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LOGICAL OPERATIONS AND CONCEPTS OF CONSERVATION IN CHILDREN, A TRAINING STUDY. FINAL REPORT.

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DESCRIPTORS- *KINDERGARTEN CHILDREN, *CONCEPT TEACHING, *LEARNING PROCESSES, *CONCEPT FORMATION, *TRAINING TECHNIQUES, COGNITIVE PROCESSES, ABSTRACT REASONING, LEARNING THEORIES, INTELLECTUAL DEVELOPMENT, COMPARATIVE TESTING, DISCRIMINATION LEARNING, CLASSIFICATION, CONSERVATION (CONCEPT),

PIAGET HAS BEEN CONCERNED WITH THE ASSESSMENT OF THE PRESENCE OR ABSENCE OF CONSERVATION AND RELATED PROCESSES, BUT HE HAS NOT FOCUSED EXPERIMENTALLY ON THE FACTORS WHICH CAN ACCOUNT FOR THE LEARNING OF CONSERVATION. TO INVESTIGATE SUCH FACTORS, RESEARCH WAS CONDUCTED (1) TO DETERMINE THE RELATIVE EFFECTIVENESS OF TWO PARTICULAR GROUP TRAINING PROCEDURES DESIGNED TO INDUCE CONSERVATION AND (2) TO ASSESS THE RELATIONSHIP BETWEEN CONSERVATION AND THE LOGICAL OPERATIONS OF CLASSIFICATION, SERIATION, AND REVERSIBILITY. AFTER PRETESTING WITH CONSERVATION TASKS, 36 KINDERGARTEN CHILDREN WERE SELECTED AS SUBJECTS BECAUSE THEY WERE ABLE TO CORRECTLY USE THE COMPARATIVE TERMS "MORE," "SAME," AND "LESS" BUT UNABLE TO CONSERVE QUANTITY, NUMBER, AND AREA. ADDITIONAL PRETESTING WITH LOGICAL OPERATIONS TASKS WAS ADMINISTERED TO THE SUBJECTS WHO WERE THEN EQUALLY DISTRIBUTED AMONG SIX TRAINING GROUPS. FOUR GROUPS RECEIVED TRAINING IN LABELING AND CLASSIFICATION SKILLS. DISCRIMINATION-MEMORY TRAINING WAS PROVIDED FOR TWO GROUPS. EACH GROUP HAD NINE 20-MINUTE TRAINING SESSIONS, AND ALL SUBJECTS WERE SUBSEQUENTLY RETESTED WITH BOTH THE CONSERVATION AND THE LOGICAL OPERATIONS TASKS TO DETERMINE IF CONSERVATION LEARNING HAD TAKEN PLACE. BASED ON ANALYSIS OF THE DATA, IT IS CONCLUDED THAT (1) BOTH TRAINING METHODS WERE SUCCESSFUL IN INDUCING CONSERVATION, (2) NEITHER METHOD WAS SIGNIFICANTLY MORE EFFECTIVE, AND (3) ONLY LIMITED RELATIONSHIPS WERE FOUND BETWEEN CONSERVATION AND LOGICAL OPERATIONS. DETAILED RESULTS, SUBSIDIARY FINDINGS, EDUCATIONAL IMPLICATIONS, AND SUGGESTIONS FOR FURTHER RESEARCH ARE INCLUDED IN THE TEXT OF THE PROJECT REPORT. FIVE APPENDIXES CONTAIN (1) TEST FORMATS AND PROTOCOLS, (2) DESCRIPTIONS OF TRAINING PROCEDURES, AND (3) RAW STATISTICAL DATA. (JS)

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A TRAINING STUDY

JUNE 1967

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

OFFICE OF EDUCATION
BUREAU OF RESEARCH

Logical Operations and Concepts of Conservation in Children

A Training Study

Project No. 6-8463
Grant No. OEG-3-6-068463-1645

Carolyn Uhlinger Shantz
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Problem

Over the past forty years, Piaget has evolved a theory of intellectual development from his extensive studies of children's problem-solving. Basically, the theory proposes that children's thought processes increasingly conform to logical operations which are organized into structures similar to those used by logicians and mathematicians in symbolic logic and mathematical concepts.

The practical application of a theory of logic to education was dramatically illustrated in recent years by the changes in mathematical and science curricula toward set theory. Piaget's theory is likewise a set theory in which "sets" may be classes rather than numbers, and subject to the same operations, such as addition and multiplication. Just as the new set curriculum stresses general operations instead of specific arithmetic skills, so too does Piaget's theory emphasize operations having general application (to number, time, space, etc.) which provide the bases for later, more complex concepts.

One concept, conservation, appears to have particularly important and general consequences for the young child. Conservation requires that the child come to the logically necessary conclusion that a criterial property such as number of objects remains unchanged even though there is obvious change in some related property, such as the length of line of objects or the area they cover. That is, as long as nothing has been added or taken away, the number of objects is maintained or conserved. Alternatively, such a concept may be viewed as the child's increasing ability to differentiate reality and appearance, or the ability to differentiate relevant from irrelevant attributes. Conservation concepts may apply not only to physical aspects of objects such as weight, quantity and volume, but to social roles as well (as, for example, the child's awareness that a father who studies and becomes a doctor conserves his role as father (Kooistra, 1963). Such acquisition would seem also to foster in the growing child an increasing trust in his own reasoning as opposed to his perceptions.

Given the generality and importance of conservation concepts, the educational questions immediately arise: Can conservation concepts be taught in the typical school situation? If so, by what type of training and by what type of method are they most efficiently taught?

Theory

Piaget's experimental study of conservation has dealt almost entirely with the assessment of states, i.e., the presence or absence of conservation and related processes. He has not focused experimentally on transitions between states, i.e., factors which can account for the learning of conservation. Piaget's method of assessment of conservation and his theoretical position on conservation will be reviewed first, followed by an analysis from a non-Piagetian point of view.

Quantity conservation will serve as an illustration of Piaget's experimental format. The child is presented with two clay balls which he agrees are of equal amounts. The experimenter then transforms one of the balls into some other shape, such as a hotdog, and poses the question, "Do these two objects have the same amount of clay or does one have more clay?" The child who asserts difference in amount is scored a nonconserver; the child who asserts equality and can justify his response is scored a conserver. There are three justifications which are usually considered adequate: (1) nothing has been added or taken away; (2) what was lost in height was gained in length (compensation); (3) the object has only been reshaped and can be returned to its original shape (simple reversibility).

Piaget has done extensive post hoc analyses of children's verbal justifications to ferret out underlying concepts and thought processes, i.e., logical operations. Such analyses led to identification of multiplication of classes and relations, reversibility, and atomistic concepts as occuring in conservation responses. Piaget made the somewhat hazardous interpretation that the apparent correlation between certain operations and conservation made it highly probable that the operations were necessary (if not necessary and sufficient) for conservation concepts. At no time did Piaget assess the presence or absence of these operations by independent methods to use as predictors of conservation performance.

As noted previously, Piaget has not investigated the learning of conservation responses. However, on the basis of the complex operations and structures (groupings) apparently underlying conservation, he proposes that conservation is a rather arduous attainment resulting from the child's repeated, active, long-term interactions with objects. Only indirect support for this view is available. Several studies, besides Piaget's research, indicate a lack of generality during the middle years in conservation concepts, e.g., usually six years intervene between the child's initial quantity conservation and later volume conservation. In summary, Piaget would hold that brief, didactic instruction can not establish stable conservation concepts in children, particularly methods providing some verbal rule of conservation. It would seem that training procedures which would be most consistent with Piaget's view would be those which attempt to induce or active related, if not "requisite", operations from which conservation would then emerge.

Conceptual analyses of conservation and studies of conservation have come almost entirely from <u>within</u> the Piagetian position. However, there has been a recent analysis of conservation from an S-R point of view (Watson, in press) which emphasizes psychological factors usually ignored from the Piagetian point of view. Watson analyzed the typical conservation experiment as composed of three temporal phases: (1) the initial stimulus situation in which two static stimuli are presented and equality established; (2) the transformation of one stimulus; (3) the presentation of two perceptually different static stimuli.

He notes the crucial position that the second phase, the transformation, holds in eliciting the criterial response "the same amount of clay." The act of transforming serves as the discriminative stimulus for the correct response. That is, the child must (1) discriminate a conserving transformation (reshaping) from a nonconserving transformation (adding or removing material), and (2) remember the transformation when phase 3 occurs.

What is unique about the second phase, the transformation, in Watson's view is that it is a time-distributed stimulus. The act begins, occurs, and ends in a perceptual difference between two objects; the act, itself, can only be carried forward in memory. Therefore, failure at conserving may have little to do with the lack of requisite logical structures; it may be, more simply, a case of insufficient information (based on inadequate discrimination and/or memory). Watson also notes that the child's response that "nothing has been added or taken away" could be interpreted as a mere description of the discriminative stimulus, not a logical, explanatory response.

Consequently, Watson suggests that training for conservation focus on promoting the child's capacity to discriminate and to remember transformational acts. For example, training would focus on a particular sequence of stimuli such that the correct response is learned to series of stimuli rather than to any "single" stimulus. In summary, this alternative viewpoint would suggest that training center upon attentional skills, discrimination of serial events, and memory for serial events rather than centering, as the Piagetian view holds, on logical operations such as reversibility, addition-subtraction schemata, multiplicative operations, etc.

Related research

The review of research will be limited primarily to conservation concepts usually attained by children from 5-7 years of age, i.e., quantity, number, length, and area. Two types of studies are reviewed: those dealing with the training of conservation, and those focusing on the relationship between certain logical operations and conservation.

Conservation studies vary widely in what concepts are trained (e.g., reversibility, rules, addition -subtraction concepts), and the method used (verbal vs. nonverbal, reinforced vs. nonreinforced, etc.). There are three primary types of training studies: (1) informal practice with materials used in testing conservation; (2) linguistic facilitation; and (3) logical operations training.

Although informal practice appears to be somewhat successful in inducing conservation (Churchill, 1958; Harker, 1960; Metcalf, 1965), the specification of the significant factor(s) in training is impossible, and thus these studies will not be reviewed.

There are a number of studies which appeared in the early 1960's which focused either on linguistic or operational training (e.g., Smedslund, 1961a, 1961b; Wohlwill & Lowe, 1962). After a thorough review of these studies, Flavell (1963) stated that most of the training methods "have had remarkably little success in producing cognitive change" (p. 377). However, in the past four years there have been several studies that report more success in eliciting conservation of various types. Prior to reviewing specific studies, the major positions of various investigators require some introduction.

There are two major investigators who have found various types of linguistic instruction or facilitation of value. Beilin (1965) found that of several types of training, verbal rule instruction was the only type of training which elicited significantly more post-training conservation that a control group. It is important to note, however, that the instruction dealt with the relevance of addition and subtraction of material, reversibility, and the irrelevance of the length of line to the number of objects: "Whenever we start with a length like this one and we don't add any sticks on it or take away any sticks, but only move it, it stays the same length even though it looks different. See, I can put them back the way they were, so they haven't really changed" (p. 326). Bruner and his colleagues (1966), on the other hand, attempted to induce the child's own symbolic-linguistic representation of conservation by screening the perceptual distortion that occurs in transformation, or, alternatively to force attention on the transformation itself by removing the perceptual illusion.

In contrast to these types of training, Smedslund (1961b) attempted to induce what he calls "cognitive conflict" between the child's use of perceptual cues and the addition/subtraction operation. Thus, if the child thought changing the shape increased the amount of clay, Smedslund coupled this transformation with removing some clay. Reversibility was the focus of training on number conservation by Wallach and Sprott (1964). Two rows of objects (dolls and doll beds) were varied in length and, on half the trials, objects removed or added so that row lengths were equal, and then the question posed, "Do you think we can put a doll in every bed now?" S was given feedback by trying to put a doll in every bed. It should be noted that the posttest question was quite similar to the training question, i.e., "Now are there the same number of dolls as beds?"

The Smedslund and Wallach and Sprott training methods are very specific to the conservation concept itself. In contrast, a third position also focuses on logical operations (Sigel, Roeper & Hooper, 1966) which are quite general and only theoretically related to conservation. Training is centered on multiplication of classes, multiplication of relations and reversibility, operations which Piaget has cited as requisites for conservation. In brief, small groups of Ss were presented with real objects whose various attributes were labeled, and classes formed on the basis of similar attributes (all red and round things, all fruit, etc.) On the basis of other empirical data (Sigel & Hooper, in preparation), a second study (Shantz & Sigel, in preparation) focused upon classification training alone. It is the authors' view that the positive results may be due to any one factor or a combination of factors such as learning classification rules, training in analyzing the multi-dimensionality of objects, and linguistic activation via labeling and small-group discussion.

There are several rather recent studies which have tested some of these positions and, with one exception, have resulted in some success in eliciting various conservations. Table 1 presents a brief summary of these studies (see pages 8 - 9). There appear to be a variety of factors which result in conservation, but for every successful study there are others testing the same type of training which report no significant transfer-of-training. Thus reversibility training was found to be highly successful by Wallach & Sprott, but unsuccessful by Sonstroem. Cognitive conflict induced little change in the Mermelstein and Beilin studies, but was successful when coupled with verbal pre-training in Gruen's study. Inducement of verbalization through screening procedures was not effective in either Sonstroem's study or Mermelstein's. Beilin found verbal rule instruction of significant merit whereas Mermelstein did not. Likewise, Mermelstein found Sigel's classification training ineffective whereas Sigel et al found it effective.

It should be noted that the criterion of conservation has varied among these studies. Gruen (1966) has noted two fundamentally different criteria: the response "the same" used as the only criterion for scoring S as a conserver (Bruner, 1964, e.g.), in contrast to requiring a logical justification as well as the response, "the same" (e.g., Piaget, 1952; Sigel, 1966; Smedslund, 1961a). (See footnotes of Table 1).

The second area of research to be reviewed is that dealing with the relationship between logical operations and conservation. Until recently such relationships were supported only by post hoc logical analyses of verbal responses in the conservation task (Piaget, 1952). Studies which have independently assessed operations and conservation generally show rather low order relationships. Smedslund (1964) found that multiplication of classes and conservation of quantity tasks were either both passed or both failed by 57% of Ss, age 5 to 7. Multiplication of classes and length conservation were either both passed or both failed by 75% of Ss. Multiplication of relations task and quantity and length conservation tasks were either both passed or both failed by 55% and 69% of Ss, respectively. In general, Ss who had "mixed" patterns tended to fail operational tasks and pass conservation tasks. This would suggest, contrary to Piaget's view, that operational skills emerge following acquisition of conservation rather than preceding acquisition. Sigel & Hooper (in preparation) also assessed multiplicative skills and conservation. They found that of all the relationships, multiplication of classes related most consistently with conservation in elementary school children (multiplication of classes and discontinuous substance conservation $r_{pbis} = +.30$, and with weight conservation $r_{pbis} = +.36$).

There is one methodological problem in virtually all conservation studies cited that deals with the concepts of "same," "more," and "less." The great majority of investigators have duplicated Piaget's method of verbal inquiry in which the child is asked, after object transformation, whether the objects have the "same" amount (number, weight, etc.) or if one has "more." The child's response, "the same," is criterial whether one employs the Bruner or Piaget-Smedslund criteria. Typically, the child's understanding of the terms "same" and "more" have not been assessed prior to conservation testing. To neglect such assessment means that a S who fails to conserve may not understand the terms, may not be able to conserve, or both. Tests by Beilin (1965) and by Griffiths, Shantz & Sigel (in press) indicate that for 4 and 5 year olds children, "same" is a significantly more difficult response than "more" and "less" when comparing the number, weight, or length of objects. It is of interest that when Gruen (1965) gave verbal pretraining on "more" and "longer" he found that "verbal pretraining alone was about as effective as either direct training or cognitive conflict in the inducement of number conservation." (p. 977). Such findings suggest that to minimize confounding of linguistic skills and conceptual (conservation) abilities, Ss either be pretested on relational terms or be trained to criterion prior to testing conservation.

Objectives

The present study has three primary aims. (1) This study will partially replicate former studies by Sigel et al (1966) as to the effectiveness of multiple labeling and classification training in inducing conservation. Whereas the former research dealt with a small sample of gifted children, the present study will assess the the training procedures with a larger sample of more intellectually average children. (2) The first empirical test of the effectiveness of discrimination-memory training, as proposed by Watson (in press), for eliciting conservation will be provided. This will afford a comparison of the relative effectiveness of the two types of training. (3) There will be an assessment of the relationship between logical operations (classification, seriation, and reversibility) and conservation (quantity, number, and area). On the basis of former research the following hypotheses will be tested:

(a) Labeling-classification training elicits significantly more conservers than discrimination-memory training. (Conservers are defined as Ss who pass at least one type of conservation problem, i.e., quantity, number, or area.)

(b) Labeling-classification training elicits significantly improved performance on the logical operations tasks.

(c) There are significant positive relationships between each logical operation skill and conservation performance, irrespective of training conditions.

Table 1

Summary of Recent Conservation Training Studies

Author(s)	Sample	Type of Conservation	Types of Training	Number of Groups	Training Sessions	Results
Wallach & Sprott, 1964	N=30 Mean CA= 6, 11	Number *	Reversibility vs. Control	N=1 C N=1 E	N=1 (included pre- & posttests & training) Individual training	All Es conserved number in at least 1 of 2 test items; no Cs did. Delayed posttest: 13 of 15 Es conserved in 3 tests; 1 of 15 Cs conserved.
Beilin, 1965	N=170 Median CA=5, 4; CA range= 6,5 to 7,8	Number & Length (Area generalization task)***	Nonverbal reinforcement Verbal reinf. Verbal rule Equilibration	N=1 C N=4 E	N=4 (Each 40 minutes; individual training	Verbal Rule instruction was only E Group which performed significantly better than C group (**Criteria) No transfer-of-training to Area conservation task
Gruen, 1965	N=90 Mean CA= 5, 1; CA Range=4½ to 6,4	Number** (Length & Substance generalization tasks)	Verbal Pretrained vs. No pretrained groups divided into: Direct Training; Conflict Training; Control Group	N=2 C N=4 E	N=2 (16 training trials per session); 12 pre-training trials	46% of total Ss gave 1 or more number conservation Rs posttest Verbal pretraining + conflict training group significantly better than C group with no pre-training Verbal pre-training alone about as effective as direct or conflict training
Sonstroem, 1966	N=81 Median CA= 7 years	Quantity* (continuous)	Compensation (labeling) vs. Reversibility (no labeling) Screening vs. no screening Ss manipulate materials vs. no handling	N=0 C N=8 E	N=1 (included pre- & posttests, & training) Individual	Conserved: N=35; No conservation: N=46. Three variables as <u>main</u> effects did not induce conservation Compensation + manipulation combined elicited significantly more conservation than any other training combination groups.

Table 1 (cont.)

Author(s)	Sample	Type of Conservation	Types of Training	Number of Groups	Training Sessions	Results
Sigel, Roeper & Hooper, 1966 (two studies combined)	N=13 CA Range= 4,2 to 5,0 Mean IQ= 147	Quantity** Weight Volume	Combined classification, seriation & reversibility vs. Control group	N=1 C N=1 E	N=9 (25 minutes each); Groups of 3 to 5 Ss	Of 10 Es, 9 conserved 1 or more types Of 8 Cs, 1 conserved 1 or more types
Sigel & Shantz, in preparation	N=30 Mean CA= 4, 10 CA range= 4,4 to 5,4	Quantity** Weight Area	Combined labeling & classification vs. Control group	N=1 E N=1 E	N=9 (25 minutes each); Groups of 5 Ss	Significant gains of Es vs. Cs in quantity and weight conservation; Of 15 Es, 5 conserved 1 or more types; of 15 Cs, none conserved any type.
Mermelstein, 1967	N =120 CA range= 5 to 6,2	Quantity** (continuous & discontinuous)	Cognitive Conflict Multiple classification Verbal Rule Language activation	N=2 C N=4 E	Mean N=7 (10 minutes each) Groups of 20 Ss (?)	No significant training effects for any E group compared to C groups No significant differences between E groups

*Conservation criterion: judgment of equality ("the same).
**Conservation criteria: judgment of equality and adequate justification.
***Both types of criteria used for various analyses.

Method

Subjects. Of the original sample pool of 71 Ss, 39 qualified on two tasks (to be described later) to serve as Ss. One S moved and two were excluded on a random basis to form a study sample of 36 Ss, i.e., 6 groups of 6 Ss each. The ages ranged from 5 years, 4 months to 5 years, 10 months. The 21 girls and 15 boys were drawn from three kindergarten classes in one suburban Detroit school, serving middle-class families primarily.

Primary pretest materials. The materials were designed to determine whether Ss could correctly label relations between objects with the words, "same," "more," and "less." Three-dimensional, familiar objects were employed for each of the types of conservation concepts tested in this study, i.e., continuous quantity, number, and area. For each type of content, a standard object and three comparison objects were used: one object was an upward comparison ("more"), another was a downward comparison ("less"), and one was the same as the standard ("same"). Continuous quantity tasks were presented by small vials of pink liquid, the standard being one-half filled and the upward and downward comparisons being 2/3 and 1/3 filled, respectively. Number comparisons were represented by pencils of equal length glued on 6 x 8¼" posterboard: the standard was three pencils, and the "more" and "less" sets had four and two pencils, respectively. For comparisons of area, red Lego blocks were combined to form the following sizes of squares glued on 5 x 5 posterboard: standard, 2½ x 2½"; upward comparisons 3 1/8" per side; downward comparisons, 1 7/8" per side.

Since previous research (Griffiths, Shantz, & Sigel, in press) indicated that the order of types of content did not significantly influence performance, the tasks were administered in one standard order: quantity, number, and area. The three types of comparisons were counterbalanced across content areas such that "more" comparison, for example, was presented first in one content, as the second comparison in another content, and as the last comparison in the remaining content type. The test protocol is presented in Appendix A.

Conservation test materials. The following materials were employed in assessing conservation of quantity, number, and area in both pretest and posttest phases of the study.

Quantity conservation. The format and materials are similar to those used by Piaget (1952) in his original study of quantity conservation. Two clay balls about the size of an egg were used, one ball representing the standard, and the other transformed into the following shapes: Trial 1, cup or nest shape; Trial 2, pancake shape; Trial 3, hotdog shape. In order not to recreate apparent "equality" before S, a new set of clay balls were used for each trial.

Number conservation. A method was adapted from Wohlwill and Lowe (1962) to assess number conservation. Standard blue and yellow poker chips, 12 of each, were presented in two rows horizontally in front of S with one row of color above the other. The following transformations were used: Trial 1, compressed blue line leaving one (apparently extra) yellow chip at each end of the yellow row; Trial 2, free scramble of yellow chips over a large area of the table; Trial 3, extension of blue row resulting in one (apparently extra) blue chip at each end.

Area conservation. This concept was assessed in a manner similar to that used by Piaget et al (1960). Two green blotters, 8½ x 11", served as "grass" or "fields." A wooden doll representing a "farmer" was placed by each field, and 1 toy sheep placed in the center of each field. Several red plastic "hotels" from the Monopoly game were used as "sheep houses" or "barns."[1] The transformation for all three trials involved the scattering of barns on one field while the barns on the standard field remained in a row along one edge of the field. The conditions for the three trials were as follows: Trial 1, 3 barns per field; Trial 2, 9 barns per field; Trial 3, 6 houses per field.

It should be noted that the sequence of trials for each type of conservation were established with the following strategy in mind: the first trial was thought to present the least illusion of inequality, the second trial to present the most illusion, and the third a moderate illusion. All Ss were administered the first two trials, thus insuring that every S was presented the apparently most difficult transformation. This more stringent test of conservation was employed because of Piaget's findings that some "transitional" conservers could only conserve with minimal illusion, only to fail with strong illusions (1960). (See Appendix A for test protocols.)

Logical Operations test materials. The following tests were developed and used to assess Ss ability to perform multiple classification, multiple seriation, and reversibility in pretest and posttest phases of the study. Illustrations of all tests are presented in Appendix B.

Multiple classification. The task requires that S fill in one empty cell of a four-cell matrix (i.e., a 2 x 2 matrix) with a picture that includes both subclass attributes relevant to the matrix. For example, in a color (green-yellow) and size (big-little) matrix, a large yellow clock, a small yellow clock, and a large green clock were presented in a matrix; the correct picture for completion would be a small green clock. S selected a clock from four choices: 2 clocks were duplicates of cells adjacent to the empty cell, 1 clock had irrelevant attributes, and 1 clock was correct. A total of four matrices were constructed from the following combinations of dimensions: color-size, orientation-emptiness, color-number, and border-size. The definitions of each dimension are presented in Table 1. The position of the correct choice was randomized across matrix choice sheets.

[1]Appreciation is expressed to Parker Bros. Company for supplying this material.

Table 1

Definitions of Dimensions on Classification and Seriation Tasks

Dimensions	Symbol	Classification	Seriation
Color	C	Yellow vs. Green Red vs. Green	Four values: light green to dark green light red to dark red
Size	S	Big vs. little	Four values: Big to little
Orientation	O	Up vs. tilted	Four values: 0° (up) 45° (upward tilt) 135° (downward tilt) 180° (upside down)
Number	N	2 vs. 3	1, 2, 3, 4
Border	B	Entirely bordered vs. no border	¼ bordered ½ bordered 3/4 bordered totally bordered
Emptiness	E	Full vs. ¼ full	Full 3/4 full ½ full ¼ full

The four matrices and choice sheets were presented by E in a notebook one at a time in the following order: color-size matrix (clocks) served as a practice task to insure S's understanding of the requirements of the task; orientation-emptiness (pitchers); number-color (apples); and size-border (trees). The first three items were presented to all Ss, the fourth task presented only if S had passed either the second or third task.

Multiple seriation. The task requires that S fill in one empty cell on astrip of four cells with a picture that includes both values of two continuous dimensions from which the strip is constructed. For example, aseries of leaves were presented with the top leaf being large and light green, and the following leaves decreasing in size and increasing in darkness ending in a small dark leaf. S selects a leaf from four choices: one leaf is a duplicate leaf adjacent to the empty cell in the strip, one is correct on both values, and two leaves have only one correct value (i.e., correct on size and incorrect on shade, or the reverse). The position of choices was randomized across strip choice sheets.

A total of four strips were constructed from the same combination of dimensions as the classification matrices. The dimensions for the strips were continuous, however (such as shades of green) as compared to discontinuous in the matrices (color represented by green vs. yellow). The definitions of the continuous dimensions and values are presented in Table 1.

The four strips and choice sheets were presented by E is a separate notebook one at a time in the following order: color-size (leaves) as the practice item; orientation-emptiness (bottles); number-color (tulips); and size-border (houses). As with the matrices, the first three items were presented to all Ss, the fourth being used only when S passed either item 2 or 3.

Reversibility. The reversibility task was devised from an adaptation of Braine's method (1959). The task requires S to insert a missing picture in a series of pictures which were reversed horizontally from a standard series. For example, a series of colored 2 x 2" squares from S's left to right were red, blue, yellow, brown, and green (standard series). E then presented a series from S's left to right of green, yellow, blue and red equally spaced. S inserted the brown square between the yellow and green to be correct.

Four series were presented in the following sequence: colors (practice task); fruit; geometric shapes; and animals. The first three items were administered to all Ss, the fourth being used when S passed only one item (either test 2 or 3).

Training session materials. The materials used in the labeling-classification (LC) training and the discrimination-memory (DM) training are detailed in Appendix C. Briefly, the LC materials were three-dimensional, familiar objects in the general categories of clothing, musical instruments, fasteners, containers, and washing things, as well as a few miscellaneous items.

For the DM training, a large variety of materials were used such as block of five different shapes; pictures from standard school workbooks concerning a family scene, arbitrary collections of familiar objects (pictures); strips of objects in which one was slightly different from the others; pictures illustrating a simple story if correctly arranged in sequence, such as a boy getting a haircut, a girl buying shoes, etc. For one session, about six objects used in LC training were presented in DM training, the particular objects randomly chosen by each Trainer.

Procedure

The procedures related to the general experimental design of the study will be presented first, followed by procedures relating to specific tests. To remain in the study, Ss were required to pass the primary pretest and fail the conservation pretests. In the first case, Ss were required to pass 7 of the total 9 trials indicating their ability to label correctly the comparisons of "more," "same," and "less" with objects that varied in quantity, number, or area. The sample attrition resulting from this selection criterion is presented in Table 2.

Table 2

Sample Description

Sequence of Study Phases	N
Total Ss in three classrooms	73
1 S moved	
1 S with severe speech problem	- 2
Original sample pool	71
Failed primary pretest	- 25
Passed primary pretest[a]	46
Ss excluded	
1 S moved	
1 S uncooperative	- 2
Conservation pretesting	44
Passed conservation pretest	- 5
Failed conservation pretest[b]	39
S excluded: 1 S moved	- 1
Operations pretesting	38
Ss excluded: 2 Ss randomly excluded to form 6 training groups of 6 Ss each	- 2
	36
Training and posttesting	36

[a]To remain in study, S must pass primary pretest.

[b]To remain in study, S must fail conservation pretest.

The second selection criterion was each S's failing all conservation tasks. Failure was defined generally as inadequate response to two of three trials in each of the three types of conservation tasks.

If S met these two criteria, he was administered the three operations tasks. Ss were then assigned randomly to one of six groups with three restrictions on randomization being the following. The groups were matched as closely as possible on mean number of correct tasks on operations since, theoretically, operational ability should relate to conservation ability. Thus, each group was heterogeneous in operation ability, i.e., 2 Ss performed well, in terms of the total sample, on operational tasks; 2 Ss performed about average and 2 Ss performed poorly. The matching of groups on mean operational performance is detailed in Table 3. The second restriction was primarily a practical one: the 6 Ss in each group were members of the same classroom except for one group which had members from two classrooms. The third involved having boys and girls in each group.

Table 3

Operations Pretest Performance of Each Training Group

		Number of Correct Trials on Pretests			
Group	Type of Training	Classification	Seriation	Reversibility	Total
I	Labeling-Classification[a]	6	11	8	25
II	Discrimination-Memory[a]	5	7	8	20
III	Labeling-Classification[b]	3	7	9	19
IV	Labeling-Classification[a]	5	7	8	20
V	Labeling-Classification[b]	3	10	10	23
VI	Discrimination-Memory[b]	5	8	9	22

[a]Trainer: IS
[b]Trainer: CS

Following training sessions, the 36 Ss were re-tested on operations and conservations with the same materials, format, and task sequence as each received in pretesting.

Primary pretest. Prior to the primary pretest, both Es spent several days visiting classes and talking informally with the children in each classroom. When S was taken out of the class, he was seated opposite E and told that he would be shown some things and E would ask him some questions. The quantity pretest will serve as an illustration of the format and sequence of questions.

E presented the standard, for example, the half-filled vial of liquid to S's left and the comparison object (e.g., 2/3 filled vial) to S's right, and asked, "What can you tell me about these?" Unless S spontaneously used the word "more" in referring to the comparison object, E's next question was posed: (2) "Are they the same or are they different?"; (3) "How are they the same (different)?"; (4) "Is there the same amount of water, more water or less water in this one (E points to comparison object) as in this one (E points to standard)?"; (5) "Point to the one that has more water; point to the one that has less water; do they have the same amount of water?" E's reference in the fourth and fifth questions to "same," "more," and "less" were varied in sequence for the various comparisons. Testing was discontinued when S correctly used the relevant term, except correct answer to (2) required continued testing until S responded correctly to (3), (4), or (5). In cases of ambiguity, E continued the series of questions until E determined that S gave a complete and correct response. The criterion for passing the primary pretest was correct response to 7 or more of the 9 total comparisons. At no time was S given any indication of the correctness of his response. This task was administered by E_1.

The results of the primary pretest are presented in Table 4. For the original sample pool (N=71), the most difficult relational term is "same" and the least difficult, "more," corroborating previous findings (Griffiths, Shantz, & Sigel, in press). Correct use of relational terms occurs most frequently in quantity comparisons, and least frequently in area comparisons. Of the 71 Ss, 25 Ss did not meet the criterion of passing 7 of 9 total comparisons and were excluded from further participation. The distribution of scores for the remaining, non-conserving Ss (N=39) reflect the same trends as found in the total sample, as shown in Table 4.

Table 4

Number of Correct Answers on Primary Pretest

Original Sample: N=71

	Quantity	Number	Area	Total
More	66	66	60	192
Same	48	46	36	130
Less	59	57	51	167
Total	173	169	147	

Study Sample: N=39

	Quantity	Number	Area	Total
More	39	39	38	116
Same	33	30	33	96
Less	37	38	34	108
Total	109	107	105	

Conservation tests. S was seated opposite E and given standard introductory instructions to the conservation tasks, as given on the protocol sheets in Appendix A. For each trial, S was asked whether there was the "same" amount (number, area) or "more." He was asked his reason. All Ss were administered the first two trials and testing was discontinued if S either failed both or passed both trials. If only one item was passed, the third trial was administered. If two trials had been passed, then E administered a "check." For example, E removed a small portion of clay from one ball in S's view and asked the standard question. If S responded that the two balls were unequal in amounts of clay, he passed the check. The primary rationale for administering the check trial was to identify those Ss who might have established a response set, i.e., saying "the same," regardless of what E did to the material even in the case when E removed material. The check also provided information as to S's awareness that addition or subtraction of material was relevant to changing the amount of material. At no time was S informed of the adequacy of any of his responses. All tasks were administered by E2.

The scoring criteria for the verbal responses in the conservation tasks are presented in a later section.

The order of administration of the three conservation tasks were counterbalanced across the 39 Ss who met the two study criteria: one-third of the Ss had the sequence quantity, area, number; one-third had number, quantity, area; and the remaining, area, number, and then quantity. The random exclusion of 2 Ss and moving of 1 S resulted in unequal Ns in the three orders for the study sample of 36 Ss. To assess order effects, it was necessary to exclude at random three additional Ss. The Friedman two-way analysis of variance (N=33) showed no significant order effects (X_r^2 = -0.20).

Operation tasks. The instructions for the classification, seriation, and reversibility tasks are included on the protocol sheets in Appendix A. On the classification and seriation tasks S selected the picture he thought would complete the matrix and strips, respectively. E asked his reason for selecting that picture. Then E selected two other pictures for S to accept or reject as adequate to complete the task. Such "probes" were used in order to identify Ss who may have happened to select the correct answer initially, but thought several other pictures would qualify as correct. If S accepted either of the probes, E asked which of the pictures S thought was the "very best" to complete the task. Although reasons were asked in these two tasks, the scoring was based only on the correct selection. No reasons for response were asked in the reversibility task. All three tasks were administered by E_1.

The criterion for passing classification, seriation, and reversibility was the same in all cases: two of three trials correct. E administered the third trial only in cases where S had not failed items 1 and 2, or passed both items 1 and 2.

The order of administration of the three operations tasks were counterbalanced across the 39 Ss, one-third of the Ss in each of the following orders: reversibility, classification, seriation; classification, seriation, reversibility; seriation, reversibility, classification. To assess possible order effects for the study sample (N=36), it was necessary to randomly exclude three Ss to establish equal Ns in each order condition. The Friedman two-way analysis of variance (N=33) indicated no significant effects of order of administration in pretesting or posttesting (X_r^2= 0.30 and -0.20, respectively), the $p < .20$ level requiring $X_r^2 = 4.67$.

In summary, each S was tested individually in the following sequence of sessions for pre- and posttesting: primary pretest averaged about 15 minutes; conservation testing averaged about 25 minutes; and operations testing averaged about 30 minutes. All pretesting was completed within two months in the fall.

Training sessions. The 36 Ss were divided into 6 groups of 6 Ss each upon completion of pretesting. Four of the groups were randomly assigned as LC groups, and two groups as DM training groups. The two authors served as Trainers, and each randomly assigned two LC groups and one DM group.

Each Trainer had a total of nine sessions with each of his three groups, one session per day, over a three week period. Each session lasted from 20-30 minutes and the entire proceedings were tape recorded. In general, Trainers encouraged as much verbal participation as possible by each child. The manuals for the training sessions are presented in Appendix C. A partial transcript of one session is included in Appendix D.

Among the 36 Ss, 6 were absent for one session only, and 1 S missed two sessions. Neither the Trainers nor the kindergarten teachers informed Ss of any connection between the initial two Es and the two Ts.

Posttesting. Approximately one week after training ended, Ss were posttested first on operations, and then on conservations by the same Es who had administered the tasks in the pretest phase. An effort was made to test Ss in approximately the same random order as they had been pretested. Each S was administered the operations and conservation tasks in the same sequence as in the pretest. The Es were not informed as to which type of group, LC or DM, any S belonged. Posttesting was completed within three weeks.

Conservation scoring criteria. One of the crucial methodological issues in studies of conservation is the definition of a conserving response. In some studies, the S's acknowledgement of "same" after transformation is accepted as prima facie evidence of conservation ability (Bruner, 1964), whereas in other studies, a logical justification is required in addition (Gruen, 1965; Piaget, 1952; Sigel, 1966; Smedslund, 1963). The problems and implications of these two criteria are discussed by Gruen (1966). The major difficulty in accepting "same" as the only criterion for conservation is the identification of what S's referent for sameness is (e.g., the same color of clay, the same clay but not the same amount of clay (Bruner, 1966), etc.). To avoid such uncertainty, each S was required to explain his initial response.

Thus, in the present study, a S was classified as a conserver if on two trials he (1) stated equality, and (2) gave an adequate reason, and, then, (3) passed a final "check" as previously described.

Defining what constitutes an "adequate" explanation is, perhaps, one of the most difficult aspects of scoring and one seldom discussed in detail in the literature. For example, differentiating among those Ss who are merely describing past actions, and those who use past actions as the basis for inferring the logical necessity of equality. The criteria of adequacy of response used in this study followed generally those used by Piaget (1952, 1957) as follows: (1) addition-subtraction schema: Those explanations which involved such statements as "you didn't add any (clay, chips, etc.) and you didn't take any away"; (2) reversible action: References to the possibility of changing the transformed object by the opposite act back to its original state;

and (3) compensation: references to the perceptual dimensions of transformed object(s), e.g., what the clay ball gained in length, it lost in thickness.

A particular problem was noted in area conservation in which a few Ss stated that the areas were the same because the papers ("grass," "fields") were the same size to begin with. It seemed that these Ss were ignoring the crucial factor of the equality of the number of houses on each field. Therefore, E directed their attention in testing to the houses and moving of houses, and asked again the standard question. If S stated that no houses were added or taken away, and/or the houses were only moved around, he was scored a conserver.

The two Ts and E_2 independently scored the verbal responses of all Ss on all trials in the conservation tasks without knowing the identity of any S. The reliability of scoring, represented by the percentage of agreement of the three judges as to adequacy or inadequacy, was as follows: quantity, 86.1%; number, 88.8%; area, 91.6%. Disagreements were resolved in conference.

Results

Effects of Training on Conservation

The first hypothesis posed in this study is that labeling classification training elicits significantly more conservers (in at least one area) than discrimination training. Analysis of the first test results reveals that 70.8% of the LC group conserved in at least one area and 58.1% of the DM group ($X^2 = 0.1406$). The difference is not statistically significant, leading to rejection of the hypothesis. Induction of some conservation responses is possible with either of these types of training.

Table 1 provides the information regarding the percentage of children who pass the conservation tasks. It will be noted that in each training group the percentages of children passing each of the types of conservation are very similar. The differences between the groups for each type of conservation are not significant. Comparisons with X^2 analysis reveals the following: quantity, $X^2 = 0.02$; number, $X^2 = 0.01$; area, $X^2 = 0.02$. It can be concluded that LC or DM training does not differentially influence acquisition of conservation in general, or any one in particular. The ease with which particular conservation tasks are solved is similar for each group. Number is solved by most children, followed by quantity and then area.

Table 1

Percentage of Children Passing Each of the Conservation Tasks for the Two Training Conditions

	Conservation Tasks		
Training Condition	Quantity	Number	Area
Labeling-Classification (LC)	45.8	62.5	20.8
Discrimination-Memory (DM)	50.0	58.3	25.0

Solution to a conservation test does not necessarily indicate generalized conservation ability. The generalization of a conservation response is shown by the frequency with which children pass more than one type of conservation task. In Table 2 are listed the percentages of children solving one, two, and/or three conservation problems. For each training condition, the largest percentage of the group could solve both number and quantity, and a smaller percentage solve all three. It can also be noted that approximately one-fourth of the LC children solved only one type of conservation problem, with approximately a third solving two types. Approximately one-third failed to solve any. For this group there is no evidence for strong generality of conservation skill.

Table 2

Percentage of Children in Each Training Group Passing Conservation Tasks

Type of Conservation	LC Group (N=24)		DM Group (N=12)	
Number only	16.7		8.3	
Quantity only	4.2		0	
Area only	4.2		0	
		25.1		8.3
Number + Quantity	29.2		25.0	
Number + Area	4.2		0	
Quantity + Area	0		0	
		33.4		25.0
Number + Quantity + Area	12.2		25.0	
Failure on all types	29.2		41.7	

A different pattern is apparent in the DM group. Of this group one-fourth conserved two, number and quantity, and another fourth conserved three types. If the children succeeded in the DM group, they tended to solve two or three types.

There is some tendency for the LC group to vary more in the type of conservation problems solved, revealing less generality in comparison to the DM group. The LC group had, however, fewer failures than the DM group (29.2 and 41.7%, respectively).

Conservation of number and quantity were the most frequent pair of problems solved by children in each of the training groups, with only one case out of the total sample solving the number and area.

It is of interest to note that 47.2% of the children (combining the total sample) pass at least two of the conservation tasks after training. That is, each training program facilitated the elicitation of a limited type of generalized response for virtually one-half of the entire sample.

In sum, then LC or DM training did not differ significantly in eliciting conservation responses. Rejection of the hypothesis relative to the superiority of one type of training over another is in order. However, the fact that conservation responses <u>were</u> elicited in each of the groups demonstrates that it is possible to induce conservation among a group of nonconservers who understood the terms "same" or "more," and had some, although varied, competence in each of the three operations. Further, acquisition of conservation in one area does <u>not</u> necessarily predispose solution in other areas.

Effect of Training on Operations

A second hypothesis, that LC training would yield significant improvements in performance on the operations tasks, was tested. Comparisons of the pretest and posttest performances for each of the training conditions is presented in Table 3. Using pass-fail criterion, there is no significant difference between the two training groups in the percentage of Ss improving from pre- to posttesting. The second hypothesis is, therefore, rejected.

Table 3

Percentage of Ss in Each Training Group Passing Each Operations Task

	LC Group (N=24)		DM Group (N=12)	
Type of Operation	Pretest	Posttest	Pretest	Posttest
Classification	16.7	29.1	25.0	41.5
Seriation	66.7	50.0	58.3	58.3
Reversibility	66.7	87.5	58.3	75.0

In general, classification and reversibility skills improved in each training group in contrast to seriation where a decrement (LC) or no change (DM) is evident. Exposure of children to labeling-classification training does not yield any greater success in classification skills than DM training. It is of interest to note that the order of difficulty of operations tasks (posttest) from least to most difficult is the following: reversibility, seriation, classification.

A detailed analysis of the patterns of passes on operations tasks singly or in combination for each of the training groups is presented in Table 4. To provide a background for examining posttest performances, attention will be directed first to the pretest scores. Inspection of Table 4 reveals that 33.4% of the LC group passed only one operation in pretest, and 45.9% passed two. Very few (8.3%) passed all three operations. In sum, 87.5% of LC Ss passed at least one operations task. In contrast, 16% of the DM Ss passed only one operation, half of the Ss passed two operations, and very few (8.3%) passed all three. In sum, 75% of the Ss solved at least one operations task.

Table 4

Percentage of Ss in Each Training Group Passing Various Combinations of Operations Tasks

Type of Operation	LC Group Pretest	LC Group Posttest	DM Group Pretest	DM Group Posttest
Classification only	4.2	4.2	8.3	0
Seriation only	16.7	0	8.3	0
Reversibility only	12.5	33.4	0	33.3
Classification + seriation	0	0	0	16.7
Classification + reversibility	4.2	4.2	8.3	0
Seriation + reversibility	41.7	29.2	41.7	16.7
Classification, seriation + reversibility	8.3	20.9	8.3	25.0
Total failure	12.5	8.3	25.0	8.3

In comparison to the pretest results, posttest performances show the following changes after training: the percentage of LC Ss solving one operation task only or all three operations increases; similar trends are found for the DM Ss. These increases are at the expense of the percentage of Ss solving two operations in each group (Table 4).

In conclusion, the two types of training are not differentially associated with improvement in solution of logical operations problems.

Relationship between Logical Operations and Conservation

A third hypothesis of this study dealt with the relationship between logical operations and conservation irrespective of training conditions. Specifically, it was proposed that positive relationships exist between each operation (seriation, reversibility and classification) and conservation. Phi coefficients were computed for each of the logical operations assessed and the successful performance on at least one conservation task. Analysis of relationship between the logical operations and conservation shows a significant relationship between reversibility and conservation (ϕ =.40 $p < .02$). Classification and seriation did not relate significantly to conservation (ϕ =.09 and .04, respectively). Thus, one logical operation does relate, albeit at a low level, to conservation. The third hypothesis is supported only in the case of reversibility.

To determine the degree of relationship of the operations to specific types of conservation, a more detailed analysis was done. These results, based on the total sample, indicate that relationships vary with the type of conservation. Reversibility is most closely related to conservation of number ($\phi = .34$, $p < .05$), but is not significantly related to quantity or area conservation ($\phi = .22$, $p > .10$, in both cases). Classification is significantly related to area conservation ($\phi = .37$, $p < .05$) but has little relationship to quantity conservation ($\phi = .22$, $p > .10$). Likewise, there is no significant relationship between classification and number ($\phi = .16$). Seriation stands alone among these operations as unrelated to any of the conservations ($\phi = 0$, quantity; $\phi = .16$, number; and $\phi = .10$, area). The relationships of classification and of reversibility to any specific conservation are of a low magnitude, accounting for no more than 14% of the variance in any case.

A further analysis was done of the relationship between operations and conservation problem-solving by examining the pattern of successes on one or more particular operations with a success on one or more conservation tasks. As can be seen in Table 5, no S solved a conservation problem who did not solve an operation problem. However, the reverse does not hold: success on operations does not necessarily predict to conservation. For example, some children who solve all three operations may or may not conserve. Of significance is the fact that the number and type of conservation problems solved does not appear to require the same operations. Children solving all the conservation tasks vary in the number of operations solved. Thus, these data indicate that solution to a particular conservation problem does not predict to a specific operation ability. Similarly for the operations, the particular operation solved does not predict to ability to solve a particular conservation problem.

In effect, the only conclusion is that conservation in general is predictive of some operation skill, but further specification is not possible. The patterns of each of the training groups differ, but the conclusions described above hold for each of these conditions -- success in conservation is always associated with success in at least one operation task. (See Table 5 on following page.)

Table 5

Number of Ss Solving Operations Tasks and Conservation (N=36)

Type of Operation	N	Type of Conservation
Classification only	1	Quantity and Number
Seriation only	0	None
Reversibility only	2	None
	3	Number
	1	Quantity
	1	Area
	4	Quantity and Number
	1	Quantity, Number + Area
Classification + Seriation	1	Number
	1	Quantity and Number
Classification + Reversibility	1	Quantity, Number, + Area
Seriation + Reversibility	3	None
	3	Number
	2	Quantity
	1	Quantity, Number, + Area
Classification, Reversibility, + Seriation	2	None
	2	Quantity and Number
	1	Number and Area
	3	Quantity, Number + Area
Failure on all operations	3	None

Interrelationships of Operations

The independent assessment of three logical operations for each S provides some additional information concerning relations among operations. As noted previously, Piaget et al (1964) have analyzed the ontogenesis of each operation, and propose a close relationship among operations. However, there has been no assessment previously of all three operations in young children.

The frequencies of Ss passing and failing each of the operations in the pre- and posttesting conditions are presented in Table 6. Contingency tables demonstrate the relationship among pairs of operations.

Table 6

Distribution of Ss on Operations for Pre- and Posttesting (N=36)

		Pretest		Posttest		
		Seriation		Seriation		
		Pass	Fail	Pass	Fail	Posttest:
Classification	Pass	4	3	9	2	$\chi^2 = 3.81$
						$\phi = .33$
	Fail	19	10	10	15	$(p < .10)$
		Reversibility		Reversibility		
		Pass	Fail	Pass	Fail	Posttest:
Classification	Pass	5	2	9	2	$\chi^2 = 0.$
	Fail	18	11	22	3	
		Reversibility		Reversibility		
		Pass	Fail	Pass	Fail	Posttest:
Seriation	Pass	17	6	18	1	$\chi^2 = 1.21$
						$\phi = .19$
	Fail	6	7	13	4	

Since expected cell frequencies in the pretest condition do not meet the requirements for computing the phi (ϕ) coefficient, no correlation analysis is reported. Inspection of Table 6, however, would suggest no relationships between pairs of logical operations in pretest.

Table 6 also contains a similar analysis for the same pairs of operations for posttest conditions. In this case phi coefficients were computed, yielding no significant relationships. The only pair of operations showing a trend is classification and seriation ($\phi = .33$, $p < .10$). In this case, the high frequency is found in the cell indicating failure in both seriation and classification.

Thus it can be concluded that seriation, reversibility and classification are independent in children of the age studied here. Success in one operation is not predictive to success in any other. The one operational task that is most frequently passed after training is reversibility. It will be recalled that a low order positive significant relationship was found between reversibility and conservation. Thus, the acquisition of a reversibility is associated with training, and, secondly, there is a moderate relationship with conservation. But, training does not significantly influence the degree of relationship between any combination of operations.

Subsidary Findings

The hypotheses of this study did not deal with a number of factors that appear to add further understanding of logical thinking in children. *Post hoc* analyses of the data were focused upon the role of three factors --verbalization, sex, and classroom differences.

Effect of training on verbalization

Logical operations tasks. On two operations tasks, classification and seriation, Ss were asked to describe each matrix and strip before selecting a picture to complete the tasks, as well as explaining why they selected a particular picture. These responses would be based on S's skill in discriminating and verbalizing various attributes. Such verbal skills might well relate to S's ability to analyze and label aspects of the conservation tasks (and/or general verbal fluency)--particularly since one of the criteria for passing conservation tasks was a verbal justification. Therefore, a *post hoc* analysis was done comparing the DM and LC groups, and comparing conservers vs. nonconservers on their (1) initial level of verbalization, and (2) pretest to posttest gains or losses in verbalizing. The data for all analyses were the percentage of Ss who correctly verbalized three or more dimensions (of a possible six dimensions) in Trials 2, 3, and 4 of classification, and of seriation tasks.

The first analysis, comparing DM and LC groups, indicated that the two groups showed identical pretest classification performance and very similar, small gains in posttest in verbalizing. In the seriation task, the LC group was superior in pretest, but Table 7 showed only half the gain (17%) in posttest compared to the DM group (33%).

Table 7

Percentage of Ss in DM and LC Groups Verbalizing from Three to Six Dimensions on Operations Tasks

	Classification			Seriation		
	Pretest	Posttest	Gains	Pretest	Posttest	Gains
DM Group (N=12)	75	91	16	50	83	33
LC Group (N=24)	75	87	12	70	87	17

Secondly, the groups were combined and Ss regrouped on the basis of conservers vs. nonconservers. The former group was also divided into groups based on how many types of conservation were passed (Table 8).

Table 8

Percentage of Conservers vs. Nonconservers Verbalizing from Three to Six Dimensions on Operations Tasks

	Classification			Seriation		
	Pretest	Posttest	Gains	Pretest	Posttest	Gains
Nonconservers (N=12)	66	92	26	58	74	16
Conserved 1 or more (N=24)	79	85	6	65	95	30
Conserved 1 (N=7)	71	71	0	57	100	43
Conserved 2 (N=11)	81	90	9	81	90	9
Conserved 3 (N=6)	83	100	17	49	100	51

The amount of gains in verbalizing in the classification task from pre- to posttesting were generally low (0 to 26%); in contrast, more gains were found in the seriation task, particularly for those Ss who conserved one type only (43%) or all three types (51%). However, it should be noted that these latter two groups of Ss initially showed the lowest level of pretest seriation performance, i.e., had the greatest chance of showing substantial gain. In general, for all comparisons (Tables 7 and 8), approximately 75% to 100% of each group verbalized 3-6 dimensions in posttest phase on both classification and seriation. Likewise, pretest performance does not seem to afford good prediction of conservation performance, i.e., there was only slight superiority of conservers vs. nonconservers (79% vs. 66%, classification; 65% vs. 58%, seriation).

Conservation tasks. An analysis was made of the types of responses used to justify conservation responses, regardless of whether the S had asserted "sameness" or inequality. This analysis was applied only to the posttest conservation data. There were five general categories: (1) Reversibility; (2) Compensated relations; (3) Addition-subtraction schema; (4) Perceptual features and (5) Irrelevant answers or "I don't know". More specifically, the reversibility category included Ss who mentioned, for example, returning an object back into a ball and references to the previous state of equality. Category (2), Compensated relations, referred to statements involving the change in one dimension (e.g., length) being compensated for by a change in another dimension (e.g., width). Category (3) included such statements as "you didn't add any and you didn't take any away," as well as references to the exact number of chips being unchanged. The perceptual category (4) included references to attributes of the object, statements of "it looks like more," and labeling objects only such as "now it's a hotdog." This category also included statements describing actions such as "you pressed it down (so its smaller)" or "you just pressed it down (so its the same)". S's use of the term "only" or "just" in reference to E's actions implied that S viewed these acts as irrelevant to changing the amount of material (number, quantity and area), and therefore were scored as an adequate justification of the judgment, "same amount." The last category included defeat statements and irrelevant statements such as "I have one of those at home," etc., or referring to weight of objects in the quantity task.

For the total 248 responses,[1] 21% dealt with reversibility, less than 1% with compensated relations, 7% with addition-subtraction, 62% with perceptual features, and 9% in the irrelevant or defeat category. In the reversibility category, the most frequent answer referred to the previous state of equality (15%) and 7% referred to reversed action or repeating the action on the standard object. In the perceptual category, by far the largest category, 42% of the responses referred to the perceptual attributes of the object or labeling the object, whereas only 20% described E's actions on the object. Thus, in both the reversibility and perceptual categories, there appears to be a preference on the Ss part to attend to the static aspects of the conservation task (previous equality of the objects or current appearance of objects) rather than attention on E's actions. It is notable that the rationale of compensated relations is an extremely rare justification, corroborating findings of other investigators (Bruner, 1964; Smedslund, 1961a). This is in sharp contrast to Piaget's presentation of his results on quantity conservation, and his interpretation that multiplication of relations (i.e., compensated relations) is one of the major bases of conservation. Certainly the <u>post hoc</u> verbal explanation of Ss of this age do not support such a contention.

The percentage of responses in the five categories were analyzed for the nonconservers and for those Ss who conserved one or more types, as presented in Table 9. It should be noted that the table reflects, in part, the criteria for what constituted a conserving response, notably reversibility, compensated relations, and addition-subtraction.

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[1]The total responses are based on quite similar percentages of Ss in each of the training groups. The number of responses given by individual Ss ranged from 6 to 9, with three-fourths of the Ss (N=36) giving 6 or 7 total responses to the 3 conservation tasks.

Table 9

Percentage of Conservation Responses of Various Types

Types of Responses	Conservers (N=169 responses)	Nonconservers (N=79 responses)
Reversibility	27.8	6.3
Compensated Relations	.6	0
Addition-Subtraction	9.5	2.5
Perceptual	55.6	77.2
Irrelevant or Defeat	6.5	13.9

As would be expected, the conservers have a higher percentage of responses in these categories. The perceptual category, however, included responses which were deemed inadequate and adequate (the latter, for example, might include "you just pressed it down so it still has the same amount of clay"). The nonconservers have a greater proclivity for using perceptually-based responses (77%) than do conservers (56%), and likewise, nonconservers are about twice as prone as conservers to noting irrelevancies or stating defeat.

Sex Differences: Sex differences in conservation performance have not usually been found in the literature for samples comparable to the one used in this study.

Analysis of sex differences (Table 10) indicates that more girls than boys could conserve in each of the conservation areas after training although only one difference, conservation of quantity, approaches statistical significance $X^2 = 3.06$, $p < .10$).

Table 10

Percentage of Boys and Girls Passing Each Conservation Task

Conservation Tasks	Boys	Girls
Quantity	26.7	61.9*
Number	46.6	71.4
Area	6.7	33.3

*p < .10

As for the logical operations, no statistically significant differences are found for the pre- or posttest data. There is no consistent pattern either. In Table 10 are listed the pre-and posttest percentages.

Table 11

Percentage of Boys and Girls Passing Each Operations Task

	Classification		Seriation.		Reversibility	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Boys	27	27	73	67	67	73
Girls	14	33	58	43	62	90

Boys do virtually the same in pre-and posttest situations, whereas girls improve after training. Although those changes do not reach statistical difference the fact that training does have differential impact suggests the need for further study.

Classroom Experience: Since the Ss were attending one school with a coordinated kindergarten program, there was no reason to expect that classroom experience would make for substantial differences in abilities.

As indicated in Table 12, the number of conservers varied among the various classrooms. Conservers of quantity and number came most often from room A, whereas children conserving area tended to come from rooms B and C.

Table 12

Percentage of Ss from Three Kindergarten Classrooms Passing Conservation and Logical Operations Tasks

	Classrooms		
Conservation Tasks	A (N = 16)	B (N = 14)	C (N = 6)
Quantity	62.5	35.7	33.3
Number	75.0	50.0	50.0
Area	12.5	28.6	33.3
Operations Tasks			
Classification	25.0	35.7	93.7
Seriation	35.7	50.0	78.5
Reversibility	33.3	50.0	83.3

Variations in solution of logical operations are also found among the three classrooms. Comparison of the classrooms reveals the highest percentage of Ss passing each of the operations tasks comes from Room C and the least successful group coming from Room A (Table 12). Patterns within each group vary. Turning to success on specific operations, it can be seen from Table 12 that children from Room C do best in classification, followed by reversibility and seriation. For each of the other two rooms, classification is solved by the fewest number of children, with reversibility and seriation solved by virtually equal numbers. It is of interest to note that each classroom yields differential outcomes in terms of conservation skills and logical operations.

Discussion

There are several major findings from this study which bear discussion in terms of their interrelationship as well as their relationship to other training conservation studies. It will be recalled that the major hypothesis of this investigation dealt with the superiority of labeling-classification in comparison to discrimination-memory training as a means of inducing some conservation skill. The hypothesis was rejected and it is this finding that merits examination. Before discussing the similarity of outcomes of the two training procedures, it is worth examining two other aspects - first, the effectiveness of these methods in relation to those used in other studies, and secondly, issues relating to the identification of conservation, since this is the criterion for success of the training procedures.

The two training methods employed in this study are different from those used in studies reported in the Introduction. In this investigation, the training techniques dealt with general psychological processes quite distant from the actual operations in the conservation task. In contrast, previous studies, attempting to induce conservation, used materials and questions very closely related to the conservation situation. For example, some of the studies testing for number conservation involve manipulation of rows of objects similar to the posttesting task (Beilin, 1965; Gruen, 1965; Wallach & Sprott, 1964). In contrast to these studies, the present study employed none of the conservation materials in the training and no questions or rules were posed which were directly transferable to the posttest conservation task. Instead, the training tended to focus on those operations or processes presumed to be related to conservation. The LC training emphasized the children's ability to identify attributes of objects to discover simple classification rules and to utilize similarities singly or in combination as criteria for building these classes. The DM groups' training focused upon memory for action sequences (not the specific acts of transforming objects in conservation), finding the logical sequences of pictures in a story and remembering contents of stories or arrays of pictured objects.

Combining the outcomes of these two training studies, we find that virtually two-thirds of all the children show at least one type of conservation. Such a finding suggests that specific training in specific logical operations, for example, reversibility as employed by Wallach and Sprott, addition and subtraction as employed by Smedslund, provide only one means of inducing conservation, but apparently other procedures are equally, if not more, effective. Attention should be given perhaps to more general psychological processes, such as visual analysis of detail, memory for sequences, etc., as effective means of inducing conservation. Certainly the effectiveness of DM training suggests that confining procedures to logical operations per se as posited by Piaget is too limiting to the search for other means of inducing conservation. However, it may well be that training in logical operations is effective to the degree that is focuses attention on the trainer's actions and does involve memory for those actions. This may be the effective ingredient and not the content of the logical operations. Such an interpretation requires further testing since the present study is the first to assess the effectiveness of the memory-discrimination aspect.

A second issue worthy of discussion revolves around the question of the criteria used in identifying the conservation response, that is, the confidence one would have that the children cited as conservers in this study would meet other researchers' criteria. The significance of this issue rests on the fact that a substantial number of the children conserved in posttest. There are three factors which should be identified as related to this question. First, in this study, all the subjects exhibited the ability to use correctly relational terms of "more," "same," and "less" in quantity, number, and area tasks. This criterion minimized the possibility that children who did not conserve in the pretest were actually children who could conserve, but who did not know the meaning of the terms. Further, since these children did know these terms prior to their participation in this study, it is unlikely that they learned this term in the training and merely exhibited their conservation ability later by virtue of having acquired this term. This study is unique in using such linguistic skills as a basis for selection of the sample. Second, this study required adequate justification for the response "the same" in the conservation task, in contrast to at least two studies (Sonstroem, 1966; Wallach & Sprott, 1964) where "the same" without justification was deemed adequate. The more stringent criterion of justification is in fact similar to that used by most investigators in the field. The criterion is obviously based on the researcher's theoretical concept of conservation (Gruen, 1966). By requiring a logical justification one avoids "false positives," that is, cases where children have established a response set, "That's the same," but can not give any justification for it.

Thirdly, the present study included a check on each conservation problem. As will be recalled in each case the experimenter removed some material, e.g. clay, chips, houses, to determine whether S's response "the same" was contingent upon the type of transformation performed. Again the Ss who established a response set, "That's the same," regardless of what E did, would probably fail this check. In summary, the first criterion, knowing relational terms, screened out "false negatives," that is, Ss who could conserve in the pretest but for linguistic deficiencies would be scored as nonconservers; the second and third criteria were attempts to locate "false positives," that is, Ss who appeared to be conservers but were not. It should be noted, however, that there are difficulties in determining the adequacy of a verbal justification, a problem deserving much more discussion in the current conservation literature. The criteria for determination of the conservation response as employed in this study would suggest that a low proportion of those Ss scored as conservers were in fact nonconservers.

The fact that LC and DM training were equally effective raises some of the most significant questions of this study. The explanation is not apparent in other results and requires an analysis of the training procedures themselves. Two major possibilities emerge: first, that the two training procedures activate and improve different processes, thus suggesting that there are at least two routes to inducing conservation; or, second, the two procedures trained similar processes even though their content differed and thus were similar in inducing conservation ability.

The discussion will deal first with the differences in training conditions to examine what processes in each training might be effective in transfering to conservation. The LC training focused upon the child's discriminating a variety of object attributes in the service of building a class with the generic nature of any object always being conserved. For example, the shoe remained a shoe in face of detailing its attributes. Similarly for classes of objects, the class was constructed, divided into subclasses, destroyed and/or reconstructed. In each case the previous relevant attribute used for classifying, for example, color or material, became irrelevant with new classification. The child now had to ignore some attributes with the transformation of including the object in a new class of objects. This type of activity is in many ways analgous to the conservation task: the retention of salient attributes with transformation. This experience, however, did not contribute to later conservation any more than DM training in which this particular type of activity was absent.

Secondly it is of interest to note that a question posed several times in the LC training that would appear to be particularly relevant for assessing conservation was, "Can this (an object) be the same as this (another object) and also be different from it at the same time?" This is similar to the conservation test question in which a ball of clay and a pancake of clay are presented and the children indicate that they have the same amount, although aware of the fact that they both are clay, or you play with both, or you can roll both. Yet posing the question of simultaneous similarity and difference and either eliciting or giving the correct answer was not associated significantly more often with conserving than DM training where such a question was never used.

The third unique aspect of the LC training was the attempt to train simple classification skills which according to Piagetian theory should serve as substrates from which conservation emerges. An informal assessment of classification ability in the last training session with LC groups indicated to both trainers that their respective groups had learned, albeit to varying degrees, these classification skills. However, independent assessment of multiple classification (the classification matrices) indicates that the LC training group was no better at solving classification problems. This suggests classification training in general was not the factor associated with eliciting conservation of number and quantity. To be sure the multiple classification task may be said to assess only one type of classification skill and therefore is not an adequate measure of classification skills in general. But the lack of classification training for the DM group suggests that classifying skills have minimal if any direct bearing on conservation ability. It might be noted here that there was a low order association between classification skill and area conservation, which will be discussed later.

To turn now to the DM training which was derived from Watson's argument that conservation tasks involve discrimination and memory of temporal action sequences, as well as details of the static objects. Solution to conservation tasks, it is argued, is a function of the ability to discriminate and to retain information rather than an ability to think in logical terms. In the standard conservation test situations the child is asked to attend, to discriminate and to retain relevant actions of the experimenter. The DM training did not employ the specific actions performed by the experimenter in typical conservation testing, i.e. adding and taking away material, reversibility, and compensating actions. More emphasis on actions is included in DM than LC training and as such, shares some features with Bruner's screening procedures (1964) in forcing Ss' attention on E's actions. The effects of orienting children's attention to actions as relevant to outcome-states warrants more study.

A second feature of DM training is the emphasis upon time-distributed events, i.e., not only on single acts but action sequences and the memory of such sequences. There was also some experience given in establishing logical sequences in stories, logic based on temporal factors much like the WISC Picture-Arrangement subtests. Watson suggested that such training might transfer to the essential temporal relationships in the conservation paradigm -- linking of what was done to what resulted. The action orientation and temporal sequencing experiences have some face validity as transferable experiences. The initial effectiveness of DM training found in this study provides impetus for exploring the potential of this type of training.

The other explanation for the effectiveness of both LC and DM training lies, not in their differences, but in their commonalities -- the possibility that similar processes were involved which induced conservation. First, both methods, in contrast to training methods of other studies, employed small groups rather than individual training, as well as the use of highly verbal procedures. The small group condition provides for maximum confrontation of ideas between children as well as between the adult and children. In these particular training procedures each trainer encouraged children to respond to what others said, to discuss and to arrive at conclusions among themselves. The fact that this confrontation occurred in each training condition might be one reason for the comparable outcomes. This interpretation is consistent with a recent statement of Smedslund (1967) who has come to the view that cognitive conflict induced by subject-object confrontation is not nearly as effective a means of changing cognitive structure as is subject-subject confrontation. This view is also consistent with Piaget (Sigel & Hooper, in press). Such a proposition of course requires further study assessing the same content in training by two methods, that is, individual and group. It would seem necessary, however, to determine <u>what</u> constitutes the confrontation as well as <u>how</u> the confrontation occurs. Small group training has been effective in eliciting conservation in several studies (Sigel, Roeper, Hooper, 1966; Shantz & Sigel, in preparation) but not always as indicated in Mermelstein's recent study (although the number of children in each group is not identified). The question of individual vs. group training certainly appears to be an important one for exploration, but nevertheless only provides one factor that may account for some of the outcomes.

A second factor common to both training methods is the increased opportunity for the children to verbalize, to express their ideas -- apart from the fact that it occurred in this study in a small-group setting. The examiners noticed that children tended to verbalize somewhat more freely in posttesting than they did prior to the training situation. The verbalization data reported indicated that on operations task there were moderate gains by both DM and LC groups in verbalizing three to six dimensions after training. Thus, there is some evidence of an increase in verbalization subsequent to training. It might be posed that the training methods merely increased Ss' verbal facility, especially in relation to an adult asking a question of S. On the other hand, considering how small a proportion of each child's total daily and weekly time was spent in training, it seems to stretch credulity to pose that verbal skills <u>in general</u> were sufficiently increased to transfer to the verbal justification aspect of the conservation tests.

One aspect related to verbalization is the amount of emphasis in both groups on the "sameness" of objects or actions in training. In LC training, sameness was embedded within the context of finding similar attributes to define whether an object was a class member or not. In DM training, Ss matched their sequence of actions to E's, and matched identical pictures of objects. In relation to this possibility, Gruen (1965) found that pretraining Ss on "more" and "longer" was almost as effective in eliciting conservation as direct- and cognitive-conflict training, suggesting that emphasis on such "relations" among objects may have been the effective factor. Training on equality and inequality terms would be quite a tenable interpretation of the present findings were it not for the fact that all Ss had demonstrated prior to training that they could correctly use the terms "more," "same," "less." The possibility that training generalized or consolidated such linguistic skills further to the point of changing a large proportion of children from nonconservers to conservers seems somewhat unlikely, but open to further empirical assessment.

The final apparent commonality between the two training methods is the degree to which both require focusing upon relevant details in problem solution. In each type of training, the child spent a high proportion of time attending to objects or pictures, and to analysis of details. For example, after children initially labeled attributes of objects, they were usually ready to go on to another object, but the trainer encouraged them to produce more attributes in addition to those spontaneously given. Similarly for the DM training, the children sought the identity among pictures but were then required to specify why the other pictures were different from the standard. In each situation, the children were encouraged to employ a larger array of attributes, or to focus more carefully on detail than they might have done on their own. They were encouraged to deal with more than salient stimulus aspects, to go beyond the given and apparent. The attention required and the eliciting of less global responses may have influenced the child's style of categorization by accentuating a more analytic response style (Kagan, Moss, & Sigel, 1963) or reflective attitude (Kagan, et al, 1964) in dealing with the problem. In the conservation assessment procedure where two different appearing objects are presented after transformation, the child has to either inhibit his "impulsive" response to perceptual differences or, noting them, "go beyond" these perceptual differences to the equality of amount established before transformation and remember the type of transformation which took place. Reflective attitudes and tendencies toward visual analysis in problem-solving by young children has been identified by Kagan et al (1964). These information-processing attitudes appear quite related to what is proposed here, i.e., that the training procedures may have facilitated the child's ability to inhibit impulsive responding, to reflect over alternative responses, and engage in thorough visual analysis. The developmental shift described by White (1965) may also be relevant here -- the proposal that children between five and seven years of age move from fast responding on an associative basis to delayed responding to tasks on a cognitive basis. The roles of visual attention, focusing, and reflection in the conservation problem require further clarification through systematic, experimental study.

The logical operations assessed in this study indicated that for 5 year olds (1) the operations are not closely related to each other, which has also been found in 7, 9, and 11 year olds (Shantz, 1967): (2) they did not improve significantly with either DM or LC training; and (3) they had no significant relationship to conservation performance except in the case of reversibility to number conservation, and classification to area conservation. The first finding provides little support for Inhelder and Piaget's proposal (1964) that multiplicative operations in particular emerge simultaneously and are closely related throughout middle childhood. The second finding, in the case of LC training, and the third finding provide evidence that these logical operations are not causally related to conservation (i.e., prerequisites), and, in fact, show little relationship at all. It is worth noting, however, that reversibility training has been shown previously (Wallach & Sprott, 1964) to be very effective in eliciting number conservation, but not quantity conservation (Sonstroem, 1966). The Piagetian proposal that reversibility is "the core property of cognition-in-a-system...the one from which all others derive" (Flavell, 1963, p. 189) seems somewhat suspect in that the relationship of reversibility to other operations and to conservation are so modest, if not lacking entirely. It may be that reversibility is logically central but not psychologically.

The relationship, albeit modest, between area conservation and classification provides some support for Piaget's proposal, based on a logical analysis, that area conservation and classification skills are closely related in being part-whole problems -- spatial part-whole, in the case of area, and logical part-whole problem in the case of classification. In summary, training on classification operations, and independent assessment of multiplicative and reversible operations indicate no clear, direct relationship to conservation skills. The importance of operational abilities is paramount in Piaget's theory of intellectual development, and further assessment of other operations and conservations, and the relationship among operations would be in order.

Educational Implications

The results of this study have direct relevance for education in two areas: (1) teaching strategies, (2) further understanding of cognitive growth.

The fact that each of the training conditions are associated with indication of conservation attest to the value of the type small group interaction employed here. Whether the content of the training or the small group format is the most potent factor is a moot question. Nevertheless each of these factors can be applied to the kindergarten setting. The teacher can employ the techniques involved in DM and LC training in the classroom. It is not unusual for kindergarten teachers to work with small groups for short periods of time. Incorporating the teaching strategies described in this project with some regularity over an extended period of time may yield outcomes relevant to cognitive growth. It is of interest to note that the outcomes for each training condition are positive in terms of conservation. Whether such experiences have other educational benefits have to be determined. There is nothing in our data nor in the feedback received from the teachers to suggest negative results. Quite the contrary -- the teachers did report transfer of the training activities to the classroom, such as "show and tell" periods.

Should teachers use one training procedure other than another? The results of this study reveal that each has a similar outcome as far as conservation skills are concerned. These findings, therefore, provide no justification for recommending one or the other in terms of conservation. As indicated previously, differential side effects can only be conjectured and the perspicacious teacher will have to observe these for herself. There seem, on the basis of logical analysis, no contradiction between the two training techniques. Thus, there is little reason to expect that employment of one or both will create confusion among children. The results do not allow for the conclusion that using both will be any better than using one as far as enhancing cognitive growth is concerned.

The second contribution rests on the substantive findings -- highlighting the range of individual differences in ability and in knowledge among kindergarten children. Beginning with the frequency of awareness of relational terms to solution of conservation problems, strong individual differences abound. These results provide further evidence for the oft stated proposition that CA is but one criterion for grouping children, that within a relatively homogeneous group, wide differences in reasoning and logical abilities are apparent. It is also interesting that children of this age demonstrate far better seriation ability than classification ability, a finding noted previously with gifted four-year olds (Shantz & Sigel, preparation). Whether this reflects early schooling in number concepts is moot.

The fact that conservation could be induced in these children demonstrates that given the appropriate situation and availability of some prerequisites (understanding of relational terms) children could be taught by indirect methods to conserve. The potential of these young children may be greater than realized. This study does not answer the question of the long term stability of these accomplishments. The fact, however, that conservation is maintained even over a relatively short term does speak to some stability. Likewise, limited generality of conservation skills were demonstrated.

Finally, the two subsidiary findings -- sex and classroom differences -- bear further thought for education. Although our results are not explanatory, they should sensitize the teacher to the role of these factors in cognitive growth.

In sum, the implications of this study rest on the demonstration that some aspects of cognitive growth can be induced by employment of either two training devices.

Conclusions

It is concluded that concepts of conservation of quantity and number, and to a lesser extent, conservation of area, can be induced in kindergarten children by two types of training procedures: labeling classification and discrimination-memory training. In contrast to other training studies in the literature, the methods used in this study were focused upon general psychological processes. Possible explanations were offered for the similarity in outcome of the two methods, in terms of providing training in different processes which might lead to conservations, and similar processes which the two training methods shared that might induce conservations.

In general, there were few significant relationships between various logical operations (multiple classification, multiple seriation and reversibility) and various conservations, as well as very low relationships among operations. The findings were discussed in relation to Piaget's theory of intellectual development and in relation to their application to educational objectives and methods.

Summary

The purposes of this study were (1) to determine whether conservation of number, quantity, and area could be induced by one of two particular group training procedures, and (2) to assess the relationship between conservation and the logical operations of classification, seriation, and reversibility.

Thirty-six kindergarten children met two criteria on pretesting: ability to correctly use the terms "more," "same," and "less" when comparing the quantity, number, and area of objects; and, inability to conserve quantity, number and area. After logical operations tasks were administered, the children were assigned to a training group. One type of training, based on Piaget's theory of intellectual development, focused upon the labeling of object attributes and learning simple classification skills (LC). The other training procedure, based on a stimulus-response analysis of conservation tasks, centered upon the discrimination of and memory for action sequences, visual detail, etc. (DM). Four LC groups and two DM groups (N=6 Ss per group) had nine training sessions of 20 minutes each. After training, conservation tasks and logical operations tasks were administered again.

Two-thirds of the total sample passed one or more conservation problems (quantity, number, and/or area). The two training methods did not differ significantly in the percentage of Ss who could conserve in at least one area. Conservation ability did not relate to any of the logical operations, with the exception of low order, significant relationships between reversibility and number conservation, and classification and area conservation. The success of each training method in inducing some conservation warrants further research, particularly focused upon delineating what aspect(s) of training might be crucial in inducing conservation.

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Appendix A

Quantity Pretest (Water)

Name ____________________

N.B. Relational response to step A eliminates steps B, C, D, E.

Order

_____ 1. Less Water

A. Initial question: "What can you tell me about these?"

B. "Are they the same or are they different?"

C. "How are they the same?" (How are they different?)

D. "Is there more water, less water or the same amount of water in this one (point to comparison) as in this one (point to standard)?"

More   Less   Same   Don't know

E. "Point to the one that has less water; point to the one that has more water; do they both have the same amount of water?" _____

_____ 2. Same Water

A. Initial question:

B. Same   Different

C. How

D. "Is there more...same...less..."

More   Less   Same   Don't know

E. Point, etc. _____

_____ 3. More Water

A. Initial question:

B. Same   Different

C. How

D. "Is there same...more...less..."

More   Less   Same   Don't know

E. Point, etc. _____

Number Pretest (Pencils)

Name ______________________

N.B. Relational response to Step A eliminates steps B, C, D, E.

Order

_____ 1. Two Pencils (Less)

A. Initial question: "What can you tell me about these?"

B. "Are they the same or are they different?"

C. "How are they the same?" (How are they different?)

D. "Are there more pencils, less pencils, or the same number of pencils here (point to comparison set) as here (point to standard set)?"

More Less Same Don't know

E. "Point to the one that has less pencils; point to the one that has more pencils; do they have the same number of pencils?" _____

_____ 2. Three Pencils (Same)

A. Initial question:

B. Same Different

C. How

D. "Are there more...same...less..."

More Less Same Don't know

E. Point, etc. _____

_____ 3. Four Pencils (More)

A. Initial question:

B. Same Different

C. How

D. "Are there the same...more...less..."

More Less Same Don't know

E. Point, etc. _____

Area Pretest (Lego Blocks)

Name ____________________

N.B. Relational response to Step A eliminates steps B, C, D, E.

Order

_____ 1. Small Lego Square (Less)

A. Initial question: "What can you tell me about these?"

B. "Are they the same or are they different?"

C. "How are they the same?" (How are they different?)

D. "Is there more red, less red, or the same amount of red here (point to comparison) as here (point to standard)?"
More Less Same Don't know

E. "Point to the one that has less red; point to the one that has more red; do they have the same amount of red?" _____

_____ 2. Medium Size Lego Square (Same)

A. Initial question:

B. Same Different

C. How

D. "Is there more...same....less"

i. More Less Same Don't know

E. Point, etc. _____

_____ 3. Large Lego Square (More)

A. Initial question

B. Same Different

C. How

D. "Is there same...more...less..."

More Less Same Don't know

E. Point, etc. _____

Name ______________________________

Present two clay balls to S. "Do these have the same amount of clay?" (If S says no, follow his suggestions of how to make them the same. If all else fails, tell him they have the same amount.) "Now watch."

1. Cup (change one ball into a cup shape)

   a. "Do these have the same amount of clay or does one have more clay?"

      SAME　　MORE: V　　MORE: S　　DK

   b. "Why do you think so?" ______________________________

      ____

Get new set of balls; place balls near each other and establish equality.

2. Pancake (change one ball into a pancake) "Does...more...same?"

   a. SAME　　MORE: V　　MORE: S　　DK

   b. Why: ______________________________

      ____

Establish equality between first set of balls.

3. Hot Dog (change one ball into a hot dog) "Do...same...more?"

   a. SAME　　MORE: V　　MORE: S　　DK

   b. Why: ______________________________

      ____

Change hot dog back into a ball, place next to other ball and establish equality between them.

4. Check

   Remove a chunk from one ball. "Watch what I do. Do these have the same amount of clay or does one have more?"

   a. SAME　　MORE: V　　MORE: S　　DK

   b. Why: ______________________________

Name ______________________________

Present 12 blue and 12 yellow chips. "Here are some colored playing chips. Some of them are blue and some of them are yellow. You take the yellow ones and I'll take the blue ones...and...let's line them up one at a time in front of us." (Complete one-to-one correspondence.)

"Are there the same number of blue chips as yellow chips?"

1. Compress blue line (resulting in one 'open' yellow chip at each end of the yellow line)

   a. "Are there the same number of yellow chips and blue chips...or...does one have more chips?"

SAME	MORE B (V) LESS B (V)	MORE Y (S) LESS Y (S)	DK

   b. "Why do you think so?" ______________________________

2. Scramble yellow line

   a. "Does one color have more chips...or...are there the same number of yellow and blue chips?

SAME	MORE B (S) LESS B (S)	MORE Y (V) LESS Y (V)	DK

   b. "Why do you think so?" ______________________________

3. Extend blue line (resulting in one 'open' blue chip at each end of blue line)

   a. "Are there the same number of yellow chips and blue chips...or...does one have more chips?"

SAME	MORE B (V) LESS B (V)	MORE Y (S) LESS Y (S)	DK

   b. "Why do you think so?" ______________________________

4. Check: "Watch what I do." (Remove a yellow chip from the middle)

   a. "Are there the same number of yellow and blue chips...or...does one color have more chips?

SAME	MORE B (S) LESS B (S)	MORE Y (V) LESS Y (V)	DK

   b. "Why do you think so?" ______________________________

Name________________________________

Put two green blotters on table. "Let's pretend these are two green fields, and here is a sheep for each field (put in middle of field) and two farmers that own the fields. Now the farmers want to build some houses. Here are some houses (3) for you to put in this field (field to E's right) and I will put houses on this other field. Every time I put a house down you will put a house in the same place on your field." (Put houses on the corner edge of a field and have S do the same.)

"Now look, do both sheep have the same amount of grass to eat?"

1. 3 houses per field (scatter houses on E's field)

   a. "Do these two sheep have the same amount of grass to eat or does one have more grass?"

      SAME   MORE: V   MORE: S   DK

   b. "Why do you think so?"________________________________

      ____

Take all houses off fields and then E & S put nine houses in a straight line on corner edge of each field; establish equality between amount of grass in each field.

2. 9 houses per field (scatter houses on S's field) "Does..more..same?"

   a. SAME   MORE: V   MORE: S   DK

   b. Why:________________________________

      ____

Take all houses off fields and then E & S put six houses in a straight line on corner edge of each field; establish equality of grass per field.

3. 6 houses per field (scatter houses on E's field) "Do..same..more?"

   a. SAME   MORE: V   MORE: S   DK

   b. Why:________________________________

      ____

Put scattered houses back in a straight line so they match the placement of the houses in the other field; establish equality.

4. Check

   Remove 2 houses from one field: "Watch. Do the two sheep have the same amount of grass to eat or does one have more grass?"

   a. SAME   MORE: V   MORE: S   DK

   b. Why:________________________________

Name________________________________

(1) PRACTICE: CLOCKS (CS)

a. "Let's look at these things. Tell me about them."________________

____

b. "Yes, this one (1) is a big yellow clock, and this one (2) is a little, yellow clock and this one (3) is a big blue clock. Now, there's nothing in this space. Let's figure out what the one would be like to fit in this space--so it would fit this way (horizontally) and this way (vertically). Here are some to look at; you find the very best one--the one that belo gs here."

Choice:____Reason:____

"This (small blue block) is the very best choice because its blue like this one (3) and small like this one (2) so it fits this way (horizontally) and this way (vertically)."

(2) PITCHERS (OE)

Description:______________________________________

Choice:____Reason:________________________________

Probe:__/__Reason:________________________________

Probe:__/__Reason:________________________________

Best:__/__

(3) APPLES (NC)

Description:______________________________________

Choice:____Reason:________________________________

Probe:__/__Reason:________________________________

Probe:__/__Reason:________________________________

Best:__/__

(4) TREES (SB)

Description:______________________________________

Choice:____Reason:________________________________

Probe:__/__Reason:________________________________

Probe:__/__Reason:________________________________

Best:__/__

Name________________________________

(1) PRACTICE: LEAVES (CS)

a. "Let's look at these things. Tell me about them."________________

____

b. "Yes, this one (1) is a big light green leaf, and this one is empty, and the next one (3) is a small dark green leaf, and this one is a tiny, very dark green leaf. The leaves are getting darker and smaller, aren't they? Now let's figure out which one would fit right in the empty place--it would come next after this one and before this one. Here are some to look at; you find the very best one to fit right in here."

Choice:____Reason:____

"This (middle size, green leaf) is the very best choice because it is a little smaller and a little darker than this one (1) and yet it is a little bigger and lighter green than this one (3)."

(2) BOTTLES (OE)

Description:____

Choice:____Reason:____

Probe:__/__Reason:____

Probe:__/__Reason:____

Best:__/__

(3) FLOWERS (NC)

Description:____

Choice:____Reason:____

Probe:__/__Reason:____

Probe:__/__Reason:____

Best:__/__

(4) HOUSES (SB)

Description:____

Choice:____Reason:____

Probe:__/__Reason:____

Probe:__/__Reason:____

Best:__/__

REVERSIBILITY

NAME________________________________

(1) PRACTICE: COLORS
"Look at this set of colors. First comes the red, then the blue, then the yellow, then brown, and then the green. Watch! I turn the colors around so the green is first, then brown, then yellow, then blue and the red is last this time. Now I am going to turn the colors back to the way they were before. Here is another set of the same colors with the green first and the red last like it was before when we turned the colors. The BROWN is missing. I want you to put the brown in the place where it belongs so that these colors will look like these colors (point to standard) <u>if those were turned around</u>."

Variable set: E's view

RED BLUE YELLOW . GREEN R W

"You see the brown should go between the green and the yellow so that all the colors are in the same order when I turn these other colors around. First, greens, then browns, then yellows, then blues, and the reds are last.

(2) FRUIT "Look at this set of fruit. Here, first are raspberries, then pineapples. then cherries, then plums, and last elderberries. Here is another set of the same fruit but the elderberries are first and the raspberries are last. The pineapple is missing. Now you have to put the pineapple in the place where it belongs so that these fruit will look like those fruit (pt. to standard) <u>if those were turned around</u>."

Variable set: E's view

RASPBERRIES . CHERRIES PLUMS ELDERBERRIES R W

(3) SHAPES "Look at this set of shapes. Here, first is a triangle, then a circle, then a square, then a diamond, and last a right angle. Here is another set of the same shapes but the right angle is first and the triangle is last. The diamond is missing. Now you have to put the diamond in the place where it belongs so that these shapes will look like those shapes (pt. to standard) <u>if those shapes were turned around</u>."

Variable set: E's view

TRIANGLE CIRCLE SQUARE . RIGHT ANGLE R W

(4) ANIMALS "Look at this set of animals. Here, first is a duck, then a pig, then a chicken, then a cat, and last a dog. Here is another set of the same animals but the dog is first and the duck is last. The pig is missing. Now you have to put the pig in the place where it belongs so that these animals will look like those animals (pt. to standard) <u>if those animals were turned around</u>."

Variable set: E's view

DUCK . CHICKEN CAT DOG R W

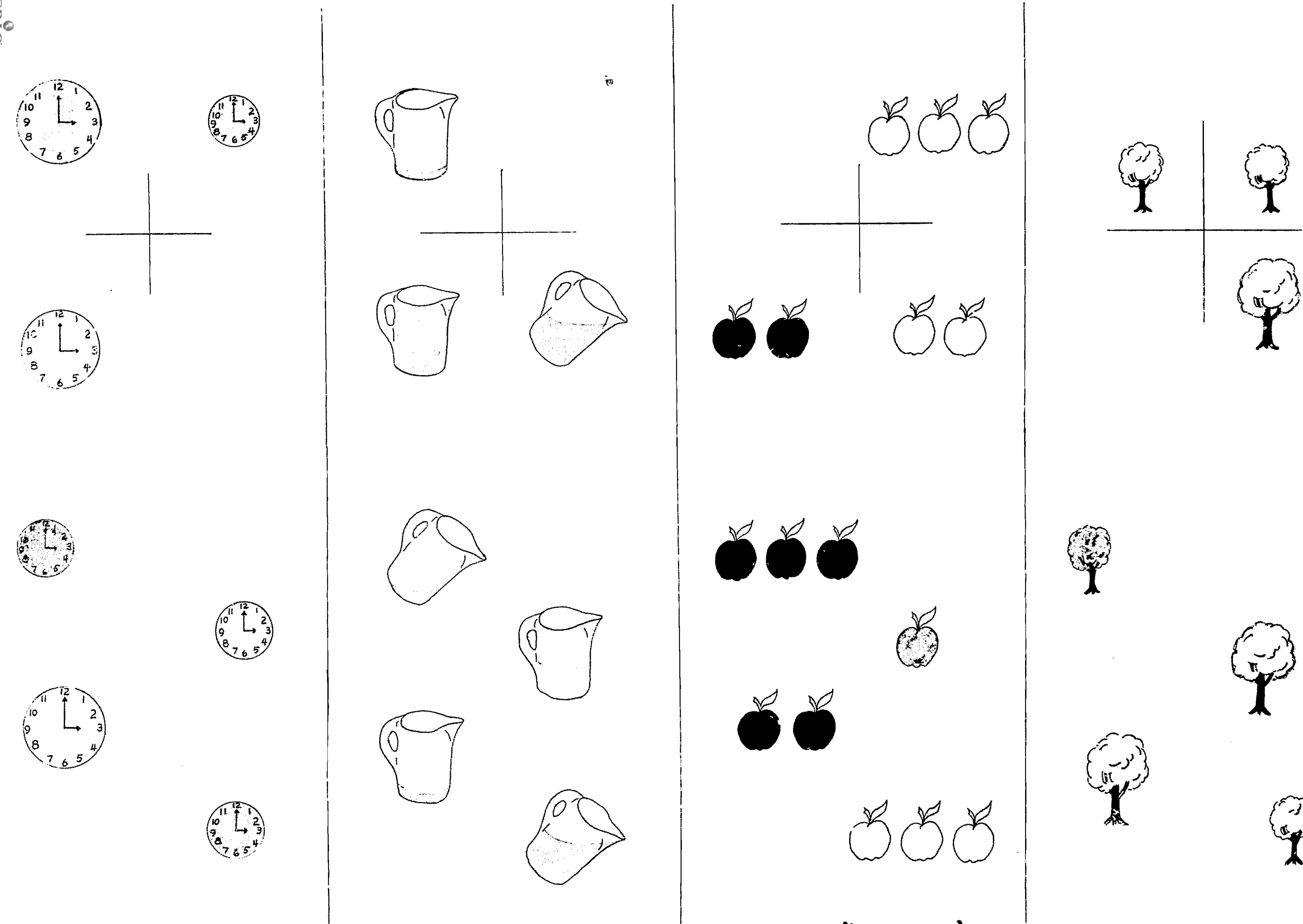


Fig. B-1. Multiple classification matrices (top row) and choice sheets (bottom row).

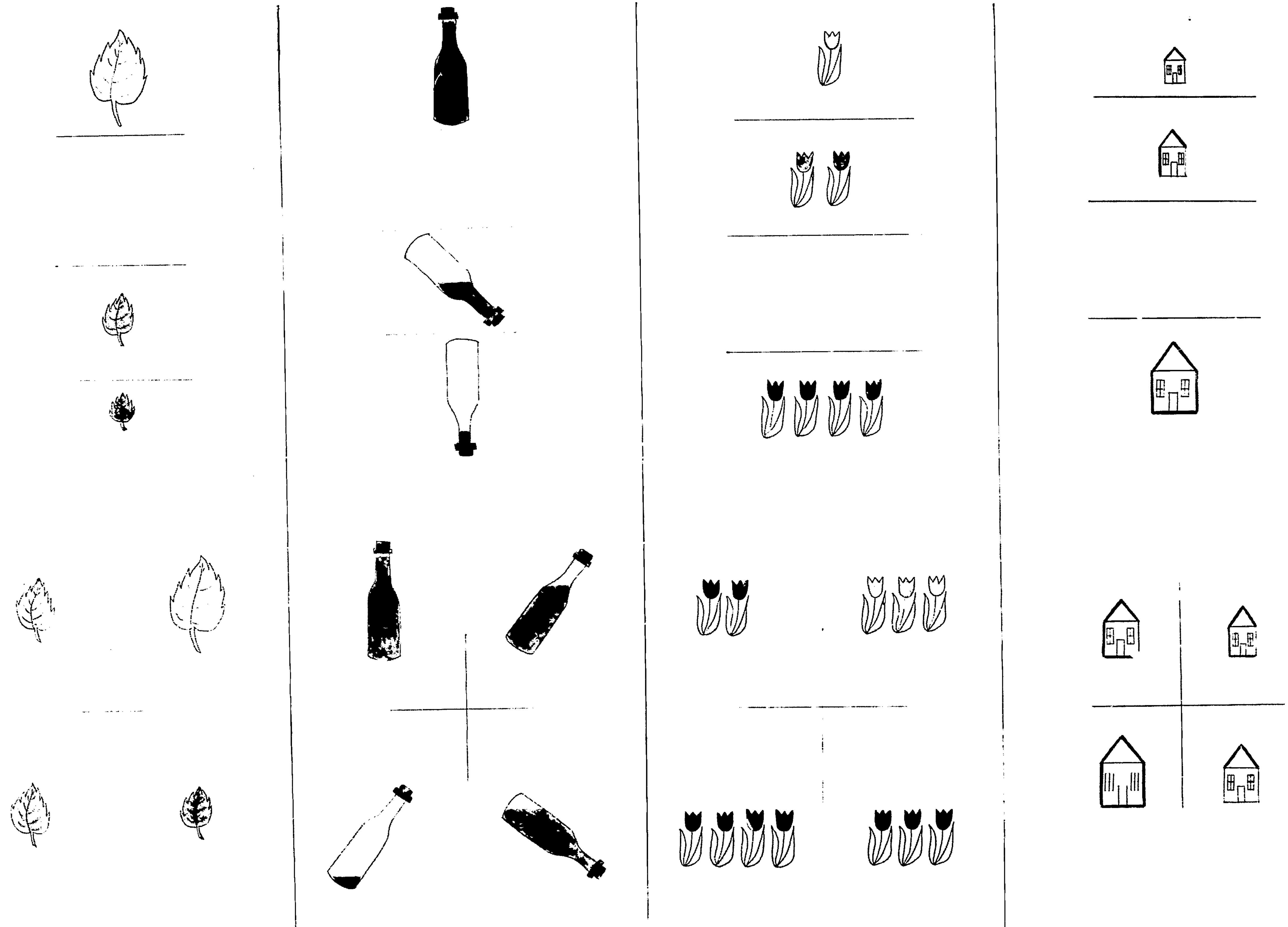


Fig. B-2. Multiple seriation strips (top row) and choice sheets (bottom row).

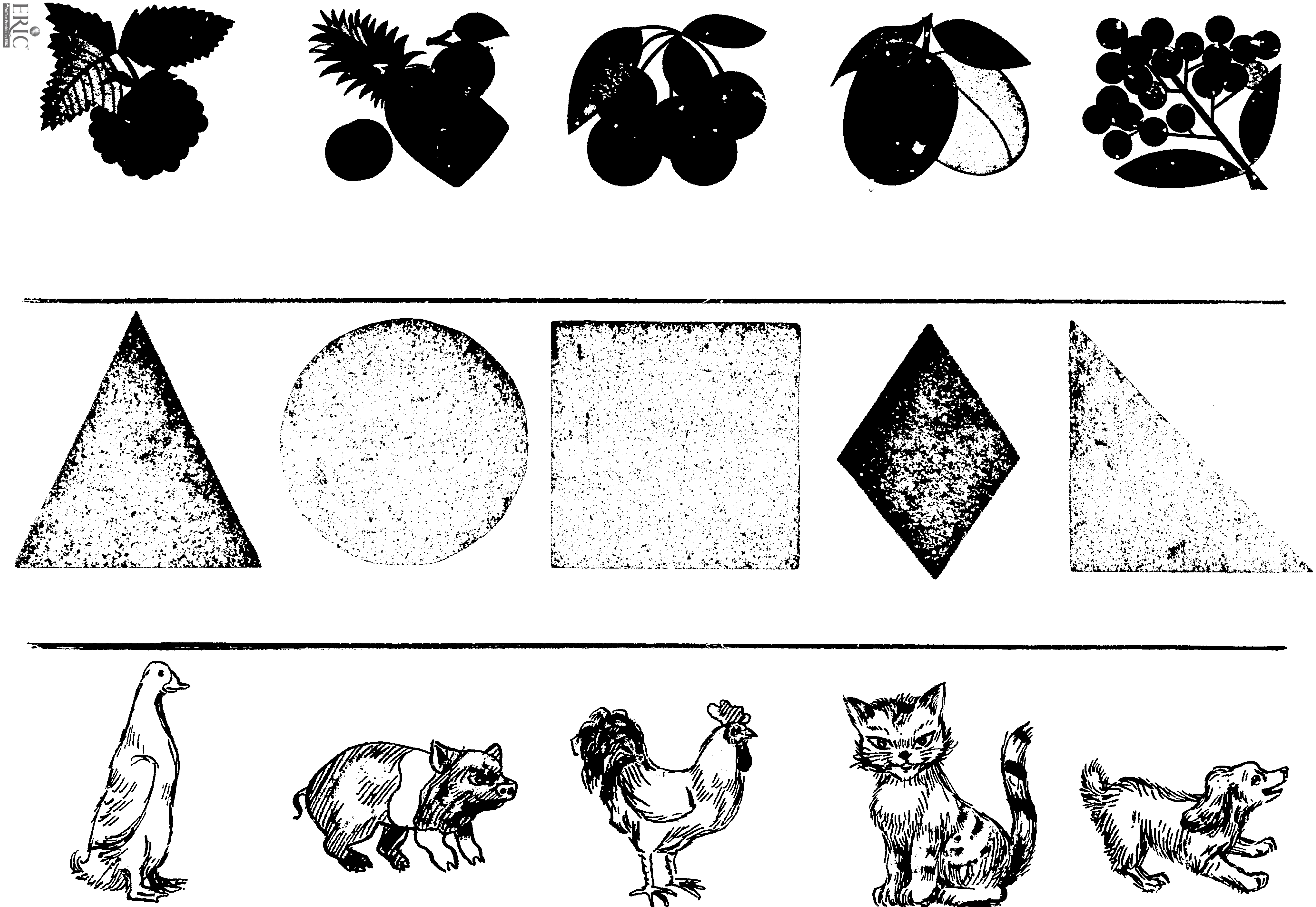


Fig. B-3. Reversibility tasks (practice task not included).

Appendix C

Labeling-Classification Training Sessions

The primary aim in these sessions was to teach children to analyze and label the multiple attributes of familiar objects (such as color, shape, function, material, etc.), and to teach simple classification skills as defined by Kofsky (1966) and Inhelder and Piaget (1964).

Training followed the sequence of concepts outlined below within each general classification of materials.

1. Multiple labeling: aim is to focus attention on multiple attributes of any one object.
    a. First obtain children's initial, spontaneous identification of all types of attributes of an object.
    b. Follow by eliciting as many other attributes as can be identified, associated and inferred.
    c. Extend attributes by T's additional labeling; sometimes suggest incorrect attributes and have Ss accept or reject.
2. Single-criterion class groupings
    a. Match two objects on the basis of similar attribute.
    b. Group several objects on similar attribute. Note: consistent grouping to be emphasized in that every object must have criterial attribute to be a member of the class.
    c. Exhaustive classification: any object which has the criterial attribute must be included no matter how "different" from other objects. For example, red button and red crayon are similar to cardinal, red book, red car, etc.
    d. Simultaneous class membership: any object may belong to more than one class at one time. Similar to exhaustive classification with emphasis upon the momentarily "irrelevant" attribute(s). For example, "Here are some red things. Can the small things be put with the red things?" (Small things also red.)
    e. Successive class membership: any one object may belong to several classes in succession ("shifting" criteria). A pencil, for example, may belong to class of "things to write with" and later shifted to class of "yellow things."
3. Double-criterion class grouping: a class is defined by the joint presence of two attributes, such as red and round; metal and to cut with. Note: give no direct practice in sorting objects in a matrix-type double classification.

In order to ximize Ss' interest and induce as much generalization as possible, a variety of methods are to be used in teaching simple classification rules, e.g., oddity problems, discovery methods, guessing games, "teacher is wrong" games, etc., as described in the sessions.

The general procedure is to present one object at a time, have Ss label as many attributes as they can, suggest further attributes, present a second object and repeat labeling, and then find similarities and differences between the two objects. As sessions proceed, more than two objects will be used for each classification.

Session	Category	Objects
1	Wearing things	Shoe, shirt, tie, glove, watch, belt
2	Musical things	Maraca, bell, drum, toy accordian
3	Fasteners	Button, safety pin, zipper, clothespin
4	Containers	Can, jar, box, wallet
5	Washing things	Towel, sponge, soap, soap dish
6	Containers & Washing things	(see above)
7	Musical things & Fasteners	(see above)
8	All materials	(see above)
9	Review	All objects above and miscellaneous items, flashlight, eye glasses, mirror, quarter, scissors

SESSION 1

1. Present shoe
   a. Identification: who knows what this is?
   b. Attributes: what can you tell me about the shoe? (brown; wear it; has laces, heels, etc.; leather; for boys; buy it in store; can do with it--bend, tap; can be done to it--fill, carry, wear, etc.)
   c. Comparison of Ss shoes with this shoe: note similarities and differences
2. Present shirt
   a. Identify
   b. What can we do with this? What is it made of?
   c. Comparison of shoe and shirt: differences (colors, etc.) and similarities (wear; buy; for boys)
3. Present tie
   a.-c. above
4. Present glove
   a.-c. above
5. Present watch
   a.-c. above
   d. Make groupings: brown leather vs. black leather vs. cloth
      metal vs. no metal
6. Present belt - no labeling; compare and group with other objects
7. Remove 2 objects: Ss recall 2 missing items; how are they alike?
   Remove 3 objects: Ss recall 3 missing items; how are they alike?
8. E groups several objects together on the basis of some obvious attribute: Who can figure out why these all go together? How are they all alike?
9. Try one class inclusion problem: shirt, tie, glove
   Are there more cloth things or wearing things?
   Are there more wearing things or leather things?

10. Guessing game: I'm thinking of something blue--what is it?
I'm thinking of something blue with buttons--what is it?
   a. ...leather
   b. ...leather & brown (still can be watch or belt)
   c. ...leather, brown & metal on it (still can be watch or belt)
   d. ...leather, brown, metal, for my arm (watch)

SESSION 2

1. Present maraca
   a. Identify (accept any reasonable term, like shaker)
   b. What can you tell me about it? (get spontaneous attributes from Ss and supply some they don't suggest)
      (color; noise-maker, has handle; roundon top; wood; things inside; buy in store; for children & grown-ups)
2. Present bell and drum
   a. Identify each
   b. Compare bell to drum, drum to maraca, bell to maraca
      Similarities: noise, moving parts, colors
      Differences: shake vs. hit; handle vs. no handle; wood vs. metal
3. Present accordian
   a. Pass around; have Ss tell about it
   b. Identify
   c. Label attributes
   d. Compare on similarities and differences with other materials
4. Auditory identification: Ss close eyes, E sounds object, Ss guess
5. Guessing game: I'm thinking of something that is.....
6. Let's pretend game: have some Ss pretend to play one of the instruments and other Ss guess
7. Let's remember game: what did we have yesterday that was the same color as the maraca? (shirt-maraca both blue)
   what did we have yesterday that was metal?
   what did we have yesterday that made noise too? (watch)

SESSION 3

1. Present button, safety pin, zipper: pass around all 3
   a. Who knows what this is?
   b. What can you tell me about the button; pin; zipper?
      (attribute labeling on color, shape, material, function, etc.)
   c. Comparisons
      1) Button with buttons on Ss clothes: color, type, material
      2) Button and pin: hard, hold things together
      3) Pin and zipper: can be open or closed
      4) Button and zipper: can be sewed on clothes
2. Present clothespin
   a. and b. above
   c. How are all 4 of these things alike, the same?

3. Have children try to think of other things that are "fasteners" or hold things together: paper clip, staples, glue, paste, nails, snaps, shoe laces, barretts, etc.
4. Have children get into groups based on:
    a. All those with buttons on their clothes; subdivide on color
    b. All those with zippers on their clothes
    c. Those with buttons and zippers on clothes

SESSION 4

1. Present can and jar
    a. Identify each
    b. Label attributes:
        What is it made of?
        What can you do with it?
        How can you use it? (fill, roll, tap, etc.)
        Shapes
        Materials

2. Present box and wallet
    a.-b. above
    How are the box and wallet alike? among others, get similarity of being containers or holding things
3. All 4 objects
    a. Each S has turn at picking out 2 objects, and other Ss guess how the 2 are alike
    b. Teacher suggests attributes and Ss call which object fits it:
        Can carry water in - jar, can
        Can burn - box
        Metal on them - can, jar lid, wallet fasteners
    c. Have 4 Ss take one of the objects each and tell everything he can think of about it; have Ss add to any he doesn't include (Correct if in error)
4. Review and have Ss think of other containers: bottle, pockets, purse, bowl, cup, chest, refrigerator, drawers, car, crayon box, etc.

SESSION 5

1. Present towel and sponge
    a. Identify
    b. Attributes: where do you have these at home?; how do they feel?; What else can you tell me about them (color, water holders; clean up spills, little holes in them, etc.) What can you do with them?--sponge can be bounced, bent, squeezed; towel--carry, wrap, dry off, fold, swing, keep warm with, wear on your head, etc.
2. Present soap
    a. Identify
    b. Have each S give one attribute (including odor, texture, etc.)
3. Present soap dish
    a-b. above

4. "Teacher is wrong game": pick out 1 object, start giving correct attributes and have Ss respond "yes" to each that is correct, then give a wrong one, and they say "no, teacher is wrong..."
   Soap: yellow, wash with, eat; or suds maker, square, dry off with
   Towel: soft, cotton, dry off with, buy in store, leather.
5. All 4 things: how are they all alike? Get as many attributes as possible; what other things do we use when washing--water, cleanser, brush, bath salts or bubble bath, etc.

SESSION 6

1. Present box and wallet
   a. Review some of the attributes
   b. Without presenting towel, ask Ss how the towel is like the wallet (bend, fold, both containers, etc.)
2. Present all the objects in container group and washing group
   a. Similar colors: soap, sponge, towel; box, soap dish
   b. Similar shapes: round vs. square
   c. Similar in softness vs. hardness
   d. Similar in openable-vs. not openable
3. Double attributes: square and yellow: sponge and soap
   holds water & has lid: jar and soap dish
   has metal and holds things: wallet, jar with lid and can
   has lid and is cardboard: box only
   yellow and hard: soap only
4. Hiding game: remove one object and tell Ss about it; they guess
   Have each S select one object and give clue to others
5. Give each S one object of the 8 and have them group themselves on the basis of some one attribute, or 2 attributes.
6. Class inclusion
   a. More yellow or more square things (sponge, towel, dish, box)
   b. More containers or more washing things? (box, sponge, can, jar)
   c. More bending things or square things? (towel, sponge, wallet)

SESSION 7

1. Present safety pin, zipper, accordian and bell
   a. Identify each
   b. Review some attributes of each
   c. Compare on similarities and differences (metal; open & closeable; moving parts)
2. Present drum, clothespin, maraca, button
   a. and b. above
   c. Find similarities with all 8 items
3. Hiding game: each S selects one item and gives clues to others
4. Memory game: combine some things from session 6 with today's objects (just from memory)
   Bell, drum, pin: all metal; what did we have yesterday that was metal? (can, wallet)

Pin, zipper, accordian, clothespin: how are these all alike? (close and open them) What did we have yesterday that you can close and open? (jar withlid, soap dish, wallet)

Zipper: what is the brown part? (cloth) What did we have yesterday that was cloth? (towel, bow tie, shirt, etc.)

5. I went to the store and I bought something that...
   a. I can shake (maraca, towel, etc.)
   b. That is metal
   c. That I can close and open
6. E makes group of things: Ss guess how they are all alike
   E makes groups of things alike in some more obvious way with one that is wrong: Ss find the wrong one in the group.

SESSION 8

1. Present all materials
   a. Have Ss take turn being teacher: asking other Ss to name each object and give some attributes
   b. Similarities and differences
      1) Put the blue things together and ask Ss why they go together
      2) Have Ss find all the plastic things; metal things; cloth;
      3) Find the wrong one: E makes group and puts one object in group that doesn't fit

         Towel, shirt, tie, soap (cloth)
         Bell, watch, maraca, and can
         Moving parts: can wrong
         Round: none are wrong
         Metal: maraca is wrong
         Round and metal: maraca is wrong
2. Have Ss take turn sorting the 22 things into their categories:
   Washing things
   Wearing things
   Musical things
   Containers
   Fasteners

3. If I had a red sock, what things would it go with? Why? (color, wear)
   If I had a banana, what things would it go with? Why? (color, soft)
   If I had a teeter-totter, what would it go with? Why? (wood, movable)
   If I had a paper clip, what would it go with? Why? (metal, fastener)

4. Can things be the same and different at the same time? How?

SESSION 9

1. Present scissors
   a. Identify
   b. Label attributes
2. Present flashlight, eye glasses and quarter
   a. and b. above
   c. Groupings:
      1) Glasses & flashlight: glass and plastic both
      2) Flashlight, quarter, scissors: metal (silver)
      3) Flashlight, quarter, scissors and glasses: round parts
      4) All but quarter have movable parts
      5) All have some writing on them
3. Present selected items from former sessions - ask Ss why all these things are alike, using attributes of metal, glass, hard, round, metal and round, red, etc.
4. Class hierarcy: all hard things subdivided into plastic vs. metal vs. glass vs. wood; resort into colors
5. Discuss again how things can be the same and different at the same time
6. Review general rules: finding things that are the same; everything that is red can go with red things; everything has to be red to go with the red, etc. Use color or material as example

DISCRIMINATION - MEMORY TRAINING SESSIONS

The primary aim of these sessions was to facilitate children's ability to remember a sequence of actions, to visually analyze pictures for details as well as memory for details, and to increase their ability to verbally express their ideas. The following is a summary of the nine sessions:

Session	Task requirements
1	Imitations of gross motor sequences by E
2	Imitation of fine motor sequences and spatial designs in patterns of blocks
3	Execution of sequence of verbal commands given to S(s) by E
4	Visual analysis of complex pictures; memory for detail
5	Analysis of series of pictures to locate the different one or to find one the same as a "standard"
6	Picture analysis and sequence: random presentation of story parts which Ss put in logical sequence
7	Story-readingby E, questions to Ss, recreating story by Ss
8	Show and tell time: Ss tell others about objects
9	Review session using materials and format of sessions 1, 3, 4, 5, and 8.

Sessions 1-3 are focused on memory for action sequences
Sessions 4-6 are focused on visual analysis and memory
Sessions 7-9 are focused on listening, memory, expression

<u>SESSION 1:</u> Motor imitation ("Copy cat game")

Format: E presents a series of gross movements; Ss must reproduce movements in correct sequence

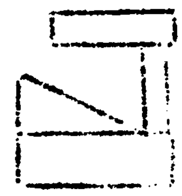
1. Copy cat game using one arm
   a. Single arm movements
      1) Flex elbow; touch shoulder; arm up
      2) Tap head, circle arm out front; touch nose; drop arm to side
      3) Ask child to make up a series for Ss to copy
2. Double arm movements in copy cat game
   a. Both arms extended to sides; clap hands;swing arms by side
   b. Rotary arm movements at sides; touch shoulders, arms over head and drop arms by side
   c. Ask one S to make up double arm series; Ss copy
3. Trunk movements in copy cat game
   a. Hands on hips; bend at waist to left; jump
   b. Turn around; squat; stand, cover mouth with two hands
   c. Have an S make up a series; Ss copy
4. Statue game: E does series of movements and says stop; E holds position and Ss try to reproduce whole series

SESSION 2: Block games

Format: E makes design and Ss copy design (end-product)
E makes design and Ss copy sequence of design building as well as end-product

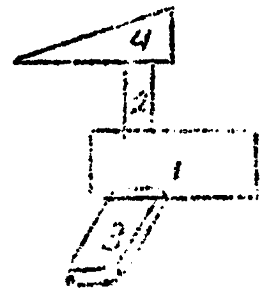
Materials: Each S gets 6 blocks: 1 small rectangle, 2 columns, 1 triangle 1 large rectangle, 1 square

1. Simple design, flat on surface
   a. E makes →



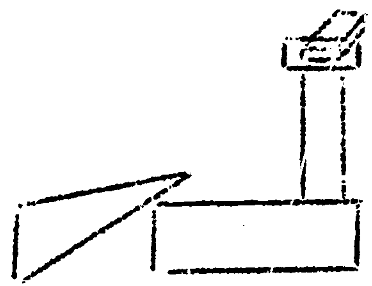
   b. Each S copies design only

2. Simple design and movements
   a. E makes design in this sequence: →



   b. Directions: "Watch how I build this; watch which block comes first, then... second, then... third and then the last one." (Destroy model)

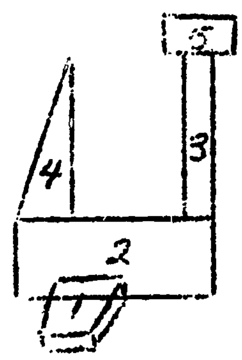
3. Complex design
   a. E makes →



   b. Each S copies design only

4. Complex design and movements

   a. E makes design in numbered sequence →



   b. E destroys model

   c. Ss build model as group

5. Have 1 or 2 Ss build model for group to recreate

SESSION 3: Commands ("Message Game")

Format: E gives series of verbal commands; 1 S tries to reproduce sequence; other Ss check his accuracy

1. E does two things; Ss tell what E did verbally
2. Two commands (no demonstration--just tell)
   a. Blink your eyes, tap your toes
   b. Run to the corner, then clap your hands
   c. Choose 1 S to give 2 commands-either to other S, Ss or whole group together.
3. Three commands
   a. First go to the door, hop once, then open the door
   b. Put this block in that corner; turn around in the corner; and come back to me.
4. Four commands
   a. Put this penny on the table; bark like a dog; touch the scales (or run around the room); and sit at the table.
   b. Pick up the pencil; go touch the doorknob; give me the pencil; and tell us your name.
5. Have each S think up a series of 2 commands, or 3 if they can; have them whisper it to E first to check whether feasible.

Additional: if time allows, give some extra 4-commands sequences.

SESSION 4 - Visual memory and analysis

Format: present picture; Ss label items in it; hide picture; Ss recall

1. Family scene picture
   a. Have Ss label as many items in picture as they can; suggest ones they miss
   b. Hide picture: "Now, this is the game...how many things can you remember in that picture? Tell me everything you remember."
   c. Return picture and check accuracy; point out omissions
   d. Hide picture: have Ss tell a story about picture
2. Magazine sheet of individual items
   a. Label each item; on some talk about its function
   b. Hide sheet
   c. Ss recall items
   d. Check accuracy; omissions noted
3. Workbook sheet of individual items
   a. Show sheet for several minutes: NO labeling or talking
   b. Hide sheet
   c. Ss recall items; check accuracy
4. If time permits: say out loud several items and have Ss remember them in any sequence (additional: try correct sequence later)
   a. Mud-pencil-orage juice-car
   b. Moon-birthday-blackboard-snow

SESSION 5 - Perceptual training ("Detective Game")

Format: present strips of pictures; Ss select the one that is different (or the same)

1. Differences: colored series of four pictures
   "Show me the one that is different from all the others. How is it different?"
   (Use 4 strips having 4 pictures in each strip)
2. Differences: xeroxed series of 5 pictures
3. Sameness: hand-made series matching 1 to standard
   "Find the one that is just the same as this one, just like it."
   "Tell me how this one (and this one, etc.) are different."
4. Additional if time permits: say series of things and have Ss note the one you repeat--let them stop you when they think you have repeated a word, e.g.,
   "dress; basement; airplane; spoon; book; tablecloth; light; basement (if Ss miss go on to:) teacher; sidewalk; TV; basement.

   "matches; thumbtack; window; shirt; milk; rocket; ring; cookies; magazine; window...grasshopper; picture; horse; window...

SESSION 6 - Picture Arrangement ("Make a Picture Story")

Format: present pictures one at a time in jumbled order to talk about; lay all on table mixed up; have 2 Ss put pictures in sequence to make a story; have other Ss check it.

1. "Block building" story - 4 parts
2. Barbershop story - 5 parts
3. Shoe-buying story - 5 parts
4. TV-puppet show story - 4 parts
5. Additional: Billy Goat Gruff story
6. Additional: give digit span type of task

SESSION 7 - Story reading and questions

Format: E reads story of Ss; E either asks questions or has Ss try to recreate entire story

1. "Timothy Titus" story
2. "Corally Crother's Birthday" story
3. Check on memory for details--get spontaneous recall; then elicit other details by asking about event or object in story.
   At end have each S tell part of the story in sequence; other Ss check accuracy.

SESSION 8 - "Show and Tell" Time

Format: E introduces some of the objects the Labeling-Classification Groups have been using; each S tells about his object. Emphasize use of objects, etc., more than attribute-labeling.
(About 12 of the 22 items were used in this session, chosen at random by E.) If Ss prefer, have them tell about something they have with them like a ring, or a dress.

SESSION 9 - Review

Format: to consolidate skills and informally assess amount of learning in past 8 sessions; use some items from each of previous sessions

1. Copy cat game
   a. 3 arm movements: hands on knees; arms out straight & wiggle fingers; cross arms at waist
   b. 3 trunk movements: turn around; touch one elbow; cover eyes; and sit down.
2. Message game
   a. 3 commands: go to the door, sit on that chair, and bring me this pencil (put pencil on table prior to commands)
   b. 4 commands: put this penny on that chair; say, "The penny is on the chair"; bring the penny to me; go to the door.
3. Visual memory
   a. Use new picture sheets provided for Ss to look at without labeling; hide picture; have Ss recall as many items as possible (note approximately how many)
      1) IS: use market-road scene
      2) CS: use railroad scene
   b. New strip of finding the one that is different; then ask Ss, "What would we do to make this one just like all the others in the row?"
      1) IS: balloons; planes
      2) CS: soap bubble pipes; balls
4. Short-story reading and questions, or brief show and tell.

Appendix D

The following is an excerpt from the transcript of Session 1 of one labeling-classification training group. Prior to this excerpt, the Trainer (T) presented individually several articles of clothing, and discussed each object's attributes with the children.

T: Now let's put all these together (shoe, shirt, bow tie, glove). Any way in which all these four things are different?

Child: Well, this you don't put on your hand.

T: That's right. You don't put that on your hand.

Child: ... but you put this on your hand.

T: Put <u>that</u> on your hand. Any other way?

Child: Put this on your stomach ...

T: All right. Any other way in which they're different? ... All right. Now ... how are they all alike?

Child: This bends ... no, that's different.

T: Right. Now how are they all alike, all the same, all of them?

Child: ... made out of leather and this is made out of leather.

T: What's made out of leather, <u>this</u>?

Child: Yes.

T: You said that was made out of cloth before.

Child: Oh yeah, I forgot.

T: You forgot ...

Child: ... made out of leather.

T: All right, now, these two made out of leather, and what are these two made out of?

Child: Cloth.

T: Cloth. So how can we ... so these two are like because ... Why are these alike?

Child: Because these ... they both cloth.

T: These two?

Child: Leather.

T: Leather. They're both leather! And these two are alike because they're both ... ?

Children: (together) Cloth.

T: Cloth! Yes. All right. Now, is there any way in which these two are alike?

Child: This is blue and this is brown.

T: Any way in which they're alike?

Children: (together) This is black and this is blue.

T: But how are these two alike?

Child: You wear it ... you wear this on your foot and you wear this on your hand ...

T: Is that how they're alike? Or is that how they're different?

Child: That's how they're alike.

T: Alike? ... Why are they alike?

Child: 'Cause you wear them!

T: You wear them! Oh, these are alike because you wear them ... and are these ... ? Do you wear these?

Children: Yes ... yes!

T: Then are these alike?

Child: You wear these in the winter time.

T: Yes ... then, these are alike, why?

Child: 'Cause you wear these.

T: You wear them. Now, how are they all alike?

Child: 'Cause you wear them!

T: You wear them all. That's right.

Table E-1

Raw Data (N=36)

Discrimination-Memory Group (N=12): Ss 1-12
Labeling-Classification Group (N=24): Ss 13-36

S	C.A.	Sex	Operations-Pretest Class.	Operations-Pretest Ser.	Operations-Pretest Rev.	Operations-Posttest Class.	Operations-Posttest Ser.	Operations-Posttest Rev.	Conservation Quant.	Conservation Num.	Conservation Area
1	5-4	M	-	+	+	-	+	+	-	-	-
2	5-7	M	-	+	+	+	+	+	+	+	+
3	5-7	M	+	-	-	-	-	+	-	-	-
4	5-4	F	-	-	-	-	-	+	-	+	-
5	5-7	F	-	+	+	-	-	+	+	+	-
6	5-5	M	+	-	+	+	+	-	+	+	-
7	5-4	F	+	+	+	+	+	+	+	+	+
8	5-7	F	-	+	+	-	+	+	+	+	-
9	5-4	F	-	+	-	+	+	+	+	+	+
10	5-7	F	-	-	-	-	-	+	-	-	-
11	5-5	M	-	+	+	+	+	-	-	-	-
12	5-4	F	-	-	-	-	-	-	-	-	-
13	5-7	F	-	-	+	-	-	+	+	-	-
14	5-7	M	-	+	+	-	+	+	-	-	-
15	5-7	M	-	-	-	+	-	-	+	+	-
16	5-7	M	-	+	+	-	-	+	+	+	-
17	5-5	F	-	-	+	-	-	+	+	+	-
13	5-5	F	-	-	-	-	-	+	-	-	+

Table E-1
(Cont'd.)

S	C.A.	Sex	Operations-Pretest Class.	Ser.	Rev.	Operations-Posttest Class.	Ser.	Rev.	Conservation Quant.	Num.	Area
19	5-9	F	-	+	+	+	+	+	-	-	-
20	5-5	M	-	-	-	-	-	-	-	-	-
21	5-7	F	-	+	-	-	+	+	+	+	-
22	5-6	F	-	-	+	-	+	+	+	+	+
23	5-10	M	-	+	+	-	+	+	-	-	-
24	5-9	F	+	-	-	-	-	+	+	+	+
25	5-9	F	-	+	+	+	+	+	+	+	-
26	5-8	M	-	+	-	-	+	+	-	+	-
27	5-4	F	-	+	+	+	-	+	+	+	+
28	5-4	M	+	+	+	+	+	+	-	-	-
29	5-6	M	-	+	+	-	+	+	-	+	-
30	5-9	M	-	+	-	-	-	-	-	-	-
31	5-8	F	+	-	+	-	-	+	-	-	-
32	5-9	F	-	+	+	+	+	+	-	+	+
33	5-7	F	-	+	-	+	+	+	+	+	-
34	5-8	F	-	+	+	-	-	+	+	+	-
35	5-7	M	+	+	+	-	+	+	-	+	-
36	5-8	F	-	+	+	-	-	+	-	+	-