBODY HAS MORE.

Repeat as required.

c. Add a checker to row on yellow side.

DOES THIS ROW (point) HAVE THE SAME NUMBER OF CHECKERS AS THIS ROW (point)?

If no: DOES ONE ROW HAVE MORE? Assist child to agree.

WHICH ROW HAS MORE CHECKERS?

HOW CAN YOU TELL?

Get him to count or match again. E should tell that 5 is more than 4 or there is one left over. Have child repeat this or complete your sentence.

If yes: HOW CAN WE FIND OUT IF THEY BOTH HAVE THE SAME NUMBER?

Have child count or match--E should tell that 5 is more than 4 or there is one left over. Then repeat questions.

d. Take 5th checker away from row and ask:

DOES THIS ROW (point) HAVE THE SAME NUMBER OF CHECKERS AS THIS ROW (point)?

If Yes: DOES ONE ROW HAVE MORE CHECKERS?

Assist child to disagree here showing him that 4 is the same number as 4.

HOW CAN YOU TELL?

Have child repeat "same number" section of 3. c. or complete your sentence.

Session 1 should end here for those who needed one-to-one correspondence sections 1. d., e., f., and g.

5. More (number) vs. Longer (more length)

a. Remove E-row toys and set up:

S:	Dg	Ch	Ro		Pg
E:		Dg	Ch	Ro	

LET'S SEE IF THESE ROWS (designate each) HAVE THE SAME NUMBER. YOU COUNT THEM (assist if necessary).

YES, THERE ARE 4 TOYS IN THIS ROW AND 3 TOYS IN THIS ROW, SO THIS ROW (designate) HAS MORE TOYS THAN THIS ROW.

Get child to repeat conclusion that S has more than E because 4 is more than 3.

NOW WHICH ROW IS LONGER, MORE STRETCHED OUT (motion with both hands), THIS ONE (point) OR THIS ONE?

Reinforce answer with:

YES (or BUT) YOU SEE THIS ROW STICKS OUT FARTHER THIS WAY AND THAT WAY SO IT IS LONGER. Repeat question if child answered wrong.

b. Remove toys and set up as follows:

```
S:    Dg  Pg  Ch  Ro
E:  Dg      Pg          Ro
```

LET'S SEE IF THESE ROWS (designate each) HAVE THE SAME NUMBER. YOU COUNT THEM. Assist if necessary.

YES, THERE ARE 4 TOYS IN THIS ROW, AND 3 TOYS IN THIS ROW, SO THIS ROW (designate) HAS MORE TOYS THAN THIS ROW.

Be sure child can tell that S has more than E because 4 is more than 3 before proceeding.

NOW WHICH ROW IS LONGER? THIS ONE (point) OR THIS ONE?

If child is wrong: NO, YOU SEE THIS ROW STICKS OUT FARTHER THIS WAY AND THAT WAY, SO IT IS LONGER.

THIS ROW (point to yellow) IS LONGER, BUT THIS ROW (point to blue side) HAS MORE TOYS.

Teaching Session 2

Children who were counting well in Session 1 begin here.

Children using correspondence begin on 2.

1. a.

CAN YOU COUNT TO 10 AGAIN FOR ME?

Put 7 blocks on the table in a heap and say:

COUNT THESE AND TELL ME HOW MANY THESE ARE.

Take all the blocks off the table and put 9 on in a heap.

COUNT THESE AND TELL ME HOW MANY THERE ARE.

b.

NOW WE'LL MAKE IT A LITTLE HARDER. I'LL MAKE TWO ROWS AND LET'S FIND OUT WHICH ROW HAS MORE BLOCKS.

Place a row of 9 blocks on yellow and of 6 blocks on blue side.

COUNT THEM AND TELL ME WHICH ROW HAS MORE BLOCKS IN IT? THIS ONE (point) OR THIS ONE (point)?

Repeat each total as child reaches it and if necessary remind him of both totals to help him reach a decision. Explain how 9 is <u>more</u> than 6.

c.

NOW I'M GOING TO PICK UP SOME BLOCKS FROM THIS ROW, THE ONE WITH MORE IN IT. YOU TELL ME WHEN THIS ROW AND THIS ROW HAVE THE SAME NUMBER IN IT.

Take 1 away.

NOW DO THEY HAVE THE SAME NUMBER?

Always allow child to correct a wrong answer by counting and E interpreting what the two numbers mean.

Take a second away.

NOW DO THEY HAVE THE SAME NUMBER?

Take a third away.

NOW DO THEY HAVE THE SAME NUMBER? HOW CAN YOU TELL THAT THEY BOTH HAVE THE SAME NUMBER?

Take a fourth away. Ask as before.

Help children to know that the row of 6 $>$ row of 5.

d. Put 18 blocks together in a heap.

NOW YOU MAKE TWO ROWS THAT HAVE THE <u>SAME</u> NUMBER OF BLOCKS.

Allow child to work with as many of the 18 as he wants to.

DO THESE ROWS BOTH HAVE THE SAME NUMBER?

HOW CAN YOU TELL?

If child shows good counting skill on preceding, omit 2 and proceed to 3.

Begin here for child using 1:1 correspondence. Continue here for weak counters.

2. <u>One:One Correspondence</u>

a. Set up toys as follows:

S:	Dg	Pg	Ch
E:	Dg	Pg	Ch

HOW CAN YOU TELL IF THESE ROWS (point) HAVE THE SAME NUMBER OF TOYS?

Encourage child to tell you that he counted or that he matched.

If necessary, say:

THIS DOG GOES WITH THIS DOG, THIS PIG GOES WITH THIS PIG, AND THIS CHICKEN GOES WITH THIS CHICKEN.

DO BOTH ROWS HAVE THE SAME NUMBER?

E repeats the reason.

b. Set up toys as follows:

S:	Dg		Pg		Ch		Ro
E:			Dg	Pg	Ch	Ro	

If child has been using 1:1 correspondence, go to 2. c. If child has been counting, say:

NOW LET'S TRY ANOTHER WAY TO SEE IF THIS ROW (point) HAS THE SAME NUMBER OF TOYS AS THIS ROW. LET'S PRETEND THAT YOU DON'T KNOW HOW TO COUNT. LET'S PUT THESE TWO TOYS JUST ACROSS FROM EACH OTHER.

Put Dog on E's side across from Dog on S's side

NOW YOU PUT THE REST OF THE TOYS ACROSS FROM THE ONE JUST LIKE IT AND WE'LL SEE IF THERE ARE ANY TOYS LEFT OVER.

Assist where necessary.

SO NOW WE KNOW ANOTHER WAY TO SEE IF TWO ROWS HAVE THE SAME NUMBER OF TOYS.

DOES THIS ROW HAVE THE SAME NUMBER OF TOYS AS THIS ROW?

c. For child using 1:1 correspondence:

LET'S SEE IF THESE ROWS HAVE THE SAME NUMBER.

PUT THE TOYS THAT ARE ALIKE ACROSS FROM EACH OTHER.

IS EVERY TOY ON THIS SIDE (point) ACROSS FROM A TOY ON THIS SIDE (point)?

ARE THERE ANY LEFT OVER?

DOES THIS ROW HAVE THE SAME NUMBER OF TOYS AS THIS ROW?

3. <u>More (number) vs. Longer (more length</u>)

a. Remove E-row toys and set up as follows:

S: Dg Pg Ch Ro
   Dg Pg Ro

LET'S SEE IF THESE ROWS HAVE THE SAME NUMBER

Assist child in matching if necessary but do not let him reposition them.

YES, THERE IS ONE <u>LEFT OVER</u> ON THIS SIDE (point), SO THIS ROW HAS <u>MORE</u> TOYS.

WHICH ROW HAS MORE TOYS?

HOW DO YOU KNOW?

Be sure child can tell you that the side with <u>one left over has more</u>.

NOW WHICH ROW IS <u>LONGER</u>, MORE STRETCHED OUT (motion with hands), THIS ONE (point) OR THIS ONE?

Reinforce answer with:

YES (or BUT) YOU SEE THIS ROW <u>STICKS OUT FATHER</u> THIS WAY AND THAT WAY, SO IT IS LONGER. Repeat question if child answers incorrectly.

b. Remove E toys and set up as follows:

E: Pg Dg Ch Ro
   Pg Dg Ro

LET'S SEE IF THESE ROWS (designate each) HAVE THE SAME NUMBER.

Assist child in matching if necessary, but maintain position of toys.

YES, THERE IS ONE LEFT OVER ON THIS SIDE (point) SO THIS ROW HAS MORE TOYS. HOW CAN YOU TELL?

Be sure child can tell you that S has more than E because there is <u>one left over</u>.

NOW WHICH ROW IS LONGER? THIS ONE (point) OR THIS ONE.

If child is wrong: NO, YOU SEE THIS ROW STICKS OUT FARTHER THIS WAY AND THAT WAY, SO IT IS LONGER.

Get child to repeat where appropriate.

BUT THIS ROW (point to blue) HAS <u>MORE</u> TOYS.

4. <u>Small Aggregates</u>

a. Set up blocks as follows:

```
S:  0    0    0
    ____________
E:  0    0    0
```

DOES THIS ROW (on blue) HAVE THE SAME NUMBER AS THIS ROW (on yellow)?

DOES ONE ROW HAVE MORE BLOCKS?

HOW CAN YOU TELL?

NOW WATCH WHAT I DO.

Expand E-row as follows:

```
S:       0      0      0
    _________________________
E:  0          0            0
```

DOES THIS ROW (on blue) STILL HAVE THE SAME NUMBER AS THIS ROW (yellow)? REMEMBER, YOU CAN COUNT OR PUT THEM ACROSS FROM EACH OTHER TO FIND OUT.

Help the child give a correct answer with the techniques he has been shown. Reposition blocks if necessary before concluding:

YES, THERE ARE 3 IN THIS ROW AND 3 IN THIS ROW (or EVERY ONE IN THIS ROW IS ACROSS FROM ONE IN THIS ROW AND THERE ARE NONE LEFT OVER). THIS ROW HAS THE SAME NUMBER OF BLOCKS AS THIS ROW. BUT WHICH ROW LOOKS LONGER?

If he answers correctly:

YES, BUT DOES IT HAVE ANY MORE BLOCKS THAN THIS ROW?

b. Set up checkers as follows:

```
S: 0    0    0    0
   ----------------
E: 0    0    0    0
```

DOES THIS ROW (on blue) HAVE THE SAME NUMBER AS THIS ROW (on yellow)?

DOES ONE ROW HAVE MORE CHECKERS?

HOW DO YOU KNOW?

NOW WATCH WHAT I DO.

Add 1 checker to E-row and reposition as follows:

```
S: 0     0     0     0
   -------------------
      0  0  0  0  0
```

LET'S SEE IF THESE ROWS (designate each row) HAVE THE SAME NUMBER.

If child needs help, remind him that he can count or he can put the toys across from each other. After he figures out with or without your help, that one side has 5 and more or that E has one left over, say:

FIVE IS MORE THAN 4 (or THERE IS ONE LEFT OVER ON THIS SIDE). THIS ROW OF 5 (designate) HAS MORE TOYS THAN THIS ROW WITH 4.

Get child to repeat conclusion.

NOW WHICH ROW IS LONGER? THIS ONE (point) OR THIS ROW?

If child is wrong:

NO, YOU SEE THIS ROW STICKS OUT FARTHER THIS WAY AND THAT WAY, SO IT IS LONGER.

Get child to repeat appropriate conclusions.

BUT WHICH ROW HAS MORE CHECKERS?

Repeat and revise as necessary to help child reach appropriate conclusion.

c. Clear table.

NOW THIS TIME YOU CAN HAVE AS MANY OF THESE BLOCKS AS YOU WANT TO MAKE TWO ROWS, ONE ON THIS SIDE (yellow) AND ONE ON THIS SIDE THAT HAVE THE SAME NUMBER.

Assist child when necessary.

NOW CAN WE FIND OUT IF BOTH ROWS HAVE THE SAME NUMBER?

Review and reinforce.

d. Clear table, leaving same 9 blocks as in 4b and c to one side of child.

NOW MAKE TWO ROWS, ONE ON THIS SIDE (yellow) AND ONE ON THIS SIDE THAT DO NOT HAVE THE SAME NUMBER.

HOW CAN WE TELL THAT THEY DO NOT HAVE THE SAME NUMBER?

WHICH ROW HAS MORE BLOCKS?

NOW CAN WE PUSH ONE ROW TOGETHER OR SPREAD ONE OUT SO THAT THIS SIDE LOOKS JUST AS LONG AS THIS SIDE?

Encourage him to match end points of the two rows so that they look the same.

THIS ROW LOOKS JUST AS LONG AS THIS ROW, DOESN'T IT?

BUT WHICH ROW HAS MORE CHECKERS?

APPENDIX D

RAW SCORE DATA

Control Condition

Code No.	Age in Months	Sex	PPVT Score	Pretest Score	Posttest I Score	Posttest II Score
			Group I			
37	44	F	38	4	6	6
38	47	F	45	8	0	0
39	47	M	55	2	2	2
40	47	F	44	2	4	0
41	47	F	46	6	8	6
42	48	M	61	8	16	16
43	49	M	50	4	12	0
44	50	M	55	2	2	0
45	51	M	50	4	0	4
46	52	M	60	4	8	10
47	53	M	59	8	8	10
			Group II			
48	55	F	49	10	16	16
49	55	M	59	16	16	16
50	58	M	57	8	8	12
51	59	M	62	14	16	16
52	59	M	52	2	12	16
53	61	F	59	6	8	8
54	62	M	63	8	14	16
55	62	M	52	14	10	6
56	63	F	66	16	16	16
57	63	F	58	16	16	16
58	64	F	62	8	6	6
59	64	M	69	6	6	8
60	65	F	63	16	16	16
			Group III			
61	70	M	66	16	16	16
62	70	M	64	16	16	16
63	72	M	75	16	16	16
64	72	F	66	16	16	16
65	72	F	62	16	16	16
66	73	M	67	16	16	16
67	74	F	53	16	16	16
68	75	F	65	14	16	16
69	78	F	74	14	16	16
70	78	F	69	16	16	16
71	80	M	70	16	16	16
72	81	M	63	14	16	16

Experimental Condition

Code No.	Age in Months	Sex	PPVT Score	Pretest Score	Posttest I Score	Posttest II Score
				Group I		
1	43	M	53	6	8	8
2	44	F	46	6	6	4
3	44	F	40	2	4	2
4	44	M	40	0	0	0
5	45	M	51	10	4	10
6	48	F	55	10	10	10
7	48	M	57	16	10	12
8	50	F	43	2	6	8
9	50	F	54	2	4	6
10	52	F	51	14	8	14
11	53	F	55	4	8	6
				Group II		
12	55	M	55	16	16	16
13	55	F	50	12	4	14
14	55	F	55	12	16	16
15	58	M	62	6	10	10
16	58	M	64	8	10	2
17	59	M	51	2	0	4
18	59	F	52	0	4	16
19	60	M	97	16	16	16
20	60	F	62	14	16	16
21	63	F	61	14	14	8
22	64	F	60	16	16	16
23	64	M	62	16	16	16
24	65	M	61	12	16	16
				Group III		
25	69	F	63	14	16	16
26	71	M	66	14	16	14
27	72	F	66	16	16	16
28	73	F	62	16	14	16
29	74	M	51	10	10	10
30	74	F	60	6	14	16
31	75	F	61	12	16	16
32	76	M	63	14	16	16
33	77	M	68	16	16	16
34	77	M	73	16	16	16
35	78	F	66	10	10	8
36	81	M	63	16	16	16