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AUTHOR Peterson, Gary W.; And Others
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ABSTRACT

The efficacy of small group instructional activities dealing with transitive inference, conservation, and class inclusion of length was investigated in a sample of kindergarten (N=44) and first grade (N=45) children (mean ages of 5 years, 7 months and 6 years, 7 months respectively). The two instructional sessions (10 to 15 minutes each) employed a game-like atmosphere, peer-groups/teacher interaction, and positive feedback within a small group context. Assessment of instructional effects included pretesting, immediate posttesting, and delayed posttesting (three months subsequent to training) on the above concept domains in addition to a quasi-standardized series of tasks based upon the concrete operations period "groupements." Preliminary analyses indicated a lack of order of presentation effects, sex differences, tester and teacher biases, and pretest distinctions among the experimental conditions (six treatment conditions, three control conditions). The normative order of item difficulty and the associated differential instructional susceptibility indicated that concepts of transitive inference precede conservation which are in turn mastered prior to class inclusion understanding. Apparent task ceiling effects precluded transitivity instructional effects. Significant specific instructional effects were shown only for the conservation training conditions. Intraconcept transfer to the counterpart weight concept cases was not shown. In relative contrast, some evidence for interconcept generalization was demonstrated for the conservation and transitivity concept domains and to the logical "groupement" performances. Little evidence was found for significant treatment/grade-level interactions. Implications of the present findings for the status of cognitive stages of development are discussed. (MS)

Technical Report No. 368

AN INVESTIGATION OF INSTRUCTIONAL TRANSFER EFFECTS FOR CONSERVATION, TRANSITIVE INFERENCE, AND CLASS INCLUSION REASONING IN KINDERGARTEN AND FIRST GRADE CHILDREN

by

Gary W. Peterson, Frank H. Hooper,
Susan K. Wanska, and John DeFrain

Report from the Project on Conditions of
School Learning and Instructional Strategies

Frank H. Hooper
Faculty Associate

Wisconsin Research and Development Center
for Cognitive Learning
The University of Wisconsin
Madison, Wisconsin

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ABSTRACT

The efficacy of small group instructional activities dealing with transitive inference, conservation, and class inclusion of length was investigated in a sample of kindergarten (N = 44) and first grade (N = 45) children (mean ages of 5 years and 7 months and 6 years and 7 months respectively). Two instructional sessions (10 to 15 minutes each) consisting of positive feedback among five children and a teacher in an open game-like discussion atmosphere for each of the experimental conditions were included. Assessment of instructional effects included pretesting, immediate posttesting, and delayed posttesting (three months subsequent to training) on the above concept domains in addition to a quasi-standardized series of tasks based upon the concrete operations period groupements. Preliminary analyses indicated a lack of order of presentation effects, sex differences, tester and teacher biases, and pretest distinctions among the experimental conditions (six treatment conditions, three control conditions). The normative order of item difficulty and the associated differential instructional susceptibility indicated that concepts of transitive inference precede conservation which are in turn mastered prior to class inclusion understanding. Apparent task ceiling effects precluded transitivity instructional effects. Significant specific instructional effects were shown only for the conservation training conditions. Intraconcept transfer to the counterpart weight concept cases was not shown. In relative contrast, some evidence for interconcept generalization was demonstrated for the conservation and transitivity concept domains and to the logical groupement performances. Little evidence was found for significant treatment/grade-level interactions. Implications of the present findings for the status of cognitive stages of development are discussed.

I

INTRODUCTION

One of the characteristics of Piagetian literature is that it leaves the reader with the impression that a stage is supposedly a unitary period of cognitive development. According to Piaget, cognitive items germane to the concrete operations period, for example, develop synchronously because the eight operational groupements that lie at their base are logically and psychologically interrelated. This generalized framework of operations, employing classes and relations as intellectual tools, has no meaning except within the context of a broadly cohesive system which develops as an ensemble of conceptual structures, marching forward in correspondence. The minor asynchronies that do appear are largely explained away as horizontal décalages, or within stage phenomena, which are not seen to be qualitative changes in conceptual development comparable to those which occur across stages (cf. Piaget, 1966; Piaget & Inhelder, 1969; Pinard & Laurendeau, 1969).

The experimental investigation of Piaget's conception of the issues of synchrony and sequence are still the most crucial areas for testing the validity of the classical Piagetian stage concept (Flavell, 1970, 1971, 1972; Hooper, 1973a; Wohlwill, 1963, 1970, 1973). At the macro-level, Piaget's writings have tended to create the generally ideal synchronous picture that is described above. At the micro-level, which is concerned with predictions about specific cognitive items, there is often "apparent" inconsistency relating to postulates about correspondence between specific cognitive elements, and frequent lack of precise definitions as to what kind of sequence is being described.

A secondary, although still very important concern that is specifically pertinent to the present study is the question of whether logical operations can be trained. The Genevans contend that operations are not truly initiated by specific learning experiences but, at maximum, what appears to be inducement, is only acceleration of already present logical structures (cf. Inhelder & Sinclair, 1969; Klausmeier & Hooper, 1974; Strauss, 1972). In addition, it should be clear that earlier than normal inducement of logical operations is not, by itself, very damaging to the stage concept as long as Piaget's contentions about invariant sequence and synchrony are substantiated by the evidence. Without resolving the questions of whether logical operations are initiated or only accelerated, it is possible to build a strong argument for the case that training experiences at least hasten the overt manifestation of logical concepts in selected task situations. Considering conservation as an example of a potentially trainable operation, gains in this concept have been reported in a distinctively larger portion of studies than those where no improvements are achieved. The difference is even more marked in favor of successful training attempts when only the more recent studies are considered. Those studies that show a lack of conservation inducement tend to be older experiments, completed

in most cases prior to 1967 (cf. Beilin, 1971; Brainerd, 1973b; Brainerd & Allen, 1971; Glaser & Resnick, 1972; Klausmeier & Hooper, 1974).

Besides the fact that many experiments have accelerated the appearance of logical operations, other intervention programs focusing on the more substantive issues of synchrony and sequence have revealed a notable lack of harmony between ideal Piagetian theory and empirical findings (Brainerd, 1973d; Hooper, Goldman, Storck, & Burke, 1971). It is within this context that the present study is designed. There is increasing evidence that would seem to require a different and more complex conception of stages than that which is portrayed within a strict Piagetian framework. For example, Flavell (1971) speculates that a stage theory such as Piaget's does not logically require anything but a very loose sort of item concurrence at most. In another paper, Flavell (1972) proposes that theoretically interesting sequences do not have to be invariant and that more systematic efforts must be applied to the taxonomic classification, description, and interpretation of diverse between-item relationships pertinent to within-stage sequences.

THE PRESENT INVESTIGATION--GENERAL CONSIDERATIONS

One of the superior strategies to test the validity of the Piagetian conception of the concrete operational stage is to examine selected indices of this period in terms of synchrony and sequence through intervention designs. The concept task domains of transitive inference, conservation, and class inclusion understanding have been selected for this experiment. The present study may be viewed as a replication and extension of a training study by Brainerd (1974) that, in turn, draws heavily from the conclusions of a previous normative assessment by the same author (Brainerd, 1973c). His major finding is that instead of synchronous emergence among any of these concepts, there is the following asynchronous order of acquisition: transitivity, conservation, and class inclusion.

Generally, the essential difference between Brainerd's intervention study and the present design is that here a definite attempt is made to apply Brainerd's conceptions and results concerning these Piagetian concepts to a realistic instructional setting. Instead of utilizing Brainerd's technique of rigid verbal-feedback protocols and one-to-one experimenter/subject interaction, this study implemented a small group atmosphere and employed a more flexible format, so that an environment was created that was conducive to self-discovery and peer-group/teacher interaction in conjunction with positive feedback. The Genevans contend that it is social interaction and experience with the world of things--the shock of the child's thought coming into contact with the thoughts of others and physical reality--that aid in propelling him to more effective levels of logical reasoning (Piaget, 1970). It is hypothesized in the present study that significant inducements of the cognitive structures examined will be the result of such an environment.

Several specific questions are focused upon in this study:

1. Whether the above described application of small group interaction is an effective method of inducing the three selected Piagetian indices of concrete operations. Most of the remaining issues are essentially the same as those confronted by Brainerd (1974).
2. As a result of the previously described instructional environment, one may ask whether it is possible to induce durable and minimally general improvements in transitivity, conservation, and class inclusion of length (the implications of which have also been briefly discussed above).

3. Another issue relates to the question of whether experimentally induced transitivity, conservation, and class inclusion of length in small group situations are differentially susceptible to training. Differences in trainability would, of course, indicate the natural order of emergence. More difficulty in training an operation should correspondingly indicate its later emergence in a sequence of logical operations.
4. Whether the effects of experimentally inducing any of the concepts transitivity, conservation, or class inclusion of length transfers to any of the other two concept domains. This issue especially focuses upon whether it is possible to verify or disconfirm Piaget's conception of the structures d'ensemble. As part of this generalized framework, a necessity for synchrony between the three indices is implied; considerable transfer of training among transitivity, conservation, and class inclusion should be an outcome of training. If asynchronies exist in reality, then little or no transfer should be manifested. Brainerd (1973c, 1974) labels transfer between the content domains of weight and length as "interconcept" transfer. In accord with Pinard and Laurendeau (1969) he seems to believe that Piagetian theory, at minimum, demands synchronous emergence and development of the same content domain across the three indices. For example, a manifestation of transitivity of length presupposes the simultaneous emergence of the length domain for conservation and class inclusion. In his conclusion, Brainerd (1974) relates that his results indicate that transfer between similar content domains of the three indices does not occur with any significance. In contrast, he does find transfer between dissimilar content domains (i.e., between length and weight) within each separate concept.

For the purposes of this study, contrary to Brainerd's analysis, and for the sake of clarity, a "concept" refers to one of the three indices--transitivity, conservation, or class inclusion. Transfer between any of these three concepts will be referred to as "interconcept" transfer. Transfer effects between length and weight for each concept, considered individually, will be referred to as "intraconcept" transfer, which is the fifth concern of issue in this study.

It is reasoned that this distinction is proper, for when the general applicability of the concept conservation is analyzed, investigators seek to discover how it manifests itself in relation to different content dimensions (i.e., length, weight). This may be comparable to the gradual extension of such a concept as conservation to different content domains in the respective order substance, weight, and volume. The Genevans and other researchers have often referred to such a nonqualitative sequence as a horizontal décalage. Since there is often a lack of clarity in both the Genevan and Neo-Piagetian literature about the definitions of concept boundaries and the precise labels for the type of sequence being described, as well as a tendency to use the horizontal décalage conception to preserve an orthodox Piagetian view of stages, it is best to say that transfer between the content domains length and weight is at the intraconcept level where the conception of a horizontal décalage is applicable. This, of course, presupposes that a horizontal décalage is a valid concept and not simply a convenient mechanism to salvage ideas about synchrony that are of critical importance for a strictly Genevan conception of stage unity. Question 5 of this study, then, is concerned with whether when training in one content domain occurs (i.e., length) it will transfer to another dimension (i.e., weight) within one of the three concerned indices (i.e., conservation). This is referred to as "intraconcept" transfer.

A sixth question is whether, if intraconcept transfer (between length and weight) is assumed to be demonstrated, there are equivalent amounts of transfer within the three indices at the intraconcept level. According to Piagetian theory, all three indices are expressions of the same tightly bound ensemble of operations which, in turn, leave no basis for predicting differential amounts of intraconcept training. As Brainerd (1974) and Piaget (1961) argue, however, there may be sufficient reason to expect more transfer of this kind for transitivity and class inclusion than for conservation. The basis for such an argument is that conservation is not a purely logical principle, but instead, only a roughly accurate physical law. On the other hand, transitivity and class inclusion are more clearly manifestations of logical principles within which generalization should progress more easily; transfer and generalization within conservation should be less apparent.

A final question, 7, deals with the effect these training procedures have on a set of quasi-standardized measures of Piagetian classes and relations (i.e., the sixty-four concrete operational groupement task items). According to Piagetian theory, the close-knit ensemble of operations that are both represented by the groupement task items and underlie the three selected indices for this study should also show improvement if positive gains for transitivity, conservation, and class inclusion of length are the consequences of training. This last consideration is one that was not addressed in Brainerd's intervention study. In a metatheoretical sense, Piagetians would predict that improvements in aspects of the groupement represented by the three indices should have impact throughout the entire system of logically interrelated configurations of classes and relations. Therefore, the effect of training upon underlying logical structures in terms of inducement, synchrony, and sequence should be readily ascertainable by the utilization of the groupement tasks as pretest and posttest measures (Brainerd, 1972; Hooper, Brainerd, & Sipple, 1975). These tasks were employed in the present study as a measure against which the validity of training procedures and posttest results relating to the three concepts of primary concern were evaluated.

With reference to the issues that the present study has in common with Brainerd's (1974) investigation, a concise reiteration of his findings is necessary. The first question, 1, is not strictly comparable to Brainerd's approach in that the method of training employed in his investigation was individual instruction, while the present study structured small groups for the training sessions. Brainerd's results did, of course, show significant training effects--which is also one of the purposes of the present study despite the different methodology. Whether training induces the three logical conceptual areas will be examined in terms of how well Brainerd's positive results are replicated; this is the purpose of question 2. Brainerd came to several other conclusions that are being examined in the present study. He claimed that the skills of transitivity, conservation, and class inclusion are differentially susceptible to training, which verifies the same respective order of acquisition discovered in his previous normative assessment design and disagrees with Piagetian conceptions of synchrony. His evidence also appeared to reveal that there was little significant interconcept transfer between the examined indices (except slight transfer between transitivity and conservation of length), which fails to support the postulates relating to synchrony and the concept of the structures d'ensemble. In the intraconcept domain, however, transfer was found for all three indices and smaller amounts of transfer were found between length and weight conservation than the corresponding content domains of the other two

conceptual areas. In the investigation by Brainerd (1974) reviewed here, the effect of inducing the three selected logical concepts upon the groupements was not explored; however, this was examined in question 7 of the present experiment.

RELATED PREVIOUS RESEARCH

Few attempts have been made to explore all three of the indices--transitivity, conservation, and class inclusion--together in the same analysis. The Genevan studies appear to suggest contrary predictions (e.g., Inhelder & Piaget, 1964; Piaget & Inhelder, 1941; Piaget, 1952; Piaget, Inhelder, & Szeminska, 1960). These sources provide two specific predictions about the relationships between the three indices. The first specific prediction is that class inclusion precedes the approximately synchronous development of transitivity and conservation. The second specific prediction is that a progressive order of emergence is exhibited in the sequence: conservation, class inclusion, transitivity (cf. Brainerd, 1973c). It is particularly noteworthy that neither of these specific predictions is compatible with the overemphasis on synchrony found in the theoretically ideal portrayal of within-stage convergence.

Most studies in the Neo-Piagetian literature have focused upon the relationship between transitivity and conservation. Smedslund (1961) published results indicating that conservation of weight precedes transitivity of weight; 20 percent of his subjects possessed the former skill while only 1 percent displayed the latter. In another study by Lovell and Ogilvie (1961), an examination of conserver and nonconserver performances as related to transitivity ability indicated that conservation acquisition did not affect transitivity judgments since both conservers and nonconservers were able to perform transitivity tasks successfully. Kooistra (1965) focused on conservation of weight and transitivity of weight and concluded that the former is structured before the latter. After testing a population of 90 normals and 90 retardates matched for mental age, McManis (1969) deduced that conservation of length and weight were acquired significantly more easily than the analogous abilities in length and weight transitive inference. Garcez (1969, cited in Beilin, 1971) in a study that attempted to determine the effect of empirical demonstrations with a scale on both conservation and transitivity of weight, reports that none of the subjects trained on transitivity by itself became operational in it. However, 24 percent of the preoperational subjects trained on both transitivity and conservation gave operational responses. Significant conservation operativity was instilled when only conservation training was given. This, as well as other related data, led to the conclusion that operational achievement of conservation is needed for transitivity.

It seems quite apparent that the Neo-Piagetian studies just described give very little credence to a theoretically ideal picture of extensive synchrony as is frequently depicted in the general accounts written by Genevans. Turning to the micro-level, the first specific prediction by the Genevans on the relationship between the three indices (class inclusion first, followed by the synchronous emergence of transitivity and conservation) is not supported by these later studies because synchrony between transitivity and conservation is not demonstrated. With reference to the second specific prediction by the Genevans relating to the order of emergence (first conservation, then class inclusion, then transitivity), the idea that conservation precedes transitivity

would seem to be in accord with a large portion of the Neo-Piagetian literature. Class inclusion, however, was not analyzed in conjunction with the other two conceptual areas of concern. Other studies (described below), related more specifically to class inclusion, find that it appears rather late and not between the other two indices as the Piagetians contend. Another critical point is that the Neo-Piagetian literature is not in agreement with the order of acquisition posited by Brainerd (1973c, 1974). The order of emergence for transitivity and conservation tends to be reversed from that which Brainerd has shown it to be.

With the exception of the studies by Brainerd (1973c, 1974), little attempt has been made to examine the order of emergence of class inclusion in relation to transitivity and conservation. Other studies that are either more pertinent to class inclusion or that examine classification skills in a broader sense, indicate that class inclusion is a skill which develops very late. Kofsky (1966) designed 11 experimental tasks to assess the hypothesized acquisition of classificatory skills in the sequence postulated by Inhelder and Piaget (1964). It is not until the age of nine that more than half (60 percent) of the subjects are able to exhibit class inclusion ability. Another multiple measure experiment by Stephens (1972) indicates that class inclusion capacity for certain task situations may not be readily apparent until a mental age of 16 is reached--an age thought to be well within formal, not concrete operations. Hooper, Sipple, Goldman, and Swinton (1974) found that only 52.5 percent of the fourth grade subjects (mean ages of 10 years, 3 months) could perform class inclusion tasks successfully. Only 65 percent of the sixth-graders (mean age 12 years, 2 months) could pass the same task. In contrast to transitivity and conservation, which emerge, depending upon the study that is consulted, somewhere between four and eight years of age, class inclusion appears very late. This late development of the class inclusion skill as a representative of classification abilities is one central reason that serious consideration must be given to re-evaluating the unitary nature of the stage of concrete operations.

A number of issues relate to whether the late emergence of class inclusion is a substantive finding or is due only to methodological weaknesses. Brainerd and Kaszor (1974) have effectively analyzed and countered the arguments for its late emergence. These investigators found no support for the perceptual set hypothesis posed by Wohlwill (1968), whose contention that a highly visible disparity between numerically unbalanced subclasses is a significant source of juxtaposition errors. Wohlwill's idea was supported by experimental evidence demonstrating that presenting class inclusion problems entirely verbally markedly improved the frequency of correct judgments. Another important support for the perceptual set hypothesis was Ahr and Youniss' (1970) findings that as disparity between the subordinate classes in a class inclusion task increases, more incorrect judgments will tend to appear. Correspondingly, as the difference between the subordinate classes is decreased, correct class inclusion judgments appear to a progressively greater extent.

A replication by Brainerd and Kaszor (1974) of Wohlwill's (1968) comparison of verbal encoding/verbal decoding versus pictorial encoding/pictorial decoding did not prove to be significant, and thus, casts considerable doubt upon the positive impact alleged to result from the exclusive use of verbal administration of class inclusion tasks. In the same study by Brainerd and Kaszor (1974) a replication of Ahr and Youniss' (1970) study did not indicate that class inclusion judgments improve when the subordinate classes are equal as opposed to when they are unequal.

Evidence from other investigations also tends to corroborate Brainerd and Kaszor's findings relevant to the verbal facilitation effect. Schwartz (1970) found that there were more errors with verbal problems. Jennings' (1970) results demonstrated that there was no difference between verbal and nonverbal problems in 5 to 6 year olds and that more errors were found when verbal problems were presented to older children. Brainerd and Kaszor (1974) did find that false positive responses are generated both from posing difference questions in conjunction with a class inclusion problem where the two subordinate classes are equal, and from asking equivalence questions in cases where the two subordinate classes are not equal. Care has been taken in the present study to ensure that difference and equivalence questions are not asked under these circumstances.

Besides the perceptual set hypothesis, another putative source of error is question misinterpretation as proposed by Ahr and Youniss (1970) and Klahr and Wallace (1972). Essentially, what is argued here is that questions involving superordinate-subordinate comparisons tend to be translated into subclass comparisons. Brainerd and Kaszor (1974) analyzed this question and did not find that translations occur, nor did they find that failure to recall the question was a significant factor in failing to make correct class inclusion judgments. In light of this evidence, it appears increasingly improbable that the late emergence of class inclusion is attributable to the methodological issues that have been raised thus far in the Neo-Piagetian literature.

Another general methodological issue that pertains to the other two conceptual domains of our study (transitivity and conservation), as well as class inclusion, is the issue of whether or not to use judgments alone or judgments-plus-explanations as criteria to determine the presence or absence of a cognitive structure. This may have been a critical factor causing the differences in age norms found for the emergence of transitivity and conservation which either corroborate or fail to agree with the studies by Piaget, Inhelder, and Szeminska (1960). Such studies as those by Smedslund (1963, 1965, 1966), as opposed to those by Braine (1959, 1964), for transitivity, and investigations of conservation (e.g., Smedslund, 1961; Braine & Shanks, 1965a, 1965b) are in this category. A review of the controversy between Braine and Smedslund by Gruen (1966) points to the fact that Braine used only judgments while Smedslund required both judgments and explanations as response criteria. Brainerd (1973a) argued effectively that neither Smedslund or Braine adequately justified their separate approaches to this issue within the context of the theory of cognitive structures. He contended that from a Piagetian perspective, both judgments and explanations tap precisely the same cognitive structures: explanations are only lengthy verbalizations; language is not an intrinsic part of thought but, instead, is a dependent variable in relation to logical structures. A lengthy verbal rationale is a sufficient but not necessary condition to prove the presence of a structure. Such verbalizations are subject to at least two sources of Type II error, while judgments alone, Brainerd argues, are not subject to any inherent or systematic type of error.

Reese and Schack (1974) have countered Brainerd's contention by claiming that an excessive reliance upon judgment-only criterion is acceptable for studying within-stage synchronies but is inappropriate for analysis of vertical décalages. Instead, they believe that judgment-plus-explanations is the most adequate criterion for the examination of between-stage asynchronies. Reese and Schack (1974) also felt that it is incorrect to argue that a judgment-only criterion is not subject to any known systematic source of error. It is also erroneous, they contended, to claim that explanations are subject to Type II

error because skilliful use of Piaget's clinical method of testing can eliminate much of this inaccuracy. The present study has dealt with the issue of judgment-only vs. judgment-plus-explanations by employing both criteria. Conservation tasks of length and weight have been analyzed by this dual pass/fail criterion to determine if the use of either criterion has any impact on the results.

To reiterate, the recent Neo-Piagetian research pertinent to the three selected concepts has not corroborated the classical Genevan conception of synchrony among cognitive elements. Asynchronies have been revealed, although the Neo-Piagetians themselves have not always agreed upon the nature of the orders of emergence (i.e., Brainerd's order of emergence versus the results of other investigators reviewed above). In addition, despite the disagreement of classical Piagetians, the Neo-Piagetian literature appears to conclude that training can induce selected logical concepts and does have differential effects on various logical skills--which, of course, reveals the lack of convergence between cognitive items. The lack of correspondence, or more specifically, the late emergence of class inclusion, cannot be explained away by the alleged methodological weaknesses that have been discussed thus far in the literature. The intent of this investigation is to focus on several aspects of these very important issues relating to stage unity.

II

METHOD AND PROCEDURES

DESIGN

The experiment was composed of four major sessions consisting of a pretest and a training session followed by a posttest and a delayed posttest. The interval between the pretest and training sessions was 5 to 10 days. After the training sessions, an interval of 7 to 10 days elapsed before the posttest was given to all of the subjects. The irregular size of the intervals between sessions was caused by the absence of some subjects from school. A second posttest was given three months after completion of the first posttest to measure the durability of acquisition. The same task array was administered at all three testing points.

A pretest was given to a total of 105 kindergarten and first grade subjects (46 kindergarteners, 59 first graders) in two sessions on successive days. During the first session all subjects were randomly given portions of the 64-item groupement task array in one of two orders: classes (groupings I-IV) first, followed by relations (groupings V-VIII) or the reverse, with classes following relations. During the second session subjects were first pretested for their understanding of certain relational terms. All subjects had to pass the initial pretest section dealing with relational terms in order to continue participating in the study. Immediately following the test on relational terms, subjects were administered tasks on transitivity, conservation, and class inclusion of length-and-weight-in-one-of-twelve-orders-of-presentation (see Table 1). After the pretest, 89 subjects (44 kindergarteners, 45 first graders) were selected and randomly assigned to one of the following conditions: (1) transitivity of length training--kindergarten, (2) transitivity of length control--kindergarten, (3) transitivity of length training--first grade, (4) transitivity of length control--first grade, (5) conservation of length training--kindergarten, (6) conservation of length control--kindergarten, (7) conservation of length training--first grade, (8) conservation of length control--first grade, (9) class inclusion of length training--kindergarten, (10) class inclusion of length control--kindergarten, (11) class inclusion of length training--first grade, (12) class inclusion of length control--first grade (see Table 2).

For each training condition, subjects were randomly assigned to groups of 5 each. Two groups from each grade were assigned to each training condition (a total of four groups, or 20 subjects, per training condition). Each group was composed of either 3 males and 2 females or 2 males and 3 females. Control subjects, matched for grade and training condition, were individually exposed to the relevant training materials and the procedures used in the experimental conditions. Those subjects allotted to training groups received instruction only

TABLE 1

ORDERS OF PRESENTATION FOR THE TRANSITIVITY, CONSERVATION, AND CLASS INCLUSION TASKS

1. A transitivity of weight B transitivity of length C conservation of weight D conservation of length E class inclusion of weight F class inclusion of length	4. A conservation of weight B conservation of length C class inclusion of weight D class inclusion of length E transitivity of weight F transitivity of length	7. A transitivity of length B transitivity of weight C conservation of length D conservation of weight E class inclusion of length F class inclusion of weight	10. A conservation of length B conservation of weight C class inclusion of lengt D class inclusion of weigh E transitivity of length F transitivity of weight
2. A transitivity of weight B transitivity of length C class inclusion of weight D class inclusion of length E conservation of weight F conservation of length	5. A class inclusion of weight B class inclusion of length C transitivity of weight D transitivity of length E conservation of weight F conservation of length	8. A transitivity of length B transitivity of weight C class inclusion of length D class inclusion of weight E conservation of length F conservation of weight	11. A class inclusion of lengt B class inclusion of weigh C transitivity of length D transitivity of weight E conservation of length F conservation of weight
3. A conservation of weight B conservation of length C transitivity of weigh D transitivity of length E class inclusion of weight F class inclusion of length	6. A class inclusion of weight B class inclusion of length C conservation of weight D conservation of length E transitivity of weight F transitivity of length	9. A conservation of length B conservation of weight C transitivity of length D transitivity of weight E class inclusion of length F class inclusion of weight	12. A class inclusion of lengt B class inclusion of weigh C conservation of length D conservation of weight E transitivity of length F transitivity of weight

TABLE 2

DISTRIBUTION OF SUBJECT SAMPLES BY TREATMENT CONDITION, GRADE, AND SEX

Treatment Condition	Kindergarten		First Grade		
	Male	Female	Male	Female	Total
Transitivity training	6	4	4	6	20
Transitivity control	1	3	3	2	9
Conservation training	5	5	5	5	20
Conservation control	4	1	3	2	10
Class inclusion training	5	5	5	5	20
Class inclusion control	2	3	4	1	10
Total	23	21	24	21	89

on the particular task to which they were randomly assigned. The instructional setting employed a game-like atmosphere, peer-group/teacher interaction, and positive feedback within a small group context. All of the training materials were pretested prior to the present study, and all four of the testing and training experimenters conducted a pilot study using the procedures described above with subjects of the same age from another elementary school.

SUBJECTS

A pretest was given to a total of 105 children as described above (46 kindergartners, 59 first graders). These children were part of the enrollment at an elementary school in a middle-class neighborhood of Madison, Wisconsin. Distribution of the subject sample by age and sex is given in Table 3. Two female testers, 27 and 41 years old, administered the pretests and posttests. Two 28 year old males served as the experimenters for the training sessions.

MATERIALS

The materials for transitivity of length consisted of seven triads of colored sticks. Each triad was composed of two sticks 27.5 cm. in length (placed in the middle and in one of the outside positions) and one stick 28.5 cm. in length (placed in one of the outside positions). One of these triads colored red/white/red was used during the pre- and posttests only. The remaining six triads were used during the training sessions. The color scheme of the

TABLE 3

DISTRIBUTION BY GRADE, MEAN AGE, AND SEX OF THE SUBJECT POPULATION

Grade	Males	Females	Total Sample	Mean Age	S.D.
Kindergarten	24	21	44	5-7	0-4.5
First Grade	24	21	45	6-7	0-5

remaining triads was blue/yellow/blue, yellow/blue/yellow, black/brown/black, brown/black/brown, green/purple/green, and purple/green/purple.

The materials utilized for transitivity of weight were three 2.50 cm. diameter clay balls. The two outside clay balls were brown; the middle one was gray. One brown ball weighed 100 gm. The other brown ball and the gray ball each weighed 50 gm.

The materials for conservation of length consisted of eight pairs of 28.0 cm. lengths of colored string. Two pairs were used during the pre- and posttests only. The colors of the remaining pairs were blue, yellow, black, brown, purple, and green.

The materials for conservation of weight were two 2.50 cm. diameter brown clay balls weighing 50 gm. each. The materials for class inclusion of length consisted of a 21.0 x 27.5 cm. drawing of four logs and two ladders, a 21.0 x 27.5 cm. drawing of three logs and three ladders, a 21.0 x 27.5 cm. drawing of four boards and two lengths of rope, and a 21.0 x 27.5 cm. drawing of three boards and three lengths of rope.

The materials for class inclusion of weight were a 21.0 x 27.5 cm. drawing of four elephants and two trucks and a 21.0 x 27.5 cm. drawing of three elephants and three trucks. The materials for the relational terms pretest consisted of two lengths of blue string measuring 10 cm. and 20 cm. respectively, and a 21.0 x 27.5 cm. drawing of an elephant and a mouse.

The materials for groupements I-III consisted of two 21.0 x 27.5 cm. drawings. The first of these was a drawing of eight circles (2 blue, 2 red, 2 yellow, and 2 both red and yellow). The second was a drawing of eight triangles (2 blue, 2 red, 2 yellow, and 2 both red and yellow). Groupement IV employed stimuli consisting of two 21.0 x 27.5 cm. drawings. The first drawing depicted 2 red triangles, 2 yellow triangles, and 2 yellow circles. The second drawing was of 2 red circles, 2 yellow circles, and 2 yellow triangles.

For groupements V-VIII triads of sticks varying in color, length, and weight were used. Groupement V used one 22.5 cm. blue stick weighing 50 gm., one 23.0 cm. green stick weighing 25 gm., and one 23.5 cm. red stick weighing 5 gm. Groupement VI employed a triad of red, green, and blue sticks, all of which were 23.5 cm. long and weighed 5 gm. Groupement VII used one 22.5 cm. red stick weighing 5 gm., one 23.0 cm. blue stick weighing 25 gm., and one 23.5 cm.

green stick weighing 50 gm. Groupement VIII used one 23.0 cm. green stick, one 23.5 cm. red stick, and one 24.0 cm. blue stick, all of which weighed 5 gms.

PROCEDURE

During the pretest and posttests subjects sat at a 4 x 12 ft. table across from the experimenter. During the training sessions groups of five subjects sat in a semi-circle facing the experimenter. The control subjects for the training sessions sat at a 4 x 12 ft. table across from the experimenter. Only the materials for the specific tasks of concern were visible during any session. All subjects were administered the tasks individually during the pretest, posttests, and training control sessions.

PRETESTS

A. Groupements Measures

During the first session of the pretest all subjects were given the sixty-four-item concrete operational groupement task array. This battery of tasks was administered in one of two randomly assigned orders: classes first, followed by relations (groupings I-VIII in succession) or relations first followed by classes (groupings V-VIII followed by groupings I-IV). The total task array consists of 64 dichotomous judgments with eight responses representative of each of the separate groupings. One-half of the items deal with the composition operation and the remainder assess either inversion or reciprocity. These 64 items are viewed as overt manifestations of the hypothesized structural groupements that in Piagetian theory compose the structures d'ensemble. The following description of the groupement tasks is adapted from a paper by Hooper, Brainerd, and Sipple (1975). Descriptions of underlying logical operations can be found in Flavell (1963), Ginsburg and Opper (1969), Piaget (1966, 1972), and Piaget and Inhelder (1969). Complete task descriptions, theoretical rationales, and the psychometric characteristics of the groupements task array are reported in Hooper, Brainerd, and Sipple (1975). Protocols for the administration of the groupements measures are provided in Appendix A.

Groupement I--Primary addition of classes--procedure.

1. A 21.0 x 27.5 cm. drawing with 2 blue, 2 yellow, 2 red, and 2 both yellow and red circles is placed before the subject and the subject is asked whether the circles of one of the specific colors are either the same or more in number as all the circles. The above procedure is repeated exactly except that a 21.0 x 27.5 cm. drawing of triangles with the same number and color pattern is used. The logical operation reflected is the composition (addition) of hierarchical primary classes.

2. With the same drawings of circles and triangles, the subject is asked whether there would be any members of the superordinate class remaining if all the members of the subordinate class were removed. The logical operation reflected is the inversion (subtraction) of hierarchical primary classes.

Groupement II--Secondary addition of classes--procedure.

1. The same drawing of circles used in groupement I is placed before the subject, who is asked whether the circles of a different specific color are the same (more) in number as all the circles. The above procedure is repeated exactly,

except that a 21.0 x 27.5 cm. drawing of triangles with the same number and color pattern is used. The logical operation reflected is the composition (addition) of hierarchical secondary classes.

2. With the same drawings of circles and triangles, the subject is asked whether there would be any members of the superordinate class remaining if all the members of a subordinate class were removed. The logical operation reflected is the inversion (subtraction) of hierarchical secondary classes.

Groupement III--Bi-univocal multiplication of classes--procedure.

1. The same drawing of circles used for groupements I and II is placed before the subject who is asked whether the figures with any amount of yellow (red) on them are the same (more) in number as the figures with both yellow and red on them. The above procedure is repeated exactly, except that a 21.0 x 27.5 cm. drawing of triangles with the same number and color pattern is used. The logical operation reflected is the composition (multiplication) of classes or the establishment of one-to-one correspondences between each of the component members of two or more series of classes.

2. With the same drawings of circles and triangles, the subject is asked whether there would be any figures with both yellow and red on them remaining if all the circles with yellow (red) on them were removed. The logical operation reflected is the inversion (division) of a product class by one class.

Groupement IV--Co-univocal multiplication of classes--procedure.

1. One of two 21.0 x 27.5 cm. drawings with two red and two yellow triangles (circles), as well as two yellow circles (triangles) is placed before the subject who is asked whether the yellow circles are the same (more) in number as the yellow figures. The logical operation that is reflected is the composition (multiplication) of classes in which a member of one class is set in correspondence with (multiplied by) several members of one or more additional series.

2. With the same drawing of triangles and circles, the subject is asked whether there would be any yellow circles remaining if all the yellow figures were removed. The logical operation reflected is the inversion (division) of product classes by one class.

Groupement V--Addition of asymmetrical relations--procedure.

1. A triad of blue/green/red sticks is placed before the subject in the center of the table in the following order: (A) 22.5 cm. blue/ (B) 23.0 cm. green/ (C) 23.5 cm. red. The subject is shown and asked to verbalize the relationship that the blue stick (A) is shorter than the green stick (B), and that the green stick (B) is shorter than the red stick (C). The experimenter then removes the green stick and asks the subject about the length relationship between the blue stick (A) and the red stick (C). The above procedure is repeated using the same stimuli except that the weight relationship between the three sticks is explored with the subject. The logical operation reflected is transitive inference as applied to the composition (addition) of difference relations.

2. With the same stimuli, the subject is shown and asked to verbalize the relationship that the red stick (C) is longer than the green stick (B) and that the green stick (B) is longer than the blue stick (A). The experimenter then removes the green stick and asks the subject about the length relationship between the red stick (C) and the blue stick (A). The above procedure is repeated using the same stimuli except that the weight relationship between the three sticks is explored with the subject. The logical operation reflected is the reciprocity of difference relations.

Groupement VI--Addition of symmetrical relations--procedure.

1. A triad of (A) blue / (B) green / (C) red sticks is placed before the subject in the center of the table in the order blue/green/red. All three sticks are 23.5 cm. long. The subject is shown and asked to verbalize the relationship that the blue stick (A) is equal in length to the green stick (B) and that the green stick (B) is equal in length to the red stick (C). The experimenter then removes the green stick and asks the subject about the length relationship between the blue stick (A) and the red stick (C). The above procedure is repeated using the same stimuli except that the weight relationship between the three sticks is explored with the subject. The logical operation reflected is the composition (addition) of equivalence relations.

2. With the same stimuli, the subject is shown and asked to verbalize the relationship that the red stick (C) is equal in length to the green stick (B) and that the green stick (B) is equal in length to the blue stick (A). The experimenter then removes the green stick and asks the subject about the length relationship between the red stick (C) and the blue stick (A). The above procedure is repeated using the same stimuli except that the weight relationship between the three sticks is explored with the subject. The logical operation reflected is the reciprocity of equivalence relations.

Groupement VII--Bi-univocal multiplication of relations--procedure.

1. A triad of red/blue/green sticks is placed before the subject in the center of the table in the following order: (A) 22.5 cm. red stick weighing 5 gm. / (B) 23.0 cm. blue stick weighing 25 gm. / (C) 23.5 cm. green stick weighing 50 gm. The subject is shown and asked to verbalize the relationship that the red stick (A) is both shorter and lighter than the blue stick (B) and that the blue stick (B) is both shorter and lighter than the green stick (C). The experimenter then removes the blue stick and asks the subject about the length and weight relationship between the red stick (A) and the green stick (C). The logical operation that is reflected is the composition (multiplication) of difference relations.

2. With the same stimuli, the subject is shown and asked to verbalize the relationship that the green stick (C) is both longer and heavier than the blue stick (B) and that the blue stick (B) is both longer and heavier than the red stick (A). The experimenter then removes the blue stick and asks the subject about the length and weight relationship between the green stick (C) and the red stick (A). The logical operation reflected is the reciprocity of difference relations.

Groupement VIII--Co-univocal multiplication of relations--procedure.

1. A triad of green/red/blue sticks is placed before the subject in the center of the table in the following order: (A) 22.5 cm. green stick / (B) 23.0 cm. red stick / (C) 23.5 cm. blue stick. All three of the sticks weigh 5 gm. The subject is shown and asked to verbalize the relationship that the green stick (A) is shorter and weighs the same as the red stick (B) and that the red stick (B) is shorter and weighs the same as the blue stick (C). The experimenter then removes the red stick and asks the subject about the length and weight relationship between the green stick (A) and the blue stick (C). The logical operation reflected is the composition (multiplication) of difference relations by equivalence relations.

2. With the same stimuli present, the subject is shown and asked to verbalize the relationship that the blue stick (C) is longer and weighs the same as the red stick (B) and that the red stick (B) is longer and weighs the same as the green stick (A). The experimenter then removes the red stick and asks

the subject about the length and weight relationship between the blue stick (C) and the green stick (A). The logical operation reflected is the reciprocity of difference relations by equivalence relations.

B. Relational Terms, Transitivity, Conservation, and Class Inclusion Measures

During the second session of the pretest, given one day after the first session, the subjects were administered tasks on transitivity, conservation, and class inclusion relating to the content domains of length and weight. The subjects were administered these tasks in one of twelve orders. Both of the experimenters giving the tasks used all possible combinations of the battery. All of the twelve orders were administered to both sexes and were preceded by a relational terms warm up dealing with the terms "more," "heavier," "same," and "longer." The following general procedures and materials are modified versions of those used by Brainerd (1974). Complete protocols are provided in Appendix B.

1. Relational terms pretest.

Two blue strings, one 10 cm., the other 20 cm., were placed in the center of the table and the experimenter asks, "Are these two pieces of string the same length? Is one of the two pieces of string longer?" Next, the drawing of an elephant and a mouse are presented to the subject and the experimenter asks, "Do these two animals weigh the same? Is one of these animals heavier?" Last of all, the experimenter asks two verbal questions without any visible stimuli as follows: "If I had four cookies and you had two cookies, would we each have the same number of cookies? If I had four cookies and you had two cookies, would one of us have more cookies?" All 105 subjects who were administered the relational terms portion of the pretest passed and were given the remaining segments of the pretest. The rest of the pretest was given to the subjects in one of the twelve orders.

2. Transitivity pretest.

Transitivity of length assessment began with the initial placement of a triad of sticks colored red/white/red in the center of the table in the order: 27.5 cm. red / 27.5 cm. white / 28.5 cm. red. The distance between each of the three sticks was approximately 0.5 m. Second, the experimenter placed the 27.5 cm. white stick next to the 27.5 cm. red stick so that the subject could observe and verbally acknowledge that their lengths were equal. Third, the experimenter placed the 27.5 cm. white stick next to the 28.5 cm. red stick so that the subject could observe and verbally acknowledge that the red stick was longer. Fourth, the experimenter removed the 27.5 cm. white stick from the table and asked two randomly ordered questions: "Are the two red sticks the same length?" "Is one of the red sticks longer (if so, then which one)?" Fifth, the experimenter reversed the positions of the two red sticks relative to the white stick and repeated the second, third, and fourth steps.

The transitivity of weight assessment began with the initial placement of a triad of clay balls colored brown/gray/brown in the center of the table in the following order: 50 gm. brown / 50 gm. gray / 100 gm. brown. The distance between each of the three balls was approximately 0.5 m. Second, the experimenter placed the 50 gm. brown ball in the subject's right hand and the 50 gm. gray ball in the subject's left hand so that the subject could observe and verbally acknowledge that they weighed the same. Third, the experimenter returned the 50 gm. brown ball to its original position on the table, switched the gray ball to the subject's right hand, and placed the 100 gm. brown ball in the

subject's left hand so that the subject could observe and verbally acknowledge that the brown ball weighed more. Fourth, the experimenter returned the brown and gray balls to their original positions on the table and asked two randomly ordered questions: "Do the two brown balls weigh the same? Does one of the brown balls weigh more (if so, which one)?" Fifth, the experimenter reversed the positions of the two brown balls relative to the gray ball and repeated the second, third, and fourth steps.

3. Conservation pretest.

Conservation of length assessment began with the initial placement of two 28.0 cm. lengths of red string side-by-side in the center of the table. Second, the experimenter asked the subject whether or not the two lengths of string were the same length. Third, following the subject's response of yes, the experimenter altered one of the strings into a circle and asked two randomly ordered questions: "Are the two pieces of string still the same length? Is one of the pieces of string longer now?" Justification was requested after each question: "How do you know that?" Fourth, the experimenter removed the first pair of strings and replaced them with a second pair of 28.0 cm. green strings. The entire procedure for conservation of length was repeated with these new stimuli, except that the string was transformed into an "L" shape.

The conservation of weight assessment began with the placement of two 50 gm. brown clay balls in the center of the table. Second, the experimenter placed one ball in each of the subject's hands and asked whether or not the two balls weighed the same. Third, following the subject's affirmative response, the experimenter returned the balls to their original positions, flattened one into a pancake and asked two randomly ordered questions: "Do the two balls still weight the same? Is one of the balls heavier now?" Justification was requested following each question: "How do you know that?" Fourth, the experimenter removed the first pair of clay balls from the table and introduced the second pair of gray balls. The entire procedure was then repeated, except that one ball was rolled into an oblong shape (sausage).

4. Class inclusion pretest.

For the class inclusion tasks, care was taken to preclude the posing of equivalence questions in conjunction with unequal subordinate classes and difference questions for tasks involving equal subordinate classes. This was in accord with Brainerd and Kaszor's (1974) findings that such procedures will generate false positive judgments by subjects. The class inclusion task was initiated by the experimenter placing a 21.0 x 27.5 cm. drawing of four logs and two ladders in the center of the table and asking whether or not logs and ladders are both "long things." Second, after the child acknowledged an understanding of this fact, the experimenter asked the subject to respond as follows: "Count all the long things; count all the logs; count all the ladders." If the subject miscounted he was asked to recount until he had done so correctly. Third, the experimenter asked two randomly ordered questions: "Are there more logs than there are long things? Are there fewer long things than there are logs?" Fourth, the experimenter repeated the entire procedure with the drawing of three logs and three ladders. During the last stage of this second triad of length assessment, the experimenter asked two randomly ordered questions: "Are there the same number of logs as there are long things? Are there the same number of long things as there are logs?"

The class inclusion of weight procedure was initiated by the experimenter placing the drawing of four elephants and two trucks in the center of the table and asking the subject whether or not elephants and trucks are both "heavy things." Second, after the subject had responded in the affirmative, the

experimenter asked the subject to respond as follows: "Count all the heavy things; count all the elephants; count all the trucks." If the subject counted incorrectly he was asked to recount until he had done so correctly. Third, the experimenter asked two randomly ordered questions: "Are there more elephants than there are heavy things? Are there fewer heavy things than there are elephants?" Fourth, the experimenter removed the initial drawing and repeated the entire procedure with a drawing of three elephants and three trucks. During the last step of the second weight assessment, the experimenter asked two randomly ordered questions: "Are there the same number of elephants as there are heavy things? Are there the same number of heavy things as there are elephants?"

TRAINING PROCEDURES

For the training sessions, 89 subjects were selected and randomly assigned to one of twelve training and training-control conditions. All of the training sessions for the three conceptual areas were done in groups of five subjects seated in a semi-circle facing the experimenter. The essentials of the Brainerd (1974) protocols were retained and care was taken so that every subject was asked and responded individually to a complete series of the protocols. During this process, however, the experimenter allowed freedom of discussion, questions, and much interaction to occur between the subjects. The experimenter utilized positive feedback to reinforce correct responses but did not employ negative feedback. Instead, when a subject responded incorrectly, the experimenter would either repeat the question for the same subject or refer it to other members of the group. This structuring of a game-like atmosphere with groups of children seemed more realistically applicable to classroom situations than the Brainerd (1974) study where one-to-one experimenter/subject interaction occurred. Complete protocols of the training procedures are provided in Appendix C.

1. Transitivity training (TT)

For the 20 subjects (4 groups: 2 first grade, 2 kindergarten) trained on transitivity of length, the same protocols were administered for training this conceptual skill as had been used for the pretest. The same materials were used except that the triads of sticks were of different color combinations and for each repetition of the training trials a different triad of the six possible stimuli was used. The major difference was, of course, the small group situation, and the informal, game-like atmosphere that was created. After each correct response, the experimenter would supply positive feedback resembling, "You're right, this [pointing] stick is longer than the other one."

2. Transitivity control (TC)

The 10 subjects assigned to the transitivity of length control sessions were exposed individually to repetitions of the same protocols and materials as those subjects in the training conditions, except that the experimenter did not provide any positive feedback after correct responses. Exposure continued until the subject completed six successive repetitions of the protocols.

3. Conservation training (CT)

For the 20 subjects (4 groups: 2 first grade, 2 kindergarten) trained on conservation of length, the same protocols were administered for training this conceptual skill as had been used for the pretest. The same materials were used except that the pairs of strings were different colors and for each repetition of the training trials a different pair of the six possible stimuli was used. The major difference was, once again, the small group situation and the informal game-like atmosphere that was created. After each correct response, the experimenter would supply positive feedback resembling, "You're right, the two pieces

of string are still the same length."

4. Conservation control (CC).

The 10 subjects assigned to the conservation of length control sessions were exposed individually to repetitions of the same protocols and materials as those subjects in the comparable training condition, except that the experimenter did not provide any positive feedback after correct responses. Exposure continued until the subject completed six successive repetitions of the protocols.

5. Class inclusion training (CIT).

For the 20 subjects (4 groups: 2 first grade, 2 kindergarten) trained on class inclusion of length, the same protocols were administered for training this conceptual skill as had been used for the pretest. Essentially the same type of materials were used except that different drawings were employed (in the pretest, pictures of logs and ladders were used while for the training sessions, boards and lengths of rope were portrayed). The major difference was the small group situation and the informal, game-like atmosphere that was created. After each correct response, the experimenter would supply positive feedback resembling, "You're right, there are more long things."

6. Class inclusion control (CIC).

The 10 subjects assigned to the class inclusion of length control sessions were individually exposed to repetitions of the same protocols and materials as those subjects in the comparable training condition, except that the experimenter did not provide any positive feedback after correct responses. Exposure continued until the subject completed six successive repetitions of the protocols.

POSTTESTS

Two posttests were given. The first posttest was given 7 to 10 days after training. A delayed posttest, assessing the durability of acquisition, was administered three months after completion of the first posttest. Both of the posttests were exact duplications of the procedures followed in the pretest.

SCORING PROCEDURES

Scores for each of the eight groupements ranged from 0 to 8; each correct response was assigned a 1, each incorrect response assigned a 0. Extending this system, each groupement was analyzed into its component composition and inversion items that were each evaluated in terms of a range from 0 to 4. The entire groupement (groupings I-VIII) was assigned a scoring range of 0 to 64. Classes and relations, two major subdivisions of the entire groupement, were each assigned interval scores of 0 to 32. For the groupement as a whole, composition was scored 0 to 32, while inversion and reciprocity were each scored with a range of 0 to 16.

For transitivity, conservation, and class inclusion of length and weight, the score of a successful response was also represented by a 1, and an incorrect response was assigned a 0. Transitivity was assigned an interval scoring range of 0 to 6. In order to pass the transitivity of length and weight tasks, a subject must have responded correctly to all six questions. Conservation of length and weight were each given a range of 0 to 4. The passing criterion required that the subject make all four responses without error to successfully complete this task. Conservation performances were also evaluated as to whether the supporting explanation was a correct or incorrect manifestation of conservation

understanding. Table 4 describes the adequate and inadequate conservation response classifications. All of the conservation judgments must have been correct before the explanation became a factor in determining whether the subject passed or failed the task. Class inclusion of length and weight required a 0 to 4 score range: the passing criterion was four correct responses.

TABLE 4

CATEGORIES OF ADEQUATE AND INADEQUATE CONSERVATION TASK EXPLANATIONS[1]

Type of Response	Description of Representative Responses
ADEQUATE	
Inversion	Child verbalizes that if the piece of clay or string were to be returned to its original state, prior to transformation, it would be the same as the other string.
Reciprocity	Child verbalizes that the standard stimulus can be made to resemble the transformed stimulus.
Compensatory Relations	Child verbalizes that a decrease in one dimension of the transformed stimulus is compensated by an increase in the other dimension or vice versa so that it remains equal to the standard stimulus.
Addition/Subtraction	Since nothing has been added to or subtracted from the transformed stimulus, it remains equal to the standard stimulus.
Statement of Operations Performed	Child verbalizes that the shape of the stimulus has been changed but that the transformed stimulus still has the same amount of clay.
INADEQUATE	
Immediate Perceptual	Concentration on features such as it (e.g., string, clay) looks shorter-longer, lighter-heavier, less-more, or the same as the standard stimulus.
Irrelevant Considerations	e.g., because; I don't know; it's flat; it's round; balls are heavy and pancakes are light: because I held them.

[1]Adapted from Toniolo and Hooper, 1975.

III

RESULTS

PRELIMINARY CONSIDERATIONS

The pretest, posttest, and delayed posttest means and standard deviations for the various measures are presented in Tables 5 to 13. Initial considerations concern possible sex differences, order of presentation effects on the groupement indices, tester and trainer biases, and pretest distinctions among the various experimental conditions. Factorial analyses of variance (factors: sex, grade level, treatment condition) indicated no significant sex differences or interactions for the 23 variables with two exceptions. A significant sex x treatment condition interaction was found for the weight class inclusion pretest scores (F [5, 65] = 3.17, $p < .05$), where relative male superiority was true for the transitivity conditions and conservation training conditions while female superiority was shown for the remaining treatment conditions. However, post hoc Scheffé and Tukey HSD procedures failed to indicate any consistently interpretable patterns (see Table 5). A significant main effect indicating female superiority was found for the delayed posttest weight class inclusion scores (F [1, 65] = 5.74, $p < .05$, see Table 11). In view of these minor distinctions all further analyses combined the male and female subjects' scores.

Factorial analyses of variance (grade level x order of presentation) were conducted on the 17 score combinations for the groupement tasks. Two significant order of presentation main effects were observed. The groupement I total scores were higher for subjects receiving the relational tasks initially (F [1, 87] = 4.53, $p < .036$), while the groupement VIII scores were higher for those subjects initially receiving the classificatory tasks (F [1, 87] = 4.80, $p < .031$). Thus it may be concluded that the order of presentation has a relatively minor influence upon groupement task performances.

Two-way analyses of variance (grade level x tester) were run on the pretest data to evaluate any tester differences among 23 dependent variables. No marked tester effects were found for any of the variables except for conservation of weight (F [1, 85] = 10.60, $p < .01$). Significant grade x tester interaction effects were found for groupement I (f [1, 85] = 4.01, $p < .05$) and groupement V (F [1, 85] = 7.29, $p < .01$). Similar analyses of posttest data (grade level x trainer) to determine any significant trainer effects revealed no significant differences.

The pretest assessment data were analyzed to identify any significant differences among the treatment conditions prior to instruction. Variance analyses (grade level x treatment condition) revealed only one significant treatment condition distinction among the 23 variables (groupement II, F (5, 77) = 2.96, $p < .05$). Tukey HSD comparisons indicated that the transitivity training condition subjects

TABLE 5

PRETEST MEANS AND STANDARD DEVIATIONS OF THE TRANSITIVITY, CONSERVATION, AND CLASS INCLUSION TASKS [a]

Treatment Condition	TRANSITIVITY		CONSERVATION		CLASS INCLUSION	
	Weight	Length	Weight	Length	Weight	Length
(1) TRANSITIVITY OF LENGTH TRAINING						
Kindergarten						
Male	4.67(1.86)	5.00(2.45)	3.17(.98)	2.17(.98)	.67(1.03)	.67(.82)
Female	4.00(2.31)	3.00(3.46)	2.75(.96)	.75(.96)	.25(.50)	.75(.96)
Combined Subsample	4.40(1.96)	4.20(2.90)	3.00(.94)	1.60(1.17)	.50(.85)	.70(.82)
First Grade						
Male	6.00(.00)	5.00(2.00)	3.25(1.50)	2.75(1.50)	2.50(1.91)	2.50(1.29)
Female	5.83(.41)	4.67(2.34)	3.67(.82)	2.17(1.33)	2.67(1.37)	2.33(1.63)
Combined Subsample	5.90(.32)	4.80(2.10)	3.50(1.08)	2.40(1.35)	2.60(1.51)	2.40(1.43)
(2) TRANSITIVITY OF LENGTH CONTROL						
Kindergarten						
Male	4.00(.00)	4.00(.00)	3.00(.00)	2.00(.00)	2.00(.00)	4.00(.00)
Female	6.00(.00)	3.33(3.06)	2.00(2.00)	.67(1.15)	2.33(2.08)	2.00(1.00)
Combined Subsample	5.50(1.00)	3.50(2.52)	2.25(1.71)	1.00(1.16)	2.25(1.71)	2.50(1.29)
First Grade						
Male	5.00(1.00)	5.00(1.73)	1.33(2.31)	1.00(1.73)	3.00(.00)	2.33(2.08)
Female	6.00(.00)	6.00(.00)	3.00(.00)	2.00(.00)	.50(.71)	1.50(.71)
Combined Subsample	5.40(.89)	5.40(1.34)	2.00(1.87)	1.40(1.34)	2.00(1.41)	2.00(1.58)
(3) CONSERVATION OF LENGTH TRAINING						
Kindergarten						
Male	6.00(.00)	5.00(2.24)	.80(1.79)	1.00(1.73)	2.20(1.30)	1.60(1.34)
Female	5.60(.89)	6.00(.00)	2.80(1.64)	2.00(1.58)	1.00(1.22)	1.40(1.67)
Combined Subsample	5.80(.63)	5.50(1.58)	1.80(1.93)	1.50(1.65)	1.60(1.35)	1.50(1.43)
First Grade						
Male	5.40(.89)	5.20(1.79)	3.60(.89)	2.00(2.00)	2.20(1.64)	2.20(2.05)
Female	5.40(1.34)	4.80(1.10)	2.80(1.79)	2.00(2.00)	1.20(1.30)	2.00(1.58)
Combined Subsample	5.40(1.08)	5.00(1.41)	3.20(1.40)	2.00(1.89)	1.70(1.49)	2.10(1.73)
(4) CONSERVATION OF LENGTH CONTROL						
Kindergarten						
Male	5.00(1.41)	5.00(.82)	2.50(1.29)	2.00(1.83)	.25(.50)	1.25(1.50)
Female	6.00(.00)	5.00(.00)	4.00(.00)	2.00(.00)	3.00(.00)	1.00(.00)
Combined Subsample	5.20(1.30)	5.00(.71)	2.81(1.30)	2.00(1.58)	.80(1.30)	1.20(1.30)
First Grade						
Male	6.00(.00)	6.00(.00)	3.33(1.15)	3.67(.58)	1.33(2.31)	1.33(2.31)
Female	4.00(1.41)	4.00(1.41)	3.00(1.41)	2.00(2.83)	3.00(.00)	3.50(.71)
Combined Subsample	5.20(1.30)	5.20(1.30)	3.20(1.10)	3.00(1.73)	2.00(1.87)	2.20(2.05)

[a] Standard deviations are given in parentheses

Table 5 (cont.)

Treatment Condition	TRANSITIVITY		CONSERVATION		CLASS INCLUSION	
	Weight	Length	Weight	Length	Weight	Length
(5) CLASS INCLUSION OF LENGTH TRAINING						
Kindergarten						
Male	5.60(.89)	5.20(1.10)	2.40(.89)	1.40(1.67)	1.20(1.79)	1.20(1.64)
Female	5.20(.84)	5.40(.55)	1.80(1.48)	2.60(1.34)	.60(1.34)	.40(.89)
Combined Subsample	5.40(.84)	5.30(.82)	2.10(1.20)	2.00(1.56)	.90(1.52)	.80(1.32)
First Grade						
Male	4.00(2.74)	5.20(1.79)	3.20(1.79)	3.00(1.41)	.80(.84)	1.40(1.34)
Female	4.80(2.68)	5.20(1.30)	3.20(1.79)	2.00(2.00)	1.80(2.05)	1.80(2.05)
Combined Subsample	4.40(2.59)	5.20(1.48)	3.20(1.69)	2.50(1.72)	1.30(1.57)	1.60(1.65)
(6) CLASS INCLUSION OF LENGTH CONTROL						
Kindergarten						
Male	5.50(.71)	4.50(2.12)	.50(.71)	2.50(2.12)	.50(.71)	.00(.00)
Female	5.00(1.73)	5.00(1.73)	2.00(2.00)	1.67(.58)	1.67(2.08)	1.67(2.08)
Combined Subsample	5.20(1.30)	4.80(1.64)	1.40(1.67)	2.00(1.22)	1.20(1.64)	1.00(1.73)
First Grade						
Male	5.75(.50)	5.00(.82)	3.00(1.15)	2.25(1.71)	.75(.50)	1.25(.96)
Female	6.00(.00)	6.00(.00)	2.00(.00)	1.00(.00)	4.00(.00)	4.00(.00)
Combined Subsample	5.80(.45)	5.20(.84)	2.80(1.10)	2.00(1.58)	1.40(1.52)	1.80(1.48)

TABLE 6

PRETEST MEANS AND STANDARD DEVIATIONS FOR THE GROUPEMENT TASK ARRAYS [a]

Tasks and Possible Score Ranges

Treatment Condition	Grmt. 0-64	Grmt. CLS 0-32	Grmt. Rel. 0-32	Grmt. Comp. 0-32	Comp. CLS 0-16	Comp. Rel. 0-16	Inv. & Recip. 0-32	Inver. 0-16	Recip. 0-16
(1) TRANSITIVITY OF LENGTH TRAINING									
Kindergarten									
Male	37.67 (5.20)	15.17 (2.56)	22.50 (4.68)	16.00 (3.46)	4.83 (2.93)	11.17 (2.93)	22.33 (3.14)	11.00 (1.27)	11.33 (2.07)
Female	38.50 (6.46)	17.50 (3.70)	21.00 (2.83)	15.00 (4.55)	5.75 (3.59)	9.25 (2.06)	23.50 (2.89)	11.75 (2.87)	11.75 (1.26)
Combined Subsample	38.00 (5.40)	16.10 (3.11)	21.90 (3.93)	15.60 (3.72)	5.20 (3.05)	10.40 (2.68)	22.80 (2.94)	11.30 (1.95)	11.50 (1.72)
First Grade									
Male	46.00 (5.72)	20.75 (3.20)	25.25 (3.30)	21.75 (4.11)	9.25 (1.89)	12.50 (2.65)	24.25 (3.59)	11.50 (3.00)	12.75 (1.71)
Female	46.00 (3.90)	18.67 (5.01)	27.33 (2.66)	19.17 (2.93)	5.67 (3.50)	13.50 (1.76)	26.83 (3.19)	13.00 (2.37)	13.83 (2.14)
Combined Subsample	46.00 (4.40)	19.50 (4.30)	26.50 (2.95)	20.20 (3.49)	7.10 (3.38)	13.10 (2.08)	25.80 (3.43)	12.40 (2.59)	13.40 (1.96)
(2) TRANSITIVITY OF LENGTH CONTROL									
Kindergarten									
Male	43.00 (.00)	17.00 (.00)	26.00 (.00)	17.00 (.00)	6.00 (.00)	11.00 (.00)	26.00 (.00)	11.00 (.00)	15.00 (.00)
Female	40.33 (6.35)	15.00 (1.73)	25.33 (8.08)	17.67 (.58)	5.00 (4.36)	12.67 (4.04)	22.67 (6.66)	10.00 (2.65)	12.67 (4.04)
Combined Subsample	41.00 (5.35)	15.50 (1.73)	25.50 (6.61)	17.50 (.58)	5.25 (3.59)	12.25 (3.40)	23.50 (5.69)	10.25 (2.22)	13.25 (3.50)
First Grade									
Male	41.67 (10.26)	18.00 (7.55)	23.67 (2.89)	18.00 (6.00)	6.33 (3.51)	11.67 (2.52)	23.67 (4.62)	11.68 (4.04)	12.00 (1.73)
Female	41.50 (2.12)	16.50 (.71)	25.00 (1.41)	15.50 (.71)	3.50 (2.12)	12.00 (1.41)	26.00 (2.83)	13.00 (2.83)	13.00 (.00)
Combined Subsample	41.60 (7.34)	17.40 (5.41)	24.20 (2.28)	17.00 (4.47)	5.20 (3.11)	11.80 (1.92)	24.60 (3.78)	12.20 (3.27)	12.40 (1.34)
(3) CONSERVATION OF LENGTH TRAININO									
Kindergarten									
Male	42.80 (9.63)	21.00 (4.85)	21.80 (6.61)	19.00 (5.24)	8.60 (2.70)	10.40 (3.65)	23.80 (4.44)	12.40 (2.30)	11.40 (3.21)
Female	41.40 (11.65)	17.40 (6.77)	24.00 (6.48)	17.20 (6.65)	5.20 (4.60)	12.00 (3.74)	24.20 (6.54)	12.20 (4.32)	12.00 (2.83)
Combined Subsample	42.10 (10.10)	19.20 (5.87)	22.90 (6.28)	18.10 (5.72)	6.90 (3.99)	11.20 (3.58)	24.00 (5.27)	12.30 (3.27)	11.70 (2.87)
First Grade									
Male	42.40 (5.60)	16.40 (5.32)	26.00 (3.32)	17.40 (4.51)	5.20 (4.09)	12.20 (1.10)	23.80 (3.27)	11.20 (1.79)	12.60 (2.07)
Female	39.80 (5.36)	16.00 (3.94)	23.80 (4.66)	17.00 (3.54)	5.40 (3.21)	11.60 (2.70)	22.80 (2.28)	10.60 (.89)	12.20 (2.49)
Combined Subsample	41.10 (5.34)	16.20 (4.42)	24.90 (3.99)	17.20 (3.82)	5.30 (3.47)	11.90 (1.97)	23.30 (2.71)	10.90 (1.37)	12.40 (2.17)

[a] Standard deviations are given in parentheses

Table 6 (cont.)

Tasks and Possible Score Ranges

Treatment Conditions	Grmt. 0-64	Grmt. CLS 0-32	Grmt. Rel. 0-32	Grmt. Comp. 0-32	Comp. CLS 0-16	Comp. Rel. 0-16	Inv. & Recip. 0-32	Inver. 0-16	Recip. 0-16
(4) CONSERVATION OF LENGTH CONTROL									
Kindergarten									
Male	35.25 (3.30)	15.25 (3.30)	20.00 (5.35)	13.75 (.50)	4.00 (3.16)	9.75 (3.10)	21.50 (3.79)	11.25 (.96)	10.25 (3.40)
Female	32.00 (.00)	13.00 (.00)	19.00 (.00)	9.00 (.00)	.00 (.00)	9.00 (.00)	23.00 (.00)	13.00 (.00)	10.00 (.00)
Combined Subsample	34.60 (3.21)	14.80 (3.03)	19.80 (4.66)	12.80 (2.17)	3.20 (3.27)	9.60 (2.70)	21.80 (3.35)	11.60 (1.14)	10.20 (2.95)
First Grade									
Male	43.33 (1.53)	14.67 (1.53)	28.67 (1.53)	16.67 (1.53)	2.33 (1.53)	14.33 (.58)	26.67 (.58)	12.33 (1.53)	14.33 (1.16)
Female	42.00 (5.66)	18.50 (3.54)	23.50 (2.12)	19.00 (.00)	8.50 (.71)	10.50 (.71)	23.00 (5.66)	10.00 (2.83)	13.00 (2.83)
Combined Subsample	42.80 (3.11)	16.20 (2.95)	26.60 (3.21)	17.60 (1.67)	4.80 (3.56)	12.80 (2.17)	25.20 (3.49)	11.40 (2.19)	13.80 (1.79)
(5) CLASS INCLUSION OF LENGTH TRAINING									
Kindergarten									
Male	42.00 (10.65)	16.40 (5.08)	25.60 (6.11)	17.80 (4.27)	4.80 (1.79)	13.00 (2.55)	25.00 (7.75)	12.40 (4.04)	12.60 (3.85)
Female	35.00 (5.39)	14.20 (3.03)	20.80 (6.14)	15.20 (1.30)	4.80 (3.42)	10.40 (3.29)	19.80 (4.97)	9.40 (2.41)	10.40 (2.88)
Combined Subsample	38.50 (8.77)	15.30 (4.11)	23.20 (6.30)	16.50 (3.27)	4.80 (2.57)	11.70 (3.09)	22.40 (6.72)	10.90 (3.51)	11.50 (3.41)
First Grade									
Male	39.00 (4.24)	13.00 (2.55)	26.00 (4.58)	14.20 (2.59)	1.40 (1.52)	12.80 (1.92)	24.80 (2.59)	11.60 (2.70)	13.20 (2.78)
Female	42.60 (4.16)	14.40 (2.79)	28.20 (2.39)	17.20 (2.28)	3.40 (1.14)	13.80 (1.64)	25.40 (2.70)	11.00 (2.24)	14.40 (.89)
Combined Subsample	40.80 (4.39)	13.70 (2.63)	27.10 (3.64)	15.70 (2.79)	2.40 (1.65)	13.30 (1.77)	25.10 (2.51)	11.30 (2.36)	13.80 (2.04)
(6) CLASS INCLUSION OF LENGTH CONTROL									
Kindergarten									
Male	36.50 (10.61)	17.50 (4.95)	19.00 (5.66)	18.00 (4.24)	8.00 (1.41)	10.00 (2.83)	18.50 (6.36)	9.50 (3.54)	9.00 (2.83)
Female	41.00 (3.00)	19.33 (4.04)	21.67 (6.35)	19.33 (5.51)	8.67 (6.43)	10.67 (3.79)	21.67 (4.93)	10.67 (3.51)	11.00 (2.65)
Combined Subsample	39.20 (6.22)	18.60 (3.91)	20.60 (5.51)	18.80 (4.49)	8.40 (4.62)	10.40 (3.05)	20.40 (5.03)	10.20 (3.11)	10.20 (2.59)
First Grade									
Male	38.50 (4.51)	13.25 (2.50)	25.25 (5.74)	16.50 (1.29)	4.00 (1.63)	12.50 (2.89)	22.00 (3.56)	9.25 (1.89)	12.75 (2.87)
Female	36.00 (.00)	15.00 (.00)	21.00 (.00)	16.00 (.00)	4.00 (.00)	12.00 (.00)	20.00 (.00)	11.00 (.00)	9.00 (.00)
Combined Subsample	38.00 (4.06)	13.60 (2.30)	24.40 (5.32)	16.40 (1.14)	4.00 (1.41)	12.40 (2.51)	21.60 (3.21)	9.60 (1.82)	12.00 (3.00)

TABLE 7

PRETEST MEANS AND STANDARD DEVIATIONS FOR THE EIGHT GROUPEMENT SUBTASKS [a]

Treatment Condition	Groupement Tasks G I	G II	G III	G IV	G V	G VI	G VII	G VIII
(1) TRANSITIVITY OF LENGTH TRAINING								
Kindergarten								
Male	4.33 (.82)	5.83 (1.47)	3.50 (1.52)	2.17 (.75)	5.67 (1.86)	7.83 (.41)	5.50 (2.88)	3.50 (1.38)
Female	4.75 (.96)	4.75 (.96)	3.50 (1.29)	4.50 (2.52)	5.25 (2.75)	5.25 (.96)	5.50 (2.38)	5.00 (.82)
Combined Subsample	4.50 (.85)	5.40 (1.35)	3.50 (1.35)	3.10 (1.97)	5.50 (2.12)	6.80 (1.48)	5.50 (2.55)	4.10 (1.37)
First Grade								
Male	7.00 (.82)	6.75 (.96)	1.75 (1.26)	5.25 (3.77)	6.75 (1.26)	7.50 (.58)	5.75 (.96)	5.25 (1.71)
Female	5.17 (1.17)	5.00 (1.10)	3.33 (2.94)	5.16 (1.83)	7.50 (.84)	7.00 (.89)	6.67 (1.37)	6.17 (1.72)
Combined Subsample	5.90 (1.37)	5.70 (1.34)	2.70 (2.45)	5.20 (2.57)	7.20 (1.03)	7.20 (.79)	6.30 (1.25)	5.80 (1.69)
(2) TRANSITIVITY OF LENGTH CONTROL								
Kindergarten								
Male	5.00 (.00)	2.00 (.00)	5.00 (.00)	5.00 (.00)	6.00 (.00)	7.00 (.00)	7.00 (.00)	6.00 (.00)
Female	3.67 (.58)	4.67 (.58)	2.00 (1.73)	4.67 (.58)	5.67 (1.53)	6.67 (2.31)	7.00 (1.73)	6.00 (2.65)
Combined Subsample	4.00 (.82)	4.00 (1.41)	2.75 (2.06)	4.75 (.50)	5.75 (1.26)	6.75 (1.89)	5.00 (1.41)	6.00 (2.16)
First Grade								
Male	5.33 (1.53)	5.00 (1.00)	3.33 (3.21)	4.33 (3.79)	6.67 (1.15)	8.00 (.00)	4.33 (2.31)	4.67 (.58)
Female	4.00 (1.41)	4.00 (.00)	4.00 (.00)	4.50 (.71)	6.00 (1.41)	8.00 (.00)	5.00 (1.41)	6.00 (1.41)
Combined Subsample	4.80 (1.48)	4.60 (.89)	3.60 (2.30)	4.40 (2.70)	6.40 (1.14)	8.00 (.00)	4.60 (1.82)	5.20 (1.10)
(3) CONSERVATION OF LENGTH TRAINING								
Kindergarten								
Male	5.80 (.84)	5.80 (1.30)	4.20 (2.05)	5.20 (1.64)	5.60 (3.58)	6.80 (1.64)	4.40 (3.65)	5.00 (.71)
Female	4.00 (1.87)	5.00 (2.00)	4.20 (1.30)	4.20 (2.77)	5.20 (1.92)	6.60 (1.95)	6.00 (1.87)	6.20 (1.92)
Combined Subsample	4.90 (1.66)	5.40 (1.65)	4.20 (1.62)	4.70 (2.21)	5.40 (2.72)	6.70 (1.70)	5.20 (2.86)	5.60 (1.51)
First Grade								
Male	5.20 (.84)	4.80 (1.30)	2.60 (1.67)	3.80 (4.02)	5.80 (2.86)	7.00 (1.73)	5.00 (2.24)	6.80 (1.10)
Female	4.60 (1.52)	4.80 (1.79)	2.80 (.84)	3.80 (1.64)	5.80 (2.17)	6.00 (2.74)	6.80 (.84)	5.20 (1.48)
Combined Subsample	4.90 (1.20)	4.80 (1.48)	2.70 (1.25)	3.80 (2.90)	5.80 (2.39)	6.50 (2.22)	5.90 (1.85)	6.00 (1.49)

[a] Standard deviations are given in parentheses

Table 7 (cont.)

Treatment Condition	Groupment Tasks G I	G II	G III	G IV	G V	G VI	G VII	G VIII
(4) CONSERVATION OF LENGTH CONTROL								
Kindergarten								
Male	4.50 (.58)	5.00 (1.41)	2.75 (2.63)	3.00 (.82)	6.00 (1.41)	5.25 (2.50)	5.00 (1.41)	3.75 (1.26)
Female	4.00 (.00)	4.00 (.00)	3.00 (.00)	2.00 (.00)	5.00 (.00)	8.00 (.00)	2.00 (.00)	4.00 (.00)
Combined Subsample	4.40 (.55)	4.80 (1.30)	2.80 (2.28)	2.80 (.84)	5.80 (1.30)	5.80 (2.49)	4.40 (1.82)	3.80 (1.10)
First Grade								
Male	4.43 (.58)	4.67 (1.15)	1.67 (1.53)	4.00 (1.00)	7.67 (.58)	8.00 (.00)	7.67 (.58)	5.33 (1.15)
Female	7.00 (1.41)	6.00 (.00)	.50 (.71)	5.00 (2.83)	8.00 (.00)	7.00 (.00)	5.50 (.71)	3.00 (1.41)
Combined Subsample	5.40 (1.67)	5.20 (1.10)	1.20 (1.30)	4.40 (1.67)	7.80 (.45)	7.60 (.55)	6.80 (1.30)	4.40 (1.67)
(5) CLASS INCLUSION OF LENOTH TRAINING								
Kindergarten								
Male	4.40 (1.14)	4.60 (1.14)	4.60 (1.95)	3.60 (2.61)	6.80 (1.30)	7.20 (1.30)	5.80 (1.64)	5.80 (2.49)
Female	4.20 (1.10)	3.60 (1.52)	2.80 (1.79)	3.60 (.89)	5.80 (2.05)	6.40 (2.19)	4.60 (1.95)	4.00 (1.87)
Combined Subsample	4.30 (1.06)	4.10 (1.37)	3.70 (2.00)	3.60 (1.84)	6.30 (1.70)	6.80 (1.75)	5.20 (1.81)	4.90 (2.28)
First Grade								
Male	4.20 (.84)	3.80 (.45)	2.60 (2.30)	2.40 (.89)	6.80 (1.10)	7.80 (.45)	5.80 (3.49)	5.60 (1.52)
Female	3.20 (.84)	3.60 (.55)	4.00 (1.58)	3.60 (3.05)	7.80 (.45)	7.80 (.45)	7.20 (.84)	5.40 (1.52)
Combined Subsample	3.70 (.95)	3.70 (.48)	3.30 (2.00)	3.00 (2.21)	7.30 (.95)	7.80 (.42)	6.50 (2.51)	5.50 (1.43)
(6) CLASS INCLUSION OF LENGTH CONTROL								
Kindergarten								
Male	3.50 (3.54)	5.00 (1.41)	4.50 (.71)	4.50 (.71)	5.50 (2.12)	5.50 (3.54)	5.00 (1.41)	3.00 (1.41)
Female	5.00 (1.00)	5.67 (.58)	4.33 (2.08)	4.33 (1.53)	4.33 (.58)	6.00 (2.00)	6.00 (2.00)	5.33 (2.31)
Combined Subsample	4.40 (2.07)	5.40 (.89)	4.40 (1.52)	4.40 (1.14)	4.80 (1.30)	5.80 (2.28)	5.60 (1.67)	4.40 (2.19)
First Grade								
Male	4.50 (.58)	4.50 (1.00)	1.75 (.96)	2.50 (3.11)	6.25 (1.71)	5.00 (2.58)	7.50 (.58)	6.50 (1.29)
Female	5.00 (.00)	6.00 (.00)	1.00 (.00)	3.00 (.00)	7.00 (.00)	7.00 (.00)	1.00 (.00)	6.00 (.00)
Combined Subsample	4.60 (.55)	4.80 (1.10)	1.60 (.89)	2.60 (2.70)	6.40 (1.52)	5.40 (2.41)	6.20 (2.95)	6.40 (1.14)

TABLE 8

POSTTEST MEANS AND STANDARD DEVIATIONS OF THE TRANSITIVITY, CONSERVATION, AND CLASS INCLUSION TASKS [a]

Treatment Condition	TRANSITIVITY		CONSERVATION		CLASS INCLUSION	
	Weight	Length	Weight	Length	Weight	Length
(1) TRANSITIVITY OF LENGTH TRAINING						
Kindergarten						
Male	4.67(2.42)	4.33(2.66)	3.00(1.26)	1.83(1.84)	1.00(1.26)	1.33(1.75)
Female	6.00(.00)	5.25(1.50)	2.25(1.71)	1.00(1.16)	1.25(1.89)	1.75(2.06)
Combined Subsample	5.20(1.93)	4.70(2.21)	2.70(1.42)	1.50(1.58)	1.10(1.45)	1.50(1.78)
First Grade						
Male	5.75(.50)	5.75(.50)	2.25(1.50)	2.75(1.26)	3.00(.82)	3.00(1.41)
Female	5.67(.82)	6.00(.00)	4.00(.00)	1.50(1.98)	2.17(1.47)	2.00(1.79)
Combined Subsample	5.70(.67)	5.90(.32)	3.30(1.25)	2.00(1.76)	2.50(1.27)	2.40(1.65)
(2) TRANSITIVITY OF LENGTH CONTROL						
Kindergarten						
Male	6.00(.00)	4.00(.00)	1.00(.00)	2.00(.00)	.00(.00)	.00(.00)
Female	6.00(.00)	5.00(1.73)	2.00(2.00)	.67(1.15)	1.33(.58)	1.33(1.53)
Combined Subsample	6.00(.00)	4.75(1.50)	1.75(1.71)	1.00(1.15)	1.00(.82)	1.00(1.41)
First Grade						
Male	5.67(.58)	6.00(.00)	2.33(2.08)	1.00(1.73)	3.00(1.00)	3.67(.58)
Female	6.00(.00)	6.00(.00)	3.50(.71)	2.50(2.12)	.00(.00)	1.00(1.41)
Combined Subsample	5.80(.45)	6.00(.00)	2.80(1.64)	1.60(1.82)	1.80(1.79)	2.60(1.67)
(3) CONSERVATION OF LENGTH TRAINING						
Kindergarten						
Male	6.00(.00)	6.00(.00)	3.20(1.79)	3.00(1.73)	1.40(1.52)	1.60(1.52)
Female	5.60(.89)	6.00(.00)	3.60(.89)	3.00(1.41)	1.40(1.67)	2.00(1.87)
Combined Subsample	5.80(.63)	6.00(.00)	3.40(1.35)	3.00(1.49)	1.40(1.51)	1.80(1.62)
First Grade						
Male	5.80(.45)	6.00(.00)	3.20(1.79)	4.00(.00)	1.80(1.79)	2.40(1.82)
Female	6.00(.00)	5.60(.89)	3.20(1.79)	2.80(1.79)	2.40(1.52)	2.40(1.82)
Combined Subsample	5.90(.32)	5.80(.63)	3.20(1.69)	3.40(1.35)	2.10(1.60)	2.40(1.71)
(4) CONSERVATION OF LENGTH CONTROL						
Kindergarten						
Male	5.50(.58)	4.25(1.71)	2.75(.96)	1.50(1.73)	.75(.96)	.25(.50)
Female	5.00(.00)	4.00(.00)	4.00(.00)	2.00(.00)	2.00(.00)	1.00(.00)
Combined Subsample	5.40(.55)	4.20(1.48)	3.00(1.00)	1.60(1.52)	1.00(1.00)	.40(.55)
First Grade						
Male	6.00(.00)	6.00(.00)	4.00(.00)	2.67(2.31)	2.00(2.00)	2.00(1.75)
Female	6.00(.00)	4.50(2.12)	3.00(1.41)	2.00(2.83)	3.00(1.41)	3.00(1.41)
Combined Subsample	6.00(.00)	5.40(1.34)	3.60(.89)	2.40(2.19)	2.40(1.67)	2.40(1.52)

[a]Standard deviations are given in parentheses

Table 8 (cont.)

Treatment Condition	TRANSITIVITY		CONSERVATION		CLASS INCLUSION	
	Weight	Length	Weight	Length	Weight	Length
(5) CLASS INCLUSION OF LENGTH TRAINING						
Kindergarten						
Male	5.40(.89)	5.00(1.22)	2.60(1.67)	2.40(1.52)	1.20(1.30)	1.80(1.30)
Female	4.40(2.61)	5.60(.89)	3.20(1.10)	2.00(1.41)	.80(1.30)	.80(1.79)
Combined Subsample	4.90(1.91)	5.20(1.06)	2.90(1.37)	2.20(1.40)	1.00(1.25)	1.30(1.57)
First Grade						
Male	6.00(.00)	4.80(2.68)	3.40(.89)	2.80(1.79)	1.60(1.67)	1.80(1.79)
Female	5.80(.45)	6.00(.00)	3.00(1.73)	2.60(1.34)	3.40(.89)	3.60(.89)
Combined Subsample	5.90(.32)	5.40(1.90)	3.20(1.32)	2.70(1.49)	2.50(1.58)	2.70(1.64)
(6) CLASS INCLUSION OF LENGTH CONTROL						
Kindergarten						
Male	4.50(2.12)	4.50(2.12)	2.00(2.83)	.50(.71)	.50(.71)	.00(.00)
Female	5.67(.58)	5.00(1.73)	2.00(2.00)	1.00(1.00)	1.67(2.08)	2.00(2.00)
Combined Subsample	5.20(1.30)	4.80(1.64)	2.00(2.00)	.80(.84)	1.20(1.64)	1.20(1.79)
First Grade						
Male	6.00(.00)	6.00(.00)	2.75(1.89)	2.75(1.89)	1.25(.96)	1.25(1.26)
Female	6.00(.00)	6.00(.00)	2.00(.00)	1.00(.00)	4.00(.00)	4.00(.00)
Combined Subsample	6.00(.00)	6.00(.00)	2.60(1.67)	2.40(1.82)	1.80(1.48)	1.80(1.64)

TABLE 9

POSTTEST MEANS AND STANDARD DEVIATIONS FOR THE GROUPEMENT TASK ARRAYS[a]

Tasks and Possible Score Ranges

Treatment Condition	Grmt. 0-64	Grmt. CLS 0-32	Grmt. Rel. 0-32	Grmt. Comp. 0-32	Comp. CLS 0-16	Comp. Rel. 0-16	Inver. & Recip. 0-32	Inver. 0-16	Recip. 0-16
(1) TRANSITIVITY OF LENGTH TRAINING									
Kindergarten									
Male	38.83 (4.79)	15.83 (5.31)	23.00 (5.87)	16.50 (3.56)	4.67 (3.83)	11.83 (2.86)	22.17 (3.82)	11.17 (2.82)	11.00 (3.74)
Female	39.75 (9.18)	16.50 (1.92)	23.25 (8.42)	14.50 (4.66)	3.25 (1.50)	11.25 (3.20)	25.00 (4.24)	13.25 (1.71)	11.75 (4.92)
Combined Subsample	39.20 (6.41)	16.10 (4.12)	23.10 (6.54)	15.70 (3.92)	4.10 (3.07)	11.60 (2.84)	23.30 (4.03)	12.00 (2.26)	11.30 (4.00)
First Grade									
Male	43.25 (3.30)	19.75 (3.30)	23.50 (1.73)	21.00 (2.94)	8.50 (3.42)	12.50 (.58)	22.25 (2.22)	11.25 (1.50)	11.00 (1.83)
Female	43.00 (6.90)	16.17 (5.42)	26.83 (4.62)	18.33 (2.88)	4.83 (3.06)	13.50 (2.07)	24.67 (4.72)	11.33 (3.27)	13.33 (2.66)
Combined Subsample	43.10 (5.49)	17.60 (4.84)	25.50 (3.98)	19.40 (3.06)	6.30 (3.56)	13.10 (1.66)	23.70 (3.95)	11.30 (2.58)	12.40 (2.55)
(2) TRANSITIVITY OF LENGTH CONTROL									
Kindergarten									
Male	37.00 (.00)	16.00 (.00)	21.00 (.00)	20.00 (.00)	9.00 (.00)	11.00 (.00)	17.00 (.00)	7.00 (.00)	10.00 (.00)
Female	39.67 (2.08)	16.00 (2.00)	23.67 (.58)	16.67 (6.03)	4.67 (5.03)	12.00 (1.00)	22.67 (5.03)	11.00 (4.58)	11.67 (.58)
Combined Subsample	39.00 (2.16)	16.00 (1.63)	23.00 (1.41)	17.50 (5.20)	5.75 (4.65)	11.75 (.96)	21.25 (4.99)	10.00 (4.24)	11.25 (.96)
First Grade									
Male	43.00 (9.54)	18.67 (7.77)	24.33 (3.22)	18.67 (5.86)	7.33 (6.03)	11.33 (1.53)	24.33 (4.04)	11.33 (2.08)	13.00 (2.00)
Female	39.50 (7.78)	16.00 (4.24)	23.50 (3.54)	15.00 (1.41)	4.00 (1.41)	11.00 (.00)	24.50 (9.19)	12.00 (5.66)	12.50 (3.54)
Combined Subsample	41.60 (8.02)	17.60 (6.07)	24.00 (2.92)	17.20 (4.66)	6.00 (4.69)	11.20 (1.10)	24.40 (5.41)	11.60 (3.21)	12.80 (2.28)
(3) CONSERVATION OF LENGTH TRAINING									
Kindergarten									
Male	43.40 (8.33)	20.60 (7.37)	22.80 (2.95)	19.00 (7.45)	7.40 (6.35)	11.60 (1.52)	24.40 (3.91)	13.20 (2.39)	11.20 (2.49)
Female	40.60 (10.85)	17.20 (7.08)	23.40 (5.55)	17.80 (7.92)	5.60 (5.86)	12.20 (2.59)	22.80 (5.12)	11.60 (3.72)	11.20 (3.11)
Combined Subsample	42.00 (9.24)	18.90 (7.05)	23.10 (4.20)	18.40 (7.28)	6.50 (5.84)	11.90 (2.03)	23.60 (4.38)	12.40 (3.06)	11.20 (2.66)
First Grade									
Male	49.60 (10.46)	21.20 (10.81)	28.40 (1.52)	22.40 (6.03)	9.00 (6.25)	13.40 (1.14)	27.20 (4.76)	12.20 (4.38)	15.00 (.71)
Female	45.00 (8.12)	19.20 (5.31)	25.80 (4.15)	20.00 (4.90)	7.60 (3.85)	12.40 (3.05)	25.00 (3.74)	11.60 (2.70)	13.40 (1.14)
Combined Subsample	47.30 (9.15)	20.20 (7.73)	27.10 (3.25)	21.20 (5.33)	8.30 (4.95)	12.90 (2.23)	26.10 (4.20)	11.90 (3.45)	14.20 (1.23)

[a] Standard deviations are given in parentheses

Table 9 (cont.)

Tasks and Possible Score Ranges

Treatment Condition	Grmt. 0-64	Grmt. CLS 0-32	Grmt. Rel. 0-32	Grmt. Comp. 0-32	Comp. CLS 0-16	Comp. Rel. 0-16	Inver. & Recip. 0-32	Inver. 0-16	Recip. 0-16
(4) CONSERVATION OF LENGTH CONTROL									
Kindergarten									
Male	38.25 (2.87)	14.50 (2.52)	23.75 (2.75)	16.75 (1.71)	5.25 (1.71)	11.50 (1.29)	22.50 (1.29)	10.25 (2.63)	12.25 (1.71)
Female	33.00 (.00)	14.00 (.00)	19.00 (.00)	14.00 (.00)	5.00 (.00)	9.00 (.00)	19.00 (.00)	9.00 (.00)	10.00 (.00)
Combined Subsample	37.20 (3.42)	14.40 (2.19)	22.80 (3.19)	16.20 (1.92)	5.20 (1.48)	11.00 (1.58)	21.80 (1.92)	10.00 (2.34)	11.80 (1.79)
First Grade									
Male	41.00 (4.00)	12.67 (2.52)	28.33 (3.79)	16.00 (3.61)	2.33 (2.52)	13.67 (2.31)	25.00 (1.00)	10.33 (.58)	14.67 (1.53)
Female	48.50 (.71)	23.00 (.00)	25.50 (.71)	23.00 (.00)	10.50 (.71)	12.50 (.71)	25.50 (.71)	12.50 (.71)	13.00 (.00)
Combined Subsample	44.00 (5.00)	16.80 (5.93)	27.20 (3.11)	18.00 (4.60)	5.60 (4.83)	13.20 (1.79)	25.20 (.84)	11.20 (1.30)	14.00 (1.41)
(5) CLASS INCLUSION OF LENGTH TRAINING									
Kindergarten									
Male	43.80 (8.14)	18.40 (3.58)	25.40 (6.58)	18.80 (5.22)	5.80 (3.63)	13.00 (3.54)	25.00 (4.06)	12.60 (1.14)	12.40 (3.29)
Female	38.20 (4.76)	15.40 (3.78)	22.80 (5.93)	18.00 (2.92)	6.40 (4.16)	11.60 (2.97)	20.20 (4.15)	9.00 (1.41)	11.20 (3.03)
Combined Subsample	41.00 (6.94)	16.90 (3.81)	24.10 (6.06)	18.40 (4.01)	6.10 (3.70)	12.30 (3.16)	22.60 (4.62)	10.80 (2.25)	11.80 (3.05)
First Grade									
Male	42.60 (5.37)	16.40 (4.98)	26.20 (5.12)	18.80 (4.82)	5.20 (4.21)	13.60 (2.30)	23.80 (.84)	11.20 (2.59)	12.60 (2.88)
Female	47.00 (7.04)	17.60 (5.37)	29.40 (2.51)	21.60 (3.78)	6.80 (2.86)	14.80 (1.30)	25.20 (4.21)	10.60 (3.13)	14.60 (1.67)
Combined Subsample	44.80 (6.34)	17.00 (4.92)	27.80 (4.16)	20.20 (4.34)	6.00 (3.50)	14.20 (1.87)	24.50 (2.95)	10.90 (2.73)	13.60 (2.46)
(6) CLASS INCLUSION OF LENGTH CONTROL									
Kindergarten									
Male	37.50 (6.36)	16.00 (.00)	21.50 (6.36)	16.00 (.00)	6.00 (2.83)	10.00 (2.83)	21.50 (6.36)	10.00 (2.83)	11.50 (3.54)
Female	42.00 (9.85)	18.00 (1.73)	24.00 (8.19)	19.00 (3.46)	7.67 (2.52)	11.33 (4.51)	23.00 (6.56)	10.33 (3.21)	12.67 (4.04)
Combined Subsample	40.20 (8.04)	17.20 (1.64)	23.00 (6.75)	17.80 (2.95)	7.00 (2.45)	10.80 (3.56)	22.40 (5.68)	10.20 (2.68)	12.20 (3.42)
First Grade									
Male	39.75 (1.89)	15.50 (2.52)	24.25 (3.40)	17.00 (1.63)	4.25 (2.63)	12.75 (1.26)	22.75 (2.22)	11.25 (2.22)	11.50 (2.89)
Female	47.00 (.00)	22.00 (.00)	25.00 (.00)	22.00 (.00)	9.00 (.00)	13.00 (.00)	25.00 (.00)	13.00 (.00)	12.00 (.00)
Combined Subsample	41.20 (3.63)	16.80 (3.63)	24.40 (2.97)	18.80 (2.65)	5.20 (3.11)	12.80 (1.10)	23.20 (2.17)	11.60 (2.07)	11.60 (2.51)

TABLE 10

POSTTEST MEANS AND STANDARD DEVIATIONS FOR THE EIGHT GROUPEMENT SUBTASKS[a]

Treatment Condition	Groupement Tasks							
	G I	G II	G III	G IV	G V	G VI	G VII	G VIII
(1) TRANSITIVITY OF LENGTH TRAINING								
Kindergarten								
Male	5.00 (1.55)	4.83 (.75)	3.67 (2.58)	2.33 (1.51)	6.33 (1.86)	6.50 (2.51)	5.50 (2.07)	4.50 (1.38)
Female	4.25 (.50)	4.50 (.58)	3.00 (1.83)	4.75 (2.50)	6.00 (2.45)	7.25 (.96)	4.75 (3.30)	5.00 (1.83)
Combined Subsample	4.70 (1.25)	4.70 (.67)	3.40 (2.22)	3.30 (2.21)	6.20 (1.99)	6.80 (1.99)	5.20 (2.49)	4.70 (1.49)
First Grade								
Male	6.00 (1.63)	5.25 (.96)	4.25 (1.50)	4.25 (2.22)	6.75 (.50)	6.50 (1.29)	5.00 (1.41)	5.25 (1.26)
Female	5.00 (1.10)	4.83 (.98)	2.33 (1.86)	4.00 (3.41)	7.00 (1.55)	6.67 (1.63)	7.00 (1.67)	6.17 (1.84)
Combined Subsample	5.40 (1.35)	5.00 (.94)	3.10 (1.91)	4.10 (2.85)	6.90 (1.20)	6.60 (1.43)	6.20 (1.81)	5.80 (1.62)
(2) TRANSITIVITY OF LENGTH CONTROL								
Kindergarten								
Male	3.00 (.00)	3.00 (.00)	6.00 (.00)	4.00 (.00)	6.00 (.00)	5.00 (.00)	6.00 (.00)	4.00 (.00)
Female	4.67 (1.15)	4.33 (.58)	2.67 (1.53)	4.00 (.00)	6.67 (1.15)	6.33 (2.08)	6.67 (.58)	4.00 (1.00)
Combined Subsample	4.25 (1.26)	4.00 (.82)	3.50 (2.08)	4.00 (.00)	6.50 (1.00)	6.00 (1.83)	6.50 (.58)	4.00 (.82)
First Grade								
Male	5.00 (2.65)	5.33 (3.06)	2.67 (1.15)	5.67 (2.08)	7.33 (1.15)	7.33 (1.15)	6.33 (.58)	3.33 (1.53)
Female	4.00 (.00)	4.00 (.00)	5.00 (1.41)	3.00 (2.83)	5.50 (3.54)	8.00 (.00)	5.00 (1.41)	5.00 (1.41)
Combined Subsample	4.60 (1.95)	4.80 (2.28)	3.60 (1.67)	4.60 (2.51)	6.60 (2.19)	7.60 (.89)	5.80 (1.10)	4.00 (1.58)
(3) CONSERVATION OF LENGTH TRAINING								
Kindergarten								
Male	5.60 (1.67)	5.80 (2.05)	4.00 (2.35)	5.20 (2.95)	6.60 (.55)	6.40 (2.30)	4.80 (2.68)	5.00 (1.23)
Female	5.20 (1.79)	4.80 (2.17)	3.80 (1.30)	3.40 (2.97)	5.60 (1.95)	7.40 (1.34)	5.80 (2.95)	4.60 (1.14)
Combined Subsample	5.40 (1.65)	5.30 (2.06)	3.90 (1.79)	4.30 (2.95)	6.10 (1.45)	6.90 (1.85)	5.30 (2.71)	4.80 (1.14)
First Grade								
Male	6.00 (1.58)	6.40 (1.52)	3.80 (3.35)	5.00 (4.12)	7.40 (1.34)	8.00 (.00)	7.00 (1.23)	6.00 (1.87)
Female	6.00 (1.22)	6.60 (1.14)	3.40 (2.70)	3.20 (1.30)	6.60 (2.19)	8.00 (.00)	6.20 (1.30)	5.00 (1.73)
Combined Subsamples	6.00 (1.33)	6.50 (1.27)	3.60 (2.88)	4.10 (3.04)	7.00 (1.76)	8.00 (.00)	6.60 (1.27)	5.50 (1.78)

[a]Standard deviations are given in parentheses

Table 10 (cont.)

Groupement Tasks

Treatment Condition	G I	G II	G III	G IV	G V	G VI	G VII	G VIII
(4) CONSERVATION OF LENGTH CONTROL								
Kindergarten								
Male	5.25 (1.89)	6.25 (1.71)	3.00 (1.63)	1.00 (1.16)	7.00 (.82)	6.75 (2.50)	5.50 (2.38)	4.50 (1.00)
Female	6.00 (.00)	5.00 (.00)	2.00 (.00)	1.00 (.00)	3.00 (.00)	8.00 (.00)	2.00 (.00)	6.00 (.00)
Combined Subsample	5.40 (1.67)	6.00 (1.58)	2.80 (1.48)	1.00 (1.00)	6.20 (1.92)	7.00 (2.24)	4.80 (2.59)	4.80 (1.10)
First Grade								
Male	4.33 (.58)	4.00 (.00)	2.00 (2.00)	2.33 (1.53)	7.67 (.58)	7.67 (.58)	7.00 (1.00)	6.00 (1.73)
Female	8.00 (.00)	5.00 (1.41)	3.50 (2.12)	6.50 (.71)	8.00 (.00)	7.50 (.71)	7.00 (.00)	3.00 (.00)
Combined Subsample	5.80 (2.05)	4.40 (.89)	2.60 (1.95)	4.00 (2.55)	7.80 (.45)	7.60 (.55)	7.00 (.71)	4.80 (2.05)
(5) CLASS INCLUSION OF LENGTH TRAINING								
Kindergarten								
Male	5.20 (1.30)	5.20 (1.92)	3.00 (1.00)	5.00 (1.23)	7.20 (1.79)	6.80 (1.79)	6.20 (1.79)	5.20 (1.64)
Female	4.80 (1.30)	4.20 (.45)	3.00 (1.73)	3.40 (2.19)	6.80 (1.64)	6.20 (2.05)	5.20 (1.79)	4.60 (1.95)
Combined Subsample	5.00 (1.25)	4.70 (1.42)	3.00 (1.33)	4.20 (1.87)	7.00 (1.63)	6.50 (1.84)	5.70 (1.77)	4.90 (1.73)
First Grade								
Male	5.40 (1.52)	5.00 (1.73)	2.60 (1.14)	3.40 (3.05)	6.60 (1.67)	8.00 (.00)	6.60 (1.67)	5.00 (2.55)
Female	5.00 (1.00)	4.60 (.89)	3.40 (1.14)	4.40 (3.21)	7.60 (.55)	8.00 (.00)	7.20 (1.10)	6.60 (1.34)
Combined Subsample	5.20 (1.23)	4.80 (1.32)	3.00 (1.16)	3.90 (3.00)	7.10 (1.29)	8.00 (.00)	6.90 (1.37)	5.80 (2.10)
(6) CLASS INCLUSION OF LENGTH CONTROL								
Kindergarten								
Male	4.50 (.71)	4.00 (.00)	3.50 (.71)	4.00 (.00)	5.50 (2.12)	6.50 (2.12)	5.00 (1.41)	4.50 (.71)
Female	5.00 (.00)	4.00 (.00)	5.00 (1.73)	4.00 (1.73)	6.67 (1.15)	6.00 (2.00)	5.67 (3.21)	5.67 (2.31)
Combined Subsample	4.80 (.45)	4.00 (.00)	4.40 (1.52)	4.00 (1.22)	6.20 (1.48)	6.20 (1.79)	5.40 (2.41)	5.20 (1.79)
First Grade								
Male	4.00 (1.41)	4.75 (.50)	3.50 (.58)	3.25 (1.50)	7.25 (.96)	4.75 (2.22)	7.00 (1.41)	5.25 (.50)
Female	6.00 (.00)	6.00 (.00)	4.00 (.00)	6.00 (.00)	7.00 (.00)	8.00 (.00)	6.00 (.00)	4.00 (.00)
Combined Subsample	4.40 (1.52)	5.00 (.71)	3.60 (.55)	3.80 (1.79)	7.20 (.84)	5.40 (2.41)	6.80 (1.30)	5.00 (.71)

TABLE 11

DELAYED POSTTEST MEANS AND STANDARD DEVIATIONS OF THE TRANSITIVITY, CONSERVATION, AND CLASS INCLUSION TASKS[a]

Treatment Condition	TRANSITIVITY		CONSERVATION		CLASS INCLUSION	
	Weight	Length	Weight	Length	Weight	Length
(1) TRANSITIVITY OF LENOTH TRAINING						
Kindergarten						
Male	5.50(.84)	4.83(2.40)	2.67(1.63)	3.00(1.55)	1.17(.75)	1.83(1.47)
Female	4.75(2.50)	4.50(2.38)	2.50(1.91)	.75(.96)	1.50(1.73)	1.25(1.89)
Combined Subsample	5.20(1.62)	4.70(2.26)	2.60(1.65)	2.10(1.73)	1.30(1.16)	1.60(1.58)
First Grade						
Male	5.00(1.41)	5.25(1.50)	2.75(1.50)	3.00(1.16)	2.75(1.50)	3.00(1.16)
Female	6.00(.00)	5.00(2.00)	4.00(.00)	3.17(1.33)	1.33(1.03)	1.33(1.21)
Combined Subsample	5.60(.97)	5.10(1.73)	3.50(1.08)	3.10(1.20)	1.90(1.37)	2.00(1.41)
(2) TRANSITIVITY OF LENOTH CONTROL						
Kindergarten						
Male	6.00(.00)	5.00(.00)	1.00(.00)	.00(.00)	3.00(.00)	1.00(.00)
Female	5.33(.58)	6.00(.00)	2.33(2.08)	.33(.58)	1.33(.58)	1.67(2.08)
Combined Subsample	5.50(.58)	5.75(.50)	2.00(1.83)	.25(.50)	1.75(.96)	1.50(1.73)
First Grade						
Male	6.00(.00)	5.67(.58)	2.00(2.00)	1.33(2.31)	2.33(2.08)	2.67(2.31)
Female	6.00(.00)	6.00(.00)	4.00(.00)	3.50(.71)	1.00(1.41)	.50(.71)
Combined Subsample	6.00(.00)	5.80(.45)	2.80(1.79)	2.20(2.05)	1.80(1.79)	1.80(2.05)
(3) CONSERVATION OF LENGTH TRAINING						
Kindergarten						
Male	5.80(.45)	5.80(.45)	2.60(1.34)	2.60(1.95)	2.00(1.00)	2.00(1.00)
Female	5.80(.45)	6.00(.00)	3.20(1.79)	3.40(1.34)	1.20(1.79)	1.00(1.73)
Combined Subsample	5.80(.42)	5.90(.32)	2.90(1.52)	3.00(1.63)	1.60(1.43)	1.50(1.43)
First Grade						
Male	5.40(1.34)	5.20(1.79)	3.60(.89)	3.20(1.79)	2.00(1.87)	2.40(2.19)
Female	6.00(.00)	5.40(1.34)	3.80(.45)	3.00(1.73)	2.60(1.95)	2.40(1.82)
Combined Subsample	5.70(.95)	5.30(1.49)	3.70(.67)	3.10(1.66)	2.30(1.83)	2.40(1.90)
(4) CONSERVATION OF LENGTH CONTROL						
Kindergarten						
Male	5.50(1.00)	4.75(1.50)	2.50(1.73)	1.25(1.89)	1.00(1.15)	1.25(1.89)
Female	6.00(.00)	6.00(.00)	4.00(.00)	.00(.00)	3.00(.00)	1.00(.00)
Combined Subsample	5.60(.89)	5.00(1.41)	2.80(1.64)	1.00(1.73)	1.40(1.34)	1.20(1.64)
First Grade						
Male	6.00(.00)	6.00(.00)	4.00(.00)	3.33(1.16)	2.00(2.00)	2.33(2.08)
Female	6.00(.00)	5.50(.71)	4.00(.00)	.00(.00)	2.00(1.41)	3.00(1.41)
Combined Subsample	6.00(.00)	5.80(.45)	4.00(.00)	2.00(2.00)	2.00(1.58)	2.60(1.67)

[a]Standard deviations are given in parentheses

Table 11 (cont.)

Treatment Condition	TRANSITIVITY		CONSERVATION		CLASS INCLUSION	
	Weight	Length	Weight	Length	Weight	Length
(5) CLASS INCLUSION OF LENGTH TRAINING						
Kindergarten						
Male	5.60(.89)	4.80(1.79)	2.60(1.95)	2.40(1.52)	2.00(1.00)	2.00(1.87)
Female	5.20(.84)	5.00(1.23)	3.60(.55)	2.00(1.41)	.80(1.79)	.80(1.79)
Combined Subsample	5.40(.84)	4.90(1.45)	3.10(1.45)	2.20(1.40)	1.40(1.51)	1.40(1.84)
First Grade						
Male	5.80(.45)	4.40(2.30)	4.00(.00)	2.40(2.19)	1.80(1.79)	2.60(1.67)
Female	5.40(1.34)	5.20(1.79)	4.00(.00)	1.80(2.05)	3.20(1.79)	3.20(1.79)
Combined Subsample	5.60(.97)	4.80(1.93)	4.00(.00)	2.10(2.02)	2.50(1.84)	2.90(1.66)
(6) CLASS INCLUSION OF LENGTH CONTROL						
Kindergarten						
Male	4.00(1.41)	4.50(2.12)	2.00(1.41)	3.00(1.41)	.50(.71)	1.50(.71)
Female	5.67(.58)	3.67(3.21)	2.67(1.16)	2.00(2.00)	2.33(1.53)	2.00(2.00)
Combined Subsample	5.00(1.22)	4.00(2.55)	2.40(1.14)	2.40(1.67)	1.60(1.52)	1.80(1.48)
First Grade						
Male	6.00(.00)	5.00(1.41)	3.00(2.00)	2.25(2.06)	2.00(1.15)	1.50(.58)
Female	6.00(.00)	5.00(.00)	4.00(.00)	1.00(.00)	4.00(.00)	4.00(.00)
Combined Subsample	6.00(.00)	5.00(1.22)	3.20(1.79)	2.00(1.87)	2.40(1.34)	2.00(1.23)

TABLE 12

DELAYED POSTTEST MEANS AND STANDARD DEVIATIONS FOR THE GROUPEMENT TASK ARRAYS[a]

Treatment Condition	Grmt. 0-64	Grmt. CLS 0-32	Grmt. Rel. 0-32	Grmt. Comp. 0-32	Comp. CLS 0-16	Comp. Rel. 0-16	Inv. & Recip. 0-32	Inver. 0-16	Recip. 0-16
	Tasks and Possible Score Ranges								
(1) TRANSITIVITY OF LENGTH TRAINING									
Kindergarten									
Male	38.67 (3.27)	14.67 (4.18)	24.00 (5.14)	16.83 (1.33)	4.50 (2.43)	12.33 (2.81)	21.83 (2.79)	10.17 (2.56)	11.67 (2.58)
Female	36.00 (14.51)	15.75 (5.74)	20.25 (9.36)	13.75 (6.18)	3.25 (2.87)	10.50 (3.87)	22.25 (8.77)	12.50 (3.42)	9.75 (5.62)
Combined Subsample	37.60 (8.83)	15.10 (4.58)	22.50 (6.90)	15.60 (4.03)	4.00 (2.54)	11.60 (3.20)	22.00 (5.48)	11.10 (3.00)	10.90 (3.90)
First Grade									
Male	45.75 (7.27)	20.75 (5.38)	25.00 (4.24)	20.75 (6.13)	9.00 (5.35)	11.75 (2.22)	25.00 (2.16)	11.75 (1.71)	13.25 (2.22)
Female	43.33 (4.84)	15.83 (4.88)	27.50 (3.89)	17.33 (2.34)	3.33 (2.94)	14.00 (1.79)	26.00 (3.46)	12.50 (3.02)	13.50 (2.43)
Combined Subsample	44.30 (5.68)	17.80 (5.41)	26.50 (4.01)	18.70 (4.32)	5.60 (4.79)	13.10 (2.18)	25.60 (2.91)	12.20 (2.49)	13.40 (2.22)
(2) TRANSITIVITY OF LENGTH CONTROL									
Kindergarten									
Male	43.00 (.00)	15.00 (.00)	28.00 (.00)	22.00 (.00)	7.00 (.00)	15.00 (.00)	21.00 (.00)	8.00 (.00)	13.00 (.00)
Female	38.00 (5.20)	17.67 (1.53)	20.33 (6.43)	15.33 (2.31)	5.33 (3.06)	10.00 (3.46)	22.67 (4.51)	12.33 (1.53)	10.33 (3.06)
Combined Subsample	39.25 (4.92)	17.00 (1.83)	22.25 (6.50)	17.00 (3.83)	5.75 (2.63)	11.25 (3.78)	22.25 (3.78)	11.25 (2.50)	11.00 (2.83)
First Grade									
Male	46.33 (7.37)	18.67 (7.57)	27.67 (2.52)	20.33 (3.52)	6.33 (5.51)	14.00 (2.00)	26.00 (5.57)	12.33 (3.51)	13.67 (2.08)
Female	39.00 (7.07)	12.00 (2.83)	27.00 (4.24)	13.50 (2.12)	.50 (.71)	13.00 (1.41)	25.50 (4.95)	11.50 (2.12)	14.00 (2.83)
Combined Subsample	43.40 (7.47)	16.00 (6.63)	27.40 (2.79)	17.60 (4.62)	4.00 (5.05)	13.60 (1.67)	25.80 (4.66)	12.00 (2.74)	13.80 (2.05)
(3) CONSERVATION OF LENGTH TRAINING									
Kindergarten									
Male	41.80 (7.50)	18.60 (6.11)	23.20 (6.26)	19.80 (5.76)	8.20 (5.63)	11.60 (2.97)	22.00 (2.83)	10.40 (1.52)	11.60 (3.51)
Female	47.40 (7.60)	19.00 (7.62)	28.40 (3.44)	20.00 (4.95)	6.20 (5.98)	13.80 (1.79)	27.40 (4.67)	12.80 (3.42)	14.60 (1.67)
Combined Subsample	44.60 (7.71)	18.80 (6.51)	25.80 (5.49)	19.90 (5.06)	7.20 (5.57)	12.70 (2.58)	24.70 (4.62)	11.60 (2.80)	13.10 (3.04)
First Grade									
Male	54.80 (10.28)	24.00 (9.82)	30.80 (2.17)	25.40 (6.58)	10.20 (6.34)	15.20 (1.30)	29.60 (3.58)	14.00 (3.46)	15.60 (.89)
Female	48.80 (10.04)	20.40 (8.26)	28.40 (3.65)	22.40 (6.35)	8.40 (5.60)	14.00 (1.87)	26.40 (3.78)	12.00 (2.74)	14.40 (1.82)
Combined Subsample	51.80 (10.09)	22.20 (8.77)	29.60 (3.10)	23.90 (6.30)	9.30 (5.72)	14.60 (1.65)	28.00 (3.86)	13.00 (3.13)	15.00 (1.49)

[a]Standard deviations are given in parentheses

Table 12 (cont.)

Tasks and Possible Score Ranges

Treatment Condition	Grmt. 0-64	Grmt. CLS 0-32	Grmt. Rel. 0-32	Grmt. Comp. 0-32	Comp. CLS 0-16	Comp. Rel. 0-16	Inv. & Recip. 0-32	Inver. 0-16	Recip. 0-16
(4) CONSERVATION OF LENGTH CONTROL									
Kindergarten									
Male	41.50 (2.38)	17.00 (5.10)	24.50 (4.80)	18.25 (4.03)	6.00 (4.90)	12.25 (2.06)	23.25 (2.50)	11.00 (1.41)	12.25 (3.10)
Female	34.00 (.00)	10.00 (.00)	24.00 (.00)	13.00 (.00)	1.00 (.00)	12.00 (.00)	21.00 (.00)	9.00 (.00)	12.00 (.00)
Combined Subsample	40.00 (3.94)	15.60 (5.41)	24.40 (4.16)	17.20 (4.21)	5.00 (4.80)	12.20 (1.79)	22.80 (2.39)	10.60 (1.52)	12.20 (2.68)
First Grade									
Male	48.00 (2.65)	17.33 (3.06)	30.67 (1.53)	19.67 (.58)	4.33 (.58)	15.33 (1.16)	28.33 (2.89)	13.00 (2.65)	15.33 (.58)
Female	51.00 (9.90)	23.50 (6.36)	27.50 (3.54)	24.50 (2.12)	11.00 (1.41)	13.50 (.71)	26.50 (7.78)	12.50 (4.95)	14.00 (2.83)
Combined Subsample	49.20 (5.54)	19.80 (5.12)	29.40 (2.70)	21.60 (2.88)	7.00 (3.74)	14.60 (1.34)	27.60 (4.51)	12.80 (3.11)	14.80 (1.64)
(5) CLASS INCLUSION OF LENGTH TRAINING									
Kindergarten									
Male	39.60 (7.09)	16.80 (3.03)	22.80 (4.76)	16.60 (4.39)	5.00 (2.92)	11.60 (3.05)	23.00 (4.00)	11.80 (2.95)	11.20 (2.59)
Female	37.40 (6.58)	14.60 (5.41)	22.80 (5.40)	15.00 (4.74)	4.20 (4.97)	10.80 (2.59)	22.40 (3.85)	10.40 (1.52)	12.00 (2.92)
Combined Subsample	38.50 (6.55)	15.70 (4.30)	22.80 (4.80)	15.80 (4.39)	4.60 (3.86)	11.20 (2.70)	22.70 (3.71)	11.10 (2.33)	11.60 (2.63)
First Grade									
Male	44.60 (9.94)	16.60 (8.59)	28.00 (4.69)	18.80 (6.06)	5.20 (4.82)	13.60 (2.30)	25.40 (4.83)	11.60 (4.10)	13.80 (2.59)
Female	44.60 (3.58)	15.80 (3.83)	28.80 (1.92)	17.40 (1.52)	3.80 (2.17)	13.60 (1.14)	27.20 (2.78)	12.00 (2.45)	15.20 (.84)
Combined Subsample	44.60 (7.04)	16.20 (6.29)	28.40 (3.41)	18.10 (4.23)	4.50 (3.60)	13.60 (1.71)	26.30 (3.83)	11.80 (3.19)	14.50 (1.96)
(6) CLASS INCLUSION OF LENGTH CONTROL									
Kindergarten									
Male	37.00 (2.83)	16.00 (1.41)	21.00 (1.41)	17.50 (.71)	7.50 (.71)	10.00 (.00)	19.50 (3.54)	8.50 (2.12)	11.00 (1.41)
Female	35.00 (7.81)	14.67 (4.04)	20.33 (5.51)	14.67 (1.53)	4.33 (.58)	10.33 (1.53)	20.33 (6.35)	10.33 (3.51)	10.00 (4.00)
Combined Subsample	35.80 (5.81)	15.20 (3.03)	20.60 (3.98)	15.80 (1.92)	5.60 (1.82)	10.20 (1.10)	20.00 (4.85)	9.60 (2.88)	10.40 (2.97)
First Grade									
Male	36.50 (4.80)	12.75 (2.06)	23.75 (5.38)	13.25 (1.71)	2.00 (1.83)	11.25 (2.22)	23.25 (3.86)	10.75 (.96)	12.50 (3.32)
Female	48.00 (.00)	21.00 (.00)	27.00 (.00)	24.00 (.00)	10.00 (.00)	14.00 (.00)	24.00 (.00)	11.00 (.00)	13.00 (.00)
Combined Subsample	38.80 (6.61)	14.40 (4.19)	24.40 (4.88)	15.40 (5.03)	3.60 (3.91)	11.80 (2.28)	23.40 (3.36)	10.80 (.84)	12.60 (2.88)

TABLE 13

DELAYED POSTTEST MEANS AND STANDARD DEVIATIONS FOR THE EIGHT GROUPEMENT SUBTASKS[a]

Treatment Condition	Groupement Tasks							
	G I	G II	G III	G IV	G V	G VI	G VII	G VIII
(1) TRANSITIVITY OF LENGTH TRAINING								
Kindergarten								
Male	4.17 (.41)	5.00 (1.67)	3.33 (1.51)	2.17 (1.72)	6.17 (1.72)	7.33 (1.21)	5.83 (1.72)	4.67 (2.25)
Female	4.50 (.58)	4.50 (.58)	2.75 (1.71)	4.00 (3.37)	5.00 (3.56)	6.25 (2.36)	4.75 (3.59)	4.25 (2.06)
Combined Subsample	4.30 (.48)	4.80 (1.32)	3.10 (1.52)	2.90 (2.51)	5.70 (2.50)	6.90 (1.73)	5.40 (2.50)	4.50 (2.07)
First Grade								
Male	6.00 (1.83)	5.75 (2.06)	4.00 (1.63)	5.00 (1.16)	8.00 (.00)	7.00 (1.41)	4.75 (2.63)	5.25 (2.63)
Female	4.33 (.52)	4.83 (1.17)	2.67 (1.86)	4.00 (2.83)	7.67 (.52)	7.17 (.98)	6.50 (1.87)	6.17 (1.72)
Combined Subsample	5.00 (1.41)	5.20 (1.55)	3.20 (1.81)	4.40 (2.27)	7.80 (.42)	7.10 (1.10)	5.80 (2.25)	5.80 (2.04)
(2) TRANSITIVITY OF LENGTH CONTROL								
Kindergarten								
Male	5.00 (.00)	3.00 (.00)	4.00 (.00)	3.00 (.00)	8.00 (.00)	8.00 (.00)	6.00 (.00)	6.00 (.00)
Female	5.00 (1.73)	5.00 (1.73)	2.00 (.00)	5.67 (2.52)	6.00 (2.00)	5.33 (2.31)	5.00 (3.46)	4.00 (2.00)
Combined Subsample	5.00 (1.41)	4.50 (1.73)	2.50 (1.00)	5.00 (2.45)	6.50 (1.91)	6.00 (2.31)	5.25 (2.87)	4.50 (1.91)
First Grade								
Male	4.67 (3.51)	6.00 (2.00)	3.00 (3.00)	5.00 (3.00)	7.67 (.58)	8.00 (.00)	6.00 (1.00)	6.00 (1.00)
Female	4.00 (.00)	4.00 (.00)	.50 (.71)	3.50 (2.12)	7.50 (.71)	7.50 (.71)	7.00 (1.41)	5.00 (2.83)
Combined Subsample	4.40 (2.51)	5.20 (1.79)	2.00 (2.55)	4.40 (2.51)	7.60 (.55)	7.80 (.45)	6.40 (1.14)	5.60 (1.67)
(3) CONSERVATION OF LENGTH TRAINING								
Kindergarten								
Male	5.60 (1.82)	5.80 (1.79)	2.60 (1.95)	4.60 (2.51)	6.20 (3.49)	7.00 (1.41)	5.40 (2.97)	4.60 (.89)
Female	5.40 (1.67)	5.00 (2.00)	4.20 (1.92)	4.40 (2.88)	7.60 (.89)	7.60 (.89)	7.60 (.89)	5.60 (1.67)
Combined Subsample	5.50 (1.65)	5.40 (1.84)	3.40 (2.01)	4.50 (2.55)	6.90 (2.51)	7.30 (1.16)	6.50 (2.37)	5.10 (1.37)
First Grade								
Male	6.60 (1.67)	6.80 (1.79)	4.80 (2.95)	6.00 (3.46)	8.00 (.00)	8.00 (.00)	7.80 (.45)	7.00 (1.73)
Female	6.00 (1.87)	5.80 (2.49)	3.60 (1.41)	5.00 (3.08)	7.00 (1.22)	7.40 (1.34)	7.40 (.89)	6.60 (1.67)
Combined Subsample	6.30 (1.70)	6.30 (2.11)	4.20 (2.20)	5.50 (3.14)	7.50 (.97)	7.70 (.95)	7.60 (.70)	6.80 (1.62)

[a]Standard deviations are given in parentheses

Table 13 (cont.)

Treatment Condition	Groupement Tasks G I	G II	G III	G IV	G V	G VI	G VII	G VIII
(4) CONSERVATION OF LENGTH CONTROL								
Kindergarten								
Male	5.00 (1.41)	5.00 (2.00)	4.00 (1.41)	3.00 (2.00)	7.50 (1.00)	6.50 (1.92)	4.50 (2.08)	6.00 (.82)
Female	4.00 (.00)	3.00 (.00)	2.00 (.00)	1.00 (.00)	5.00 (.00)	8.00 (.00)	6.00 (.00)	5.00 (.00)
Combined Subsample	4.80 (1.30)	4.60 (1.95)	3.60 (1.52)	2.60 (1.95)	7.00 (1.41)	6.80 (1.79)	4.80 (1.93)	5.80 (.84)
First Grade								
Male	4.00 (.00)	4.00 (.00)	3.67 (1.53)	5.67 (3.22)	8.00 (.00)	8.00 (.00)	7.67 (.58)	7.00 (1.00)
Female	5.00 (2.83)	8.00 (.00)	3.50 (2.12)	7.00 (1.41)	8.00 (.00)	7.00 (1.41)	7.00 (.00)	5.50 (2.12)
Combined Subsample	4.40 (1.52)	5.60 (2.19)	3.60 (1.52)	6.20 (2.49)	8.00 (.00)	7.60 (.89)	7.40 (.55)	6.40 (1.52)
(5) CLASS INCLUSION OF LENGTH TRAINING								
Kindergarten								
Male	4.20 (1.79)	4.80 (.84)	3.20 (2.17)	3.40 (1.52)	6.60 (2.07)	7.40 (.89)	4.40 (2.51)	3.80 (2.68)
Female	4.60 (.89)	4.60 (1.34)	3.00 (1.87)	2.40 (3.05)	6.00 (2.55)	7.00 (1.41)	4.80 (1.79)	5.00 (1.73)
Combined Subsample	4.40 (1.35)	4.70 (1.06)	3.10 (1.91)	2.90 (2.33)	6.30 (2.21)	7.20 (1.14)	4.60 (2.07)	4.40 (2.22)
First Grade								
Male	5.40 (1.67)	5.40 (1.67)	2.60 (2.41)	3.40 (3.44)	7.20 (1.79)	8.00 (.00)	6.40 (2.61)	5.60 (2.19)
Female	4.20 (1.79)	3.80 (1.10)	3.00 (1.73)	4.80 (3.11)	7.60 (.55)	8.00 (.00)	6.60 (1.95)	6.60 (1.14)
Combined Subsample	4.80 (1.75)	4.60 (1.58)	2.80 (1.99)	4.10 (3.18)	7.40 (1.26)	8.00 (.00)	6.50 (2.17)	6.10 (1.73)
(6) CLASS INCLUSION OF LENGTH CONTROL								
Kindergarten								
Male	5.00 (2.83)	5.00 (1.41)	3.00 (1.41)	3.00 (1.41)	6.50 (.71)	6.00 (1.41)	5.00 (.00)	3.50 (.71)
Female	4.33 (2.52)	3.67 (.58)	3.33 (2.52)	3.33 (1.53)	5.67 (3.21)	7.67 (.58)	3.33 (1.15)	3.67 (2.08)
Combined Subsample	4.60 (2.30)	4.20 (1.10)	3.20 (1.92)	3.20 (1.30)	6.00 (2.35)	7.00 (1.22)	4.00 (1.22)	3.60 (1.52)
First Grade								
Male	4.00 (.00)	4.25 (.96)	2.25 (2.22)	1.75 (1.71)	6.50 (1.29)	6.25 (2.06)	5.50 (1.73)	5.50 (1.91)
Female	4.00 (.00)	6.00 (.00)	3.00 (.00)	8.00 (.00)	7.00 (.00)	8.00 (.00)	7.00 (.00)	5.00 (.00)
Combined Subsample	4.00 (.00)	4.60 (1.41)	2.40 (1.95)	3.00 (3.16)	6.60 (1.14)	6.60 (1.95)	5.80 (1.64)	5.40 (1.67)

were superior to their class inclusion training counterparts (q .05, 77 = 4.14). While the anticipated systematic differences between the grade levels were found, none of the grade/treatment condition interactions approached significance. From these preliminary analyses it may be concluded that the six treatment conditions were essentially equivalent prior to the instructional or control experiences, thus eliminating the need for gain-score or difference-score analyses in the results section to follow.

PRIMARY RESULTS

A 2 x 6 analysis of variance (factors: grade [K, 1] x treatment condition [TT, TC, CT, CC, CIT, CIC]) of posttest and delayed posttest data (see Tables 8 to 13) revealed few significant results. A significant treatment condition difference was found for conservation of length on the posttest (F [5, 77] = 2.51, $p < .05$) and two significant differences were found in the delayed posttest data (sum of groupement scores: F [5, 77] = 3.36, $p < .01$; groupement scores for composition: F [5, 77] = 3.18, $p < .05$). In the former posttest case Tukey HSD comparisons indicated conservation instructional condition subjects to be superior to transitivity control subjects (q .05, 77 = 4.14). In the latter delayed posttest cases, the conservation instructional subjects were superior to class inclusion control children.

A series of 2 x 2 analyses of variance were computed for the posttest data cases. The factors were grade (K, 1) and training versus control conditions (TT/TC; CT/CC; CIT/CIC). No significant specific training effects were found for transitive inference, conservation, or class inclusion. Only one significant training versus control group difference was found in all these analyses. The conservation training subjects were significantly better than their control counterparts in transitivity of length (F [1, 26] = 10.70, $p < .01$), and these differences were most notable at the kingergarten level (grade x condition interaction, F [1, 26] = 4.33, $p < .05$). Similar analyses for the delayed posttest scores indicated that for the length conservation task, conservation training subjects performed better than their control condition counterparts (F [1, 26] = 5.42, $p < .05$), and transitivity training subjects performed better than their control counterparts (F [1, 25] = 5.07, $p < .05$).

Following these analyses, those subjects who failed the skill on the pretest on which they were to be trained or exposed were identified. The posttest performances of these subjects were then evaluated for training effects. Since most of the subjects in the transitive inference groups passed the pretest, further analyses could not be done. A significant training effect was found for conservation (CT versus CC; means of 2.88 versus 1.20, $t = 1.78$, $df = 13$, $p < .05$) but not for the class inclusion case.

Tables 14 to 17 present the pass/fail frequency data for the focal transitivity, conservation, and class inclusion tasks. In marked contrast to the initial Brainerd (1974) training investigation, the vast majority of the present subjects passed the pretest transitive inference tasks (89 percent and 60 percent for the weight and length cases, respectively; see Table 14). This ceiling effect precluded any substantial instructional influences. There is some indication, however, of inter concept transfer to the length transitivity case for the conservation instructional condition at the initial posttest interval. The percentages of successful subjects across the three assessment points are 70 percent versus 40 percent, 95 percent versus 50 percent, and 85 percent versus 70 percent for the instructional and control conditions, respectively.

TABLE 14

FREQUENCY OF SUBJECTS PASSING OR FAILING THE TRANSITIVITY TASKS FOR THE THREE ASSESSMENT SESSIONS

	Weight Transitivity						Length Transitivity					
	Pretest		Posttest		Delayed Posttest		Pretest		Posttest		Delayed Posttest	
Treatment Condition	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Transitivity Training												
Kindergarten	6	4	8	2	7	3	7	3	6	4	6	4
First Grade	10	0	10	0	9	1	6	4	9	1	7	3
Total	16	4	18	2	16	4	13	7	15	5	13	7
Transitivity Control												
Kindergarten	4	0	4	0	4	0	1	3	2	2	3	1
First Grade	5	0	5	0	5	0	4	1	5	0	4	1
Total	9	0	9	0	9	0	5	4	7	2	7	2
Conservation Training												
Kindergarten	10	0	10	0	10	0	9	1	10	0	9	1
First Grade	10	0	10	0	10	0	5	5	9	1	8	2
Total	20	0	20	0	20	0	14	6	19	1	17	3
Conservation Control												
Kindergarten	3	2	3	2	4	1	1	4	1	4	3	2
First Grade	4	1	5	0	5	0	3	2	4	1	4	1
Total	7	3	8	2	9	1	4	6	5	5	7	3
Class Inclusion Training												
Kindergarten	9	1	9	1	10	0	5	5	6	4	5	5
First Grade	8	2	10	0	9	1	7	3	9	1	7	3
Total	17	3	19	1	19	1	12	8	15	5	12	8
Class Inclusion Control												
Kindergarten	5	0	5	0	4	1	3	2	3	2	2	3
First Grade	5	0	5	0	5	0	2	3	5	0	2	3
Total	10	0	10	0	9	1	5	5	8	2	4	6

TABLE 15

FREQUENCY OF SUBJECTS PASSING OR FAILING THE WEIGHT CONSERVATION TASKS (WITH AND WITHOUT EXPLANATIONS) FOR THE THREE ASSESSMENT SESSIONS

	Pretest				Posttest				Delayed Posttest			
	Without Explanation		With Explanation		Without Explanation		With Explanation		Without Explanation		With Explanation	
Treatment Condition	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Transitivity Training												
Kindergarten	3	7	2	8	4	6	3	7	4	6	2	8
First Grade	8	2	5	5	7	3	3	7	8	2	5	5
Total	11	9	7	13	11	9	6	14	12	8	7	13
Transitivity Control												
Kindergarten	1	3	1	3	1	3	1	3	1	3	1	3
First Grade	1	4	1	4	2	3	1	4	3	2	3	2
Total	2	7	2	7	3	6	2	7	4	5	4	5
Conservation Training												
Kindergarten	3	7	3	7	8	2	8	2	7	3	6	4
First Grade	7	3	6	4	8	2	7	3	8	2	7	3
Total	10	10	9	11	16	4	15	5	15	5	13	7
Conservation Control												
Kindergarten	2	3	2	3	2	3	2	3	3	2	3	2
First Grade	3	2	3	2	4	1	4	1	5	0	4	1
Total	5	5	5	5	6	4	6	4	8	2	7	3
Class Inclusion Training												
Kindergarten	2	8	2	8	5	5	4	6	6	4	4	6
First Grade	8	2	6	4	6	4	6	4	10	0	9	1
Total	10	10	8	12	11	9	10	10	16	4	13	7
Class Inclusion Control												
Kindergarten	1	4	1	4	2	3	2	3	1	4	2	3
First Grade	2	3	2	3	2	3	2	3	4	1	4	1
Total	3	7	3	7	4	6	4	6	5	5	6	4

TABLE 16

FREQUENCY OF SUBJECTS PASSING OR FAILING THE LENGTH CONSERVATION TASKS (WITH AND WITHOUT EXPLANATIONS) FOR THE THREE ASSESSMENT SESSIONS

	Pretest				Posttest				Delayed Posttest			
	Without Explanation		With Explanation		Without Explanation		With Explanation		Without Explanation		With Explanation	
Treatment Condition	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Transitivity Training												
Kindergarten	2	8	2	8	2	8	2	8	4	6	1	9
First Grade	3	7	3	7	3	7	2	8	6	4	5	5
Total	5	15	5	15	5	15	4	16	10	10	6	14
Transitivity Control												
Kindergarten	0	4	0	4	0	4	0	4	0	4	0	4
First Grade	0	5	0	5	1	4	0	5	2	3	2	3
Total	0	9	0	9	1	8	0	9	2	7	2	7
Conservation Training												
Kindergarten	2	8	2	8	6	4	6	4	7	3	6	4
First Grade	4	6	4	6	8	2	8	2	7	3	6	4
Total	6	14	6	14	14	6	14	6	14	6	12	8
Conservation Control												
Kindergarten	1	4	1	4	1	4	1	4	1	4	1	4
First Grade	3	2	3	2	3	2	3	2	2	3	2	3
Total	4	6	4	6	4	6	4	6	3	7	3	7
Class Inclusion Training												
Kindergarten	3	7	3	7	2	8	2	8	2	8	2	8
First Grade	5	5	5	5	5	5	5	5	5	5	5	5
Total	8	12	8	12	7	13	7	13	7	13	7	13
Class Inclusion Control												
Kindergarten	1	4	1	4	0	5	0	5	2	3	1	4
First Grade	1	4	1	4	2	3	2	3	2	3	2	3
Total	2	8	2	8	2	8	2	8	4	6	3	7

TABLE 17

FREQUENCY OF SUBJECTS PASSING OR FAILING THE CLASS INCLUSION TASKS FOR THE THREE ASSESSMENT SESSIONS

	Weight Class Inclusion						Length Class Inclusion					
	Pretest		Posttest		Delayed Posttest		Pretest		Posttest		Delayed Posttest	
Treatment Condition	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Transitivity Training												
Kindergarten	0	10	2	8	1	9	0	10	2	8	2	8
First Grade	4	6	2	8	2	8	3	7	4	6	2	8
Total	4	16	4	16	3	17	3	17	6	14	4	16
Transitivity Control												
Kindergarten	1	3	0	4	0	4	1	3	0	4	1	3
First Grade	0	5	1	4	1	4	1	4	2	3	2	3
Total	1	8	1	8	1	8	2	7	2	7	3	6
Conservation Training												
Kindergarten	1	9	1	9	1	9	1	9	2	8	1	9
First Grade	1	9	2	8	4	6	3	7	4	6	5	5
Total	2	18	3	17	5	15	4	16	6	14	6	14
Conservation Control												
Kindergarten	0	5	0	5	0	5	0	5	0	5	1	4
First Grade	1	4	2	3	1	4	2	3	1	4	2	3
Total	1	9	2	8	1	9	2	8	1	9	3	7
Class Inclusion Training												
Kindergarten	1	9	0	10	1	9	1	9	1	9	2	8
First Grade	2	8	4	6	5	5	2	8	5	5	6	4
Total	3	17	4	16	6	14	3	17	6	14	8	12
Class Inclusion Control												
Kindergarten	1	4	1	4	1	4	1	4	1	4	1	4
First Grade	1	4	1	4	1	4	1	4	1	4	1	4
Total	2	8	2	8	2	8	2	8	2	8	2	8

For the conservation tasks, the percentage of subjects in the conservation instructional condition passing the length task on posttest or delayed posttest varies from 60 to 70 percent, depending upon the response criterion selected (see Table 16). In contrast, the comparison control group (in which 40 percent of the subjects passed the pretest) values are 20 to 40 percent depending upon the response criterion employed. Thus, a certain degree of curriculum-specific transfer is indicated. As mentioned in the interval data analyses reported above, there is an indication of inter concept transfer for the transitivity training subjects on delayed posttesting; this is particularly true for the without-explanation response condition--passing percentages of 50 percent versus 20 percent for the training and control groups, respectively. For the counterpart conservation of weight case, 75 to 80 percent of the instructional condition children passed the posttest compared to 60 percent of the control group children. These slight differences are no longer evident at the time of delayed posttesting (see Table 15). Thus, little evidence for intra concept transfer is shown. Some minimal indications of inter concept transfer for class inclusion training is shown for the weight conservation delayed posttest case--passing percentages of 65 to 80 percent versus 50 to 60 percent.

In the final case of class inclusion concept attainment (see Table 17), it is interesting to note that the percentage of successful class inclusion control subjects remains a constant 20 percent across all assessment points for both the length and weight cases. In relative contrast, the instructional condition comparison percentages increase from 15 to 40 percent for the length case and from 15 to 30 percent for the weight case. There is no evidence for inter concept transfer for the transitivity and conservation instructional conditions.

IV

DISCUSSION

The results of this investigation may be discussed in regard to the initial questions posed earlier. Concerning the first and second questions, the efficacy of these small group instructional sessions which emphasized positive corrective feedback is somewhat limited in comparison to the original one-to-one training procedures of Brainerd (1974). Significant instructional effects, indicating minimal generality and durability were shown only for the conservation training condition.

The postulated order of difficulty and the suggested developmental order of emergence (transitivity→conservation→class inclusion) of Brainerd (1973c) is essentially substantiated in these findings. Transitive inference was clearly the easiest logical concept task and class inclusion the most difficult. Conservation was of intermediate difficulty. The percentages of successful subjects at the time of pretesting were 89 percent (transitivity), 46.1 percent (conservation without explanation), and 14.6 percent (class inclusion) for the weight concept cases, and 60 percent (transitivity), 28.1 percent (conservation without explanation), and 17.9 percent (class inclusion) for the length concept cases (see Tables 14 to 17). This pattern also holds insofar as differential susceptibility to instruction was concerned, i.e., no training effects were possible for the transitive inference conditions while significant specific instructional effects were found for conservation training but not for class inclusion instruction. The significant conservation instruction effects are in general accord with the previous training literature which has concerned kindergarten and first grade children (cf. reviews by Beilin, 1971; Brainerd, 1973b; Brainerd & Allen, 1971; Glaser & Resnick, 1972).

Minimal evidence for interconcept instructional transfer is found in these results. This also agrees with Brainerd's (1974) earlier conclusions. Other than certain suggestive cases in the pass/fail data, the only exceptions involve conservation training superiority (contrasted with control subjects' performances) on transitivity of length posttesting and a similar delayed posttest superiority for transitivity instructed subjects on conservation of length. Thus, interconcept instructional transfer to the extent that it is evident in the present results is restricted to the conservation and transitivity concept domains.

The questions dealing with the possibility of intraconcept instructional transfer (i.e., from length to weight concept cases) may be succinctly answered. In direct contrast to the intraconcept transfer cited in Brainerd's (1974) analyses, none of the present experimental or control condition subjects significantly differed on any of the three weight concept cases. It should be pointed out, however, that the weight transitivity and conservation concept cases were of generally lesser difficulty than the comparison length concept cases (see the pretest means and passing frequencies reported above) which may have reduced the probability of significant posttest and delayed posttest intraconcept transfer.

Concerning the final question regarding remote instructional transfer to the logical groupement tasks, few significant distinctions were observed among the present experimental conditions. As reported above, the exceptions were a significant conservation training condition superiority on the composition subtotal scores and the overall total groupement scores on delayed posttesting only.

In overview, the present result patterns indicate a notable absence of intraconcept transfer for any of the experimental conditions, a certain degree of interconcept instructional transfer between the transitive inference and conservation concept task domains, and minimal evidence for remote transfer which is restricted to the facilatory conservation training condition.

These results may be related to the general issues of stage structure and developmental synchrony as dictated by orthodox Piagetian theory. In the first instance, the differential item difficulties associated with the transitive inference, conservation, and class inclusion tasks (equated for content distinctions) are not in accord with the structural predictions of the within-stage correspondence postulate (cf. Flavell, 1971; Hooper, 1973a, 1973b; Pinard & Laurendeau, 1969; Wohlwill, 1973). In conjunction with the differential instructional outcomes which were observed, stage correspondence and developmental synchrony do not appear to be notably present in the children's performances. Moreover, acknowledging the restricted age-range involved, there was very little evidence for treatment/age-group interactions of the sort to be expected by a developmentalist orientation such as that of Piaget. Thus these results favor the recent interpretation of training studies by Brainerd (1973b) in contrast to the contentions of Strauss (1972). In terms of the major interactive determinants of instructional efficacy, i.e., the developmental status, the training techniques employed, and the complexity of the focal concept domains (Klausmeier & Hooper, 1974), the latter factor would appear to be the primary influence in this investigation.

The current picture is complicated somewhat by the suggestions of interconcept transfer which are in contrast to Brainerd's (1974) original conclusions. Conservation and transitive inference instruction did show some evidence for transfer to the counterpart conceptual domains and the conservation instruction effects carried over to the delayed groupements assessments. The transfer effects between transitivity and conservation understandings are predictable in terms of the relatively brief developmental "lag" observed for the latter skill (Brainerd, 1973c; Toniolo & Hooper, 1975) in comparison to the much later appearing class inclusion mastery (Brainerd, 1973c; Hooper, Swinton, & Sipple, in press). It may well be that the open-ended "game" atmosphere of these small group instructional sessions, while less efficient in terms of specific transfer than Brainerd's one-to-one corrective feedback strategy, is more likely to lead to interconcept generalization when significant learning does occur.

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Appendix A

Protocols for *Groupements* Measures

Groupement I

E reads the questions very slowly and emphasizes the words underlined. E may repeat questions only.

I. Circular Stimulus

A. Preliminary Counting

1. COUNT ALL THE CIRCLES THAT HAVE SOME YELLOW ON THEM. (4)*

2. COUNT ALL THE CIRCLES THAT DON'T HAVE YELLOW ON THEM. (4)*

B. Composition

1. ARE THERE THE SAME NUMBER OF CIRCLES WITH YELLOW ON THEM AS THERE ARE CIRCLES?

2. ARE THERE MORE CIRCLES THAN THERE ARE CIRCLES WITH YELLOW ON THEM?

C. Inversion

1. IF I TOOK AWAY THE CIRCLES WITH YELLOW ON THEM WOULD THERE BE SOME CIRCLES LEFT?

2. IF I TOOK AWAY THE CIRCLES WITH YELLOW ON THEM WOULD ALL THE CIRCLES BE GONE?

II. Triangular Stimulus

A. Preliminary Counting

1. COUNT ALL THE TRIANGLES THAT HAVE SOME YELLOW ON THEM. (4)*

2. COUNT ALL THE TRIANGLES THAT DON'T HAVE YELLOW ON THEM. (4)*

B. Composition

1. ARE THERE THE SAME NUMBER OF TRIANGLES WITH YELLOW ON THEM AS THERE ARE TRIANGLES?

2. ARE THERE MORE TRIANGLES THAN THERE ARE TRIANGLES WITH YELLOW ON THEM?

C. Inversion

1. IF I TOOK AWAY THE TRIANGLES WITH YELLOW ON THEM WOULD THERE BE SOME TRIANGLES LEFT?

2. IF I TOOK AWAY THE TRIANGLES WITH YELLOW ON THEM WOULD ALL THE TRIANGLES BE GONE?

* E may help S obtain correct number of each stimulus.

Groupement II

E reads the questions very slowly and emphasizes the words underlined. E may repeat questions only.

I. Circular Stimulus

A. Preliminary Counting

1. COUNT ALL THE CIRCLES THAT HAVE SOME RED ON THEM. (4)*

2. COUNT ALL THE CIRCLES THAT DON'T HAVE RED ON THEM. (4)*

B. Composition

1. ARE THERE THE SAME NUMBER OF CIRCLES WITH RED ON THEM AS THERE ARE CIRCLES?

2. ARE THERE MORE CIRCLES THAN THERE ARE CIRCLES WITH RED ON THEM?

C. Inversion

1. IF I TOOK AWAY THE CIRCLES WITH RED ON THEM, WOULD THERE BE SOME CIRCLES LEFT?

2. IF I TOOK AWAY THE CIRCLES WITH RED ON THEM, WOULD ALL THE CIRCLES BE GONE?

II. Triangular Stimulus

A. Preliminary Counting

1 COUNT ALL THE TRIANGLES THAT HAVE SOME RED ON THEM. (4)*

2. COUNT ALL THE TRIANGLES THAT DON'T HAVE RED ON THEM. (4)*

B. Composition

1. ARE THERE THE SAME NUMBER OF TRIANGLES WITH RED ON THEM AS THERE ARE TRIANGLES?

2. ARE THERE MORE TRIANGLES THAN THERE ARE TRIANGLES WITH RED ON THEM?

C. Inversion

1. IF I TOOK AWAY THE TRIANGLES WITH RED ON THEM, WOULD THERE BE SOME TRIANGLES LEFT?

2. IF I TOOK AWAY THE TRIANGLES WITH RED ON THEM, WOULD ALL THE TRIANGLES BE GONE?

* E may help S obtain correct number of each stimulus.

Groupement III

E reads the question very slowly and emphasizes the words underlined. E may repeat questions only.

I. Circular Stimulus

A. Preliminsry Counting

1. COUNT ALL THE CIRCLES THAT HAVE SOME RED ON THEM. (4)*

2. COUNT ALL THE CIRCLES THAT HAVE SOME YELLOW ON THEM. (4)*

B. Composition

1. ARE THERE THE SAME NUMBER OF CIRCLES WITH RED ON THEM AS THERE ARE CIRCLES WITH BOTH RED AND YELLOW ON THEM?

2. ARE THERE MORE CIRCLES WITH RED ON THEM THAN THERE ARE CIRCLES WITH BOTH RED AND YELLOW ON THEM?

C. Inversion

1. IF I TOOK AWAY THE CIRCLES WITH RED ON THEM, WOULD THERE BE ANY CIRCLES WITH BOTH RED AND YELLOW ON THEM LEFT?

2. IF I TOOK AWAY THE CIRCLES WITH RED ON THEM, WOULD ALL THE CIRCLES WITH BOTH RED AND YELLOW ON THEM BE GONE?

II. Triangular Stimulus

A. Preliminsry Counting

1. COUNT ALL THE TRIANGLES THAT HAVE SOME RED ON THEM. (4)*

2. COUNT ALL THE TRIANGLES THAT HAVE SOME YELLOW ON THEM. (4)*

B. Composition

1. ARE THERE THE SAME NUMBER OF TRIANGLES WITH YELLOW ON THEM AS THERE ARE TRIANGLES WITH BOTH RED AND YELLOW ON THEM?

2. ARE THERE MORE TRIANGLES WITH YELLOW ON THEM THAN THERE ARE TRIANGLES WITH BOTH RED AND YELLOW ON THEM?

C. Inversion

1. IF I TOOK AWAY THE TRIANGLES WITH YELLOW ON THEM WOULD THERE BE ANY TRIANGLES WITH BOTH RED AND YELLOW ON THEM LEFT?

2. IF I TOOK AWAY THE TRIANGLES WITH YELLOW ON THEM, WOULD ALL THE TRIANGLES WITH BOTH RED AND YELLOW BE GONE?

* E may help S obtain correct number of each stimulus.

Groupement IV

E reads questions very slowly and emphasizes words underlined. E may repeat questions only.

I. Stimulus 1

A. Preliminary Counting

1. COUNT ALL THE YELLOW THINGS. (4)*

2. COUNT ALL THE YELLOW CIRCLES. (2)*

B. Composition

1. ARE THERE THE SAME NUMBER OF YELLOW CIRCLES AS YELLOW THINGS?

2. ARE THERE MORE YELLOW THINGS THAN YELLOW CIRCLES?

C. Inversion

1. IF I TOOK AWAY THE YELLOW THINGS, WOULD THERE BY ANY YELLOW CIRCLES LEFT?

2. IF I TOOK AWAY THE YELLOW THINGS WOULD ALL THE YELLOW CIRCLES BE GONE?

II. Stimulus 2

A. Preliminary Counting

1. COUNT ALL THE YELLOW THINGS. (4)*

2. COUNT ALL THE TRIANGLES. (2)*

B. Composition

1. ARE THERE THE SAME NUMBER OF YELLOW TRIANGLES AS YELLOW THINGS?

2. ARE THERE MORE YELLOW THINGS THAN YELLOW TRIANGLES?

C. Inversion

1. IF I TOOK AWAY THE YELLOW THINGS, WOULD THERE BY ANY YELLOW TRIANGLES LEFT?

2. IF I TOOK AWAY THE YELLOW THINGS, WOULD ALL THE YELLOW TRIANGLES BE GONE?

* E may help S obtain correct number of each stimulus.

Groupement V

Like transitivity--the sticks are separated by 2 ft. The middle stick is brought to each side and compared.
E reads the question very slowly and emphasizes the words underlined.
E may repeat questions only.

I. Length

A. Preliminary Comparisons

1. E shows S that the Blue stick is shorter than the Green stick.*

2. E shows S that the Green stick is shorter than the Red stick.*

B. Composition

1. ARE THE BLUE AND RED STICKS THE SAME LENGTH?

2. IS THE BLUE STICK SHORTER THAN THE RED STICK?

C. Reciprocity Comparisons

1. E shows S that the Red stick is longer than the Green stick.*

2. E shows S that the Green stick is longer than the Blue stick.*

D. Reciprocity

1. ARE THE RED AND BLUE STICKS THE SAME LENGTH?

2. IS THE RED STICK LONGER THAN THE BLUE STICK?

II. Weight

A. Preliminsry Comparisons

1. E shows S that the Red stick is lighter than the Green stick.*

2. E shows S that the Green stick is lighter than the Blue stick.*

B. Composition

1. DO THE RED AND BLUE STICKS WEIGH THE SAME?

2. IS THE RED STICK LIGHTER THAN THE BLUE STICK?

C. Reciprocity Comparisons.

1. E shows S that the Blue stick is heavier than the Green

Groupement V continued

stick.*

2. E shows S that the Green stick is heavier than the Red stick.*

D. Reciprocity

1. DO THE BLUE AND RED STICKS WEIGH THE SAME?

2. IS THE BLUE STICK HEAVIER THAN THE RED STICK?

* E first asks S what is the relationship between the two stimuli. E helps S to understand and verbalize the relationship before going on, i.e., ARE THESE THE SAME? HOW ARE THEY DIFFERENT? WHICH ONE IS LONGER (SHORTER, HEAVIER, LIGHTER)?

Groupement VI

E reads questions very slowly and emphasizes the words underlined. E may repeat questions only.

I. Length

A. Preliminary Comparisons

1. E shows S that the Blue and Green sticks are the same length.*

2. E shows S that the Green and Red sticks are the same length.*

B. Composition

1. ARE THE BLUE AND RED STICKS THE SAME LENGTH?

2. IS THE BLUE STICK SHORTER THAN THE RED STICK?

C. Reciprocity Comparisons

1. E shows S that the Red and Green sticks are the same length.*

2. E shows S that the Green and Blue sticks are the same length.*

D. Reciprocity

1. ARE THE RED AND BLUE STICKS THE SAME LENGTH?

2. IS THE RED STICK LONGER THAN THE BLUE STICK?

II. Weight

A. Preliminary Comparisons

1. E shows S that the Red and Green sticks weigh the same.*

2. E shows S that the Green and Blue sticks weigh the same.*

B. Composition

1. DO THE RED AND BLUE STICKS WEIGH THE SAME?

2. IS THE RED STICK LIGHTER THAN THE BLUE STICK?

C. Reciprocity Comparisons.

1. E shows S that the Blue and Green sticks weigh the same.*

2. E shows S that the Green and Red sticks weigh the same.*

Groupement VI continued

D. Reciprocity

1. DO THE BLUE AND RED STICKS WEIGH THE SAME?

2. IS THE BLUE STICK HEAVIER THAN THE RED STICK?

* E first asks S what is the relationship between the two stimuli. E helps S to understand and verbalize the relationship before going on, i.e., ARE THESE THE SAME? HOW ARE THEY DIFFERENT? WHICH ONE IS LONGER (SHORTER, HEAVIER, LIGHTER)?

Groupement VII

E reads questions very slowly and emphasizes the words underlined. E may repeat questions only.

Length and Weight

I. Preliminary Comparisons

A. E shows S that the Red stick is both shorter and lighter than the Blue stick.*

B. E shows S that the Blue stick is both shorter and lighter than the Green stick.*

II. Composition

A. ARE THE RED AND GREEN STICKS THE SAME LENGTH?

B. DO THE RED AND GREEN STICKS WEIGH THE SAME?

C. IS THE RED STICK SHORTER THAN THE GREEN STICK?

D. IS THE RED STICK LIGHTER THAN THE GREEN STICK?

III. Reciprocity Comparisons

A. E shows S that the Green stick is both longer and heavier than the Blue stick.*

B. E shows S that the Blue stick is both longer and heavier than the Red stick.*

IV. Reciprocity

A. ARE THE GREEN AND RED STICKS THE SAME LENGTH?

B. DO THE GREEN AND RED STICKS WEIGH THE SAME?

C. IS THE GREEN STICK LONGER THAN THE RED STICK?

D. IS THE GREEN STICK HEAVIER THAN THE RED STICK?

* E first asks S what is the relationship between the two stimuli. E helps S to understand and verbalize the relationship before going on, i.e., ARE THESE THE SAME? HOW ARE THEY DIFFERENT? WHICH ONE IS LONGER (SHORTER, HEAVIER, LIGHTER)?

Groupement VIII

E reads questions very slowly and emphasizes the words underlined. E may repeat questions only.

I. Preliminary Comparisons

A. E shows S that the Green stick is shorter and the same weight as the Red stick.*

B. E shows S that the Red stick is shorter and the same weight as the Blue stick.*

II. Composition

A. ARE THE GREEN AND BLUE STICKS THE SAME LENGTH?

B. DO THE GREEN AND BLUE STICKS WEIGH THE SAME?

C. IS THE GREEN STICK SHORTER THAN THE BLUE STICK?

D. IS THE GREEN STICK LIGHTER THAN THE BLUE STICK?

III. Reciprocity Comparisons

A. E shows S that the Blue stick is longer and weighs the same as the Red stick.*

B. E shows S that the Red stick is longer and weighs the same as the Green stick.*

IV. Reciprocity

A. ARE THE BLUE AND GREEN STICKS THE SAME LENGTH?

B. DO THE BLUE AND GREEN STICKS WEIGH THE SAME?

C. IS THE BLUE STICK LONGER THAN THE GREEN STICK?

D. IS THE BLUE STICK HEAVIER THAN THE GREEN STICK?

* E first asks S what is the relationship between the two stimuli. E helps S to understand and verbalize the relationship before going on, i.e., ARE THESE THE SAME? HOW ARE THEY DIFFERENT? WHICH ONE IS LONGER (SHORTER, HEAVIER, LIGHTER)?

Appendix B

Protocols for Relational Terms, Transitivity, Conservation and Class Inclusion Test Measures

Relational Terms

E places one 10-cm. and one 20-cm. length of blue string adjacent to each other in the center of the table. E asks:

ARE THESE TWO PIECES OF STRING THE SAME LENGTH? _____Yes _____No

E asks:

IS ONE OF THE TWO PIECES OF STRING LONGER? _____Yes _____No

E places the line drawing of an elephant and a mouse in the center of the table. E asks:

DO THESE ANIMALS WEIGH THE SAME? _____Yes _____No

E asks:

IS ONE OF THESE TWO ANIMALS HEAVIER? _____Yes _____No

E asks:

IF I HAD FOUR COOKIES AND YOU HAD TWO COOKIES WOULD WE EACH HAVE THE SAME NUMBER OF COOKIES?

_____Yes _____No

E asks:

IF I HAD FOUR COOKIES AND YOU HAD TWO COOKIES, WOULD ONE OF US HAVE MORE COOKIES?

_____Yes _____No

Transitivity of Weight

E places three clay balls in the center of the table at 0.5-m. intervals. Their order of arrangement is: 50-gm. brown/50-gm. grey/100-gm. brown.

E places the 50-gm. brown ball in S's right hand and the grey ball in S's left hand so that S can observe that they weigh the same, and gets S to verbalize this fact.

E returns the 50-gm. brown ball to its original position on the table, switches the grey ball to S's right hand and places the 100-gm. brown ball in S's hand so that S verbalizes the fact that the brown ball weighs more.

E returns the grey and brown balls to their original positions on the table and asks (randomly ordered):

_____DO THE TWO BROWN BALLS WEIGH THE SAME?	_____Yes	_____No
_____DOES ONE OF THE BROWN BALLS WEIGH MORE.	_____Yes	_____No
_____(If so) WHICH ONE?	_____Correct	_____Incorrect

E reverses the positions of the two brown balls relative to the grey ball.

E places the 50-gm. brown ball in S's right hand and the grey ball in S's left hand, and gets S to verbalize that they weigh the same.

E returns the 50-gm. brown ball to its original position on the table, switches the grey ball to S's right hand and places the 100-gm. brown ball in S's hand, and gets S to verbalize that the brown ball weighs more.

E returns the grey and brown balls to their original positions on the table and asks (randomly ordered):

_____DO THE TOW BROWN BALLS WEIGH THE SAME?	_____Yes	_____No
_____DOES ONE OF THE BROWN BALLS WEIGH MORE?	_____Yes	_____No
_____(If so) WHICH ONE?	_____Correct	_____Incorrect

Transitivity of Length

E places three colored sticks on the table in the following order: one 27.5-cm. red/one 27.5-cm. white/one 28.5-cm. red. The distance between each of the three sticks is approximately 0.5-m.

E places the white stick next to the 27.5-cm. red stick so that S can observe that they are equal in length, and gets S to verbalize this fact.

E places the white stick next to the 28.5-cm. red stick so that S can observe that the red stick is longer, and gets S to verbalize this fact.

E removes the white stick from the table and asks (randomly ordered):

_____ARE THE TWO RED STICKS THE SAME LENGTH? _____Yes _____No

_____IS ONE OF THE RED STICKS LONGER? _____Yes _____No

_____(If so) WHICH ONE? _____Correct _____Incorrect

E reverses the positions of the two red sticks relative to the white stick.

E places the white stick next to the 27.5-cm. red stick so that S can observe that they are equal in length, and gets S to verbalize this fact.

E places the white stick close to the 28.5-cm. red stick so that S can observe that the red stick is longer, and gets S to verbalize this fact.

E removes the white stick from the table and asks (randomly ordered):

_____ARE THE TWO RED STICKS THE SAME LENGTH? _____Yes _____No

_____IS ONE OF THE RED STICKS LONGER? _____Yes _____No

_____(If so) WHICH ONE? _____Correct _____Incorrect

Conservation of Weight

E places two 50-gm. brown clay balls in the center of the table.

E places one ball in each of the subject's hands.

E shows S that the two balls weigh the same, and helps S to understand and verbalize the relationship before going on.

E returns the balls to their original positions and flattens the one nearest him into a "pancake." E asks (randomly ordered):

_____DO THE TWO BALLS STILL WEIGH THE SAME? _____Yes _____No

_____HOW DO YOU KNOW?

_____IS ONE OF THE BALLS HEAVIER NOW? _____Yes _____No

_____HOW DO YOU KNOW?

E replaces the balls with a second pair of grey balls.

E shows S that the two balls weigh the same, and helps S to understand and verbalize the relationship before going on.

E returns the balls to their original positions and flattens the one nearest him into a "sausage." E asks (randomly ordered):

_____DO THE TWO BALLS STILL WEIGH THE SAME? _____Yes _____No

_____HOW DO YOU KNOW?

_____IS ONE OF THE BALLS HEAVIER NOW? _____Yes _____No

_____HOW DO YOU KNOW?

Conservation of Length

E places two 28.0-cm. lengths of red string side-by-side in the center of the table.

E shows S that the two pieces of string are the same length, and helps S to understand and verbalize the relationship before going on.

E makes the string nearest him into a "circle." E asks (randomly ordered):

_____ARE THE TWO PIECES OF STRING STILL THE SAME LENGTH? _____Yes _____No

_____HOW DO YOU KNOW?

_____IS ONE OF THE PIECES OF STRING LONGER NOW? _____Yes _____No

_____HOW DO YOU KNOW?

E replaces the two strings with the two 28.0-cm. green strings.

E shows S that the two pieces of string are the same length, and helps S to understand and verbalize the relationship before going on.

E makes the string nearest him into an "L" shape. E asks (randomly ordered):

_____ARE THE TWO PIECES OF STRING THE SAME LENGTH? _____Yes _____No

_____HOW DO YOU KNOW?

_____IS ONE OF THE PIECES OF STRING LONGER NOW? _____Yes _____No

_____HOW DO YOU KNOW?

Class Inclusion of Weight

E places a 21.0 x 27.5-cm. drawing of four elephants and two trucks in the center of the table. E discusses with S the fact that some of the things are elephants and some are trucks.

E establishes that elephants and trucks are both "heavy things."

COUNT ALL THE "HEAVY THINGS."* 6____ Other____

COUNT ALL THE ELEPHANTS.* 4____ Other____

COUNT ALL THE TRUCKS.* 2____ Other____

E asks (randomly ordered):

____ARE THERE MORE ELEPHANTS THAN "HEAVY THINGS?" ____Yes ____No

____ARE THERE FEWER "HEAVY THINGS" THAN HERE ARE ELEPHANTS?

____Yes ____No

E places a drawing of three elephants and three trucks on the table. E discusses with S the fact that some of the things are elephants and some are trucks.

E establishes that elephants and trucks are both "heavy things."

COUNT ALL THE HEAVY THINGS. 6____ Other____

COUNT ALL THE ELEPHANTS. 3____ Other____

COUNT ALL THE TRUCKS. 3____ Other____

E asks (randomly ordered):

____ARE THERE THE SAME NUMBER OF ELEPHANTS AS THERE ARE "HEAVY THINGS?"

____Yes ____No

____ARE THERE THE SAME NUMBER OF "HEAVY THINGS" AS THERE ARE ELEPHANTS?

____Yes ____No

*If S miscounts, as him to recount.

Class Inclusion of Length

E places a 21.0 x 27.5-cm. drawing of four logs and two ladders in the center of the table. E discusses with S the fact that some of the things are logs and some are ladders.

E establishes that logs and ladders are both "long things."*

COUNT ALL THE "LONG THINGS."* 6____ Other____

COUNT ALL THE LOGS.* 4____ Other____

COUNT ALL THE LADDERS.* 2____ Other____

E asks (randomly ordered):

____ARE THERE MORE LOGS THAN THERE ARE LONG THINGS? ____Yes ____No

____ARE THERE FEWER LONG THINGS THAN THERE ARE LOGS? ____Yes ____No

E places a 21.0 x 27.5-cm. drawing of three logs and three ladders in the center of the table. E discusses with S the fact that some of the things are logs and some are ladders.

E establishes that logs and ladders are both "long things."*

COUNT ALL THE "LONG THINGS."* 6____ Other____

COUNT ALL THE LOGS.* 3____ Other____

COUNT ALL THE LADDERS.* 3____ Other____

E asks (randomly ordered):

____ARE THERE THE SAME NUMBER OF LOGS AS THERE ARE LONG THINGS?

____Yes ____No

____ARE THERE THE SAME NUMBER OF LONG THINGS AS THERE ARE LOGS?

____Yes ____No

*If S miscounts, ask him to recount.

Appendix C

Protocols for Transitivity, Conservation, and Class Inclusion Training

Training Procedures for Transitivity of Length

E: WE'RE GOING TO PLAY SOME GAMES TODAY THAT I THINK YOU'LL LIKE. EACH OF YOU IS GOING TO HAVE LOTS OF CHANCES TO PLAY, SO WE'LL ALL HAVE FUN.

E places three colored sticks on the table in the following order: 27.5-cm. blue one/27.5-cm. yellow one/28.5-cm. blue. The distance between each of the three sticks is approximately 0.5-cm.

E places the 27.5-cm. stick close to the yellow stick so that the first S can observe that they are equal in length, and gets the first S to verbalize this fact, while remaining Ss observe.

E returns the 27.5-cm. blue stick to its original position.

E places the 28.5-cm. blue stick close to the yellow stick so that S can observe that the blue stick is longer, and gets S to verbalize this fact.

E returns the 28.5-cm. blue stick to its original position and asks (randomly ordered):

ARE THE TWO BLUE STICKS THE SAME LENGTH?

IS ONE OF THE BLUE STICKS LONGER?

(If so) WHICH ONE?

E supplies the appropriate feedback:

YOU'RE RIGHT. THIS (pointing) STICK IS LONGER THAN THE OTHER ONE.

and/or

(Turning to the second S) E: WHAT DO YOU THINK ABOUT THAT? DOES THAT MAKE SENSE TO YOU? Etc. (E encourages discussion).

E reverses the positions of the two blue sticks relative to the yellow stick.

E places the 27.5-cm. stick close to the yellow stock so that the third S can observe that they are equal in length, and gets the third S to verbalize this fact.

E returns the 27.5-cm. blue stick to its original position.

E places the 28.5-cm. blue stick close to the yellow stick so that the third S can observe that the blue stick is longer, and gets the third S to verbalize this fact.

Training Procedures for Transitivity of Length (cont.)

E returns the 28.5-cm. blue stick to its original position and asks the third S (randomly ordered):

ARE THE TWO BLUE STICKS THE SAME LENGTH?

IS ONE OF THE BLUE STICKS LONGER?

(If so) WHICH ONE?

E supplies the appropriate feedback:

YOU'RE RIGHT. THIS (pointing) STICK IS LONGER THAN THE OTHER ONE.

and/or

(Turning to the fourth S) E: WHAT DO YOU THINK ABOUT THAT? DOES THAT MAKE SENSE TO YOU? Etc. (E encourages discussion.)

After this, E begins the process again with the fifth S, and continues with the game until all Ss have had a chance to be both respondent and response evaluator.

Training Procedures for Conservation of Length

E: WE'RE GOING TO PLAY SOME GAMES TODAY THAT I THINK YOU'LL LIKE. EACH OF YOU IS GOING TO HAVE LOTS OF CHANCES TO PLAY, SO WE'LL ALL HAVE FUN.

E places two 28.0-cm. lengths of string side by side in the center of the table so that the Ss can see that they are equal. E gets the first S to verbalize this fact.

E transforms the string nearest him/her into a "circle" and asks (randomly ordered):

ARE THE TWO PIECES OF STRING STILL THE SAME LENGTH?

IS ONE OF THE PIECES OF STRING LONGER NOW?

(If so) WHICH ONE?

E supplies the appropriate feedback:

YOU'RE RIGHT. THIS (pointing) STRING IS STILL THE SAME LENGTH AS THE OTHER ONE.

and/or

(Turning to the second S) E: WHAT DO YOU THINK ABOUT THAT? DOES THAT MAKE SENSE TO YOU? Etc. (E encourages discussion.)

E removes the initial pair of strings from the table and replaces them with a different colored pair in the center of the table, side by side, so that the Ss can see that they are equal. E gets the third S to verbalize that they are equal.

E transforms the string nearest him/her into an "L"-shape and asks (randomly ordered):

ARE THESE TWO PIECES OF STRING STILL THE SAME LENGTH?

IS ONE OF THE PIECES OF STRING LONGER NOW?

(If so) WHICH ONE?

E supplies the appropriate feedback:

YOU'RE RIGHT. THIS (pointing) STRING IS STILL THE SAME LENGTH AS THE OTHER ONE.

and/or

(Turning to the fourth S) E: WHAT DO YOU THINK ABOUT THAT? DOES THAT MAKE SENSE TO YOU? Etc. (E encourages discussion.)

After this, E begins the process again with the fifth S, and continues with the game until all Ss have had a chance to be both respondent and response evaluator.

Training Procedures for Class Inclusion of Length

E: WE'RE GOING TO PLAY SOME GAMES TODAY THAT I THINK YOU'LL LIKE. EACH OF YOU IS GOING TO HAVE LOTS OF CHANCES TO PLAY, SO WE'LL ALL HAVE FUN.

E places a 21.0 x 27.5-cm. drawing of four boards and two lengths of rope in the center of the table. E discusses with the first S the fact that some of the things are boards and some are lengths of rope.

E establishes that boards and lengths of rope are both "long things."*

COUNT ALL THE "LONG THINGS."* 6_____ Other_____

COUNT ALL THE BOARDS.* 4_____ Other_____

COUNT ALL THE LENGTHS OF ROPE.* 2_____ Other_____

E asks (randomly ordered):

_____ARE THERE MORE BOARDS THAN THERE ARE LONG THINGS? _____Yes _____No

_____ARE THERE FEWER LONG THINGS THAN THERE ARE BOARDS? _____Yes _____No

E supplies the appropriate feedback:

YOU'RE RIGHT. THERE ARE MORE LONG THINGS.

and/or

(Turning to the second S) E: WHAT DO YOU THINK ABOUT THAT? DOES THAT MAKE SENSE TO YOU? (E encourages discussion.)

E places a 21.0 x 27.5-cm. drawing of three boards and three lengths of rope in the center of the table. E discusses with the third S the fact that some of the things are boards and some are lengths of rope.

E establishes that boards and lengths of rope are both "long things."*

COUNT ALL THE "LONG THINGS."* 6_____ Other_____

COUNT ALL THE BOARDS.* 3_____ Other_____

COUNT ALL THE LENGTHS OF ROPE.* 3_____ Other_____

E asks (randomly ordered):

_____ARE THERE THE SAME NUMBER OF BOARDS AS THERE ARE LONG THINGS?

_____Yes _____No

_____ARE THERE THE SAME NUMBER OF LONG THINGS AS THERE ARE BOARDS?

_____Yes _____No

Training Procedures for Class Inclusion of Length (cont.)

E supplies the appropriate feedback:

YOU'RE RIGHT. THERE ARE MORE LONG THINGS.

and/or

(Turning to the fourth S) E: WHAT DO YOU THINK ABOUT THAT? DOES THAT MAKE SENSE TO YOU? Etc. (E encourages discussion.)

After this, E begins the process again with the fifth S, and continues with the game until all Ss have had a chance to be both respondent and response evaluator.

*If S miscounts, ask him to recount.

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Professor
Curriculum and Instruction

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Child Development