DOCUMENT RESUME

ED 048 936 PS 004 515

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TITLE	The Ability of Kindergarten and First Grade Children to Use the Transitive Property of Three Length Relations in Three Perceptual Situations.
INSTITUTION	Georgia Univ., Athens.
PUB DATE	4 Feb 71
NOTE	33p.; Paper presented at the Annual Meeting of the American Educational Research Association, New York, New York, February 4, 1971
EDRS PRICE	EDRS Price MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS	*Abstract Reasoning, *Conservation (Concept), *Grade 1, *Kindergarten Children, *Mathematical Concepts, Tables (Data)
IDENTIFIERS	Equivalence, Order Relations, Transitive Property

ABSTRACT

One major purpose of this investigation was to determine and compare the effects of three different perceptual situations (screening, neutral, and conflict) on kindergarten and first grade children's ability to use the transitive property of the equivalence relation "same length as" and the two order relations "longer than" and "shorter than". A total of 96 subjects (49 kindergarten and 47 first grade children) were chosen from the local public school population. Trained examiners administered the specially developed Knowledge of Terms Test and the Conservation of Length Relations Test (CLRT) individually to the children. On the basis of CLRT scores, subjects were classified as being high, medium, or low in conservation ability. CLRT materials were red, green, and blue sticks, soda straws, and pipe cleaners which the children judged and compared for equivalence in length. Results indicate (1) children in both grade levels and in all three conservation levels were able to use the transitive property in the neutral situation in many more instances than in either the screening or conflict situation and (2) first grade children significantly outperformed the kindergarten children. (WY)

The Ability of Kindergarten and First Grade Children To Use the Transitive Property of Three Length Relations In Three Perceptual Situations

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Many factors must be considered when constructing an elementary school mathematics curriculum. Some of these factors may be grouped under three main sources which, according to Glennon and Callahan (1968), "may be referred to as the nature of the learner (psychological), the nature of his adult society (sociological), and the nature of the cognitive area (logical or pure mathematical) [p.1]." At different points in time, each of these sources has received major emphasis. A considerable amount of the pressure for change that brought about the so called "revolution in mathematics" that began in the fifties, came from people who were interested in a shifting of the emphasis toward the logical or pure mathematical. That emphasis should rightly be placed on this aspect is disputed by few. However, there is an inherent danger in considering only the mathematical aspects. As an example, Lovell (1962), in reporting the results of a study dealing with the growth of geometrical concepts in children, said that the data "suggests that many children in primary schools are successfully measuring length without fully understanding the nature of the actions they are engaging in [p. 751]."

The Cambridge Conference on the Correlation of Science and Mathematics (1969) is a good example of a conference whose conferees considered mainly the cognitive areas. They recommend that the concepts of equivalence and order relations be introduced as early as kindergarten or first grade. At present, however, there is not available very much reliable data on which to base such introductions. Siegel and Hooper (1968) made this point when they

Paper presented at the Annual Meeting of the American Educational Research Association, New York, New York, February 4, 1971.

said, "there is a great need for research data describing in detail the cognitive capability of elementary school children so that curriculum innovations may be more rationally based, utilizing knowledge about competencies and abilities of children [p. 4]."

The transitive property is an important aspect of equivalence and order relations. Moreover, when any direct measurement involving the use of a standard unit is undertaken an understanding of this property is essential. In one of the first studies dealing with young children's ability to perform measuring tasks and to use the transitive property, Piaget, Inhelder, and Szeminska (1964, pp. 30-32) had 5 and 6-year old children construct a tower equal in height to a tower already built by the experimenter. On the basis of such observations, the authors concluded that children are about 7 years old before the transitive property becomes operational.

Braine (1959, p. 5), in reporting on a study in which he is critical of Piaget's results, has pointed out that Piaget based his conclusions that a child is not capable of using the transitive property on the child's measuring behavior. Braine contends that the measuring behavior observed may reflect the child's knowledge of measuring technique as much as it does his ability to use the transitive property. He further criticized Piaget's experiment by contending that the children may not have understood the verbal instructions. In order to correct some of the errors he felt Piaget made, Braine conducted a study in which he examined the two relations "longer than" and "shorter than" using non-verbal methods. In reporting his findings, he said the children were able to use the transitive property approximately two or three years before Piaget claims it first became available to them.

Smedslund (1963, pp. 403-405), in reporting on a study he did on the development of concrete transitivity of length in children ranging in age from

4 to 10 years, agreed with Braine's criticism of Piaget's experimental procedures. However, Smedslund took strong exception to Braine's finding that 50 per cent of the children he tested had transitivity of length relations somewhere between the ages of 4 years and 2 months and 5 years and 5 months. As a result of his study, Smedslund said the evidence supports Piaget's hypothesis about the average age of acquisition of concrete transitivity of length. The controversy over methodological issues and the age at which children acquire the transitive property has not been completely resolved.

Steffe and Carey (1968, pp. 111-113), in an investigation which dealt with the ability of four and five-year-old children to use the transitive property of the length relations "longer than," "shorter than," and "same length as," both before and after formal experiences in establishing length relations, found that before any formal training none of the four-year-olds and only 4/32 of the five-year-olds in their sample met criterion on a transitivity test.

There have been few studies dealing with a child's ability to use the transitive property of a length relation in different perceptual situations. Braine (1959), in his study, used wooden uprights with arms at their upper and lower extremities so as to induce a slight degree of illusion (Muller-Lyer effect) in the apparent length of the uprights. Smedslund (1963) also used stimulus materials that were intended to induce a Muller-Lyer illusion. Neither of these investigators compared the subject's performance in the supposed perceptual conflict situation with situations that did not involve an illusion effect. In a somewhat related study, Bruner (1966) found that children of ages four through seven years gave more correct responses on a conservation of liquid test when a screen was placed between them and the containers into which the liquids were poured than when a screen was not there. Bruner suggested that one possible explanation of this finding was that one of the difficulties, which he calls

"perceptual seduction," that children have to overcome to comprehend the idea of conservation had been removed.

The above studies do not satisfactorily describe consistency of performance of young children when attempting to use the transitive property. If the child can use the transitive property of one length relation, does this imply he can use the transitive property of all three length relations? What is the influence of different perceptual situations on the child's ability to use the transitive property? If the objects are placed so the subject can see them, but far enough apart that their relative lengths must be inferred rather than visually ascertained, will his performance be better than when the objects are placed so as to create an illusion effect? If the objects are screened from view at the time of the response so that visual conflict is removed, will the subject give more correct responses than in the other perceptual situations? It seems the conflict situation would be the most difficult due to the illusion effect with the neutral situation being the least difficult. However, these predictions are tenuous because in the screening situation, the child cannot see the objects and hence cannot be deceived by his perception, but on the other hand, any reinforcement he might get from seeing them has also been removed.

Thus one purpose of this investigation was to determine the effects of three different perceptual situations on kindergarten and first grade children's ability to use the transitive property of the equivalence relation "same length as" and the two order relations "longer than" and "shorter than." The situations are defined as follows: (1) neutral, a situation in which the placement of the objects is such that observing them is not expected to help or hinder the subject in reaching the correct conclusion regarding their relative lengths; (2) screening, a situation in which the placement of the objects is such that they cannot be seen by the subject at the time he gives his response; (3) conflict,

a situation in which the placement of the objects is such that observing them may hinder the subject in reaching the correct conclusion.

A second purpose was to determine effects of various length relations on the ability of five and six-year-old children to perform transitivity tasks; a third purpose was to compare general performances of five and six-year-old children on the use of the transitive property; a fourth purpose was to determine if performance on transitivity tasks is more situational specific for children who are able to conserve the relation than for those who can not conserve the relations; a fifth purpose was to investigate response consistency on transitivity tasks across relations and perceptual situations. A final purpose of the study was to determine if the subject's ability to conserve a length relation was a necessary and/or a sufficient condition for him to use the transitive property of that relation.

METHOD

The Subjects

Ninety-six subjects, comprised of forty-nine kindergarten and forty-seven first grade children, were chosen for the study. The children came from the Carter and Perkerson elementary schools of the public school system of Atlanta, Georgia. There were twenty-six kindergarten and twenty-seven first graders, all of whom were black, that came from the Carter school which had a predominately black student body. From the predominately white Perkerson school, there were twenty-three children from kindergarten and twenty children from the first grade, all of whom were white. At the time of the study in May 1970, the range of ages was 65-76 months for the kindergarten children and 78-96 months for the first graders. The mean age of the first group was 71 months and for the second group was 85 months.

First grade and kindergarten children were chosen for the study for

several reasons. First, the controversy between Braine and Smedslund regarding the age at which the transitive property becomes operational for the child has centered around the age of five to eight years. Second, according to Piaget, it is at about seven years of age when the child enters the concrete operational stage and hence may have developed the cognitive structures necessary for using the inference pattern required for the successful use of the transitive property. Finally, a discussion with school officials along with a review of the curriculum materials being used in the schools convinced the investigators that few, if any, of the concepts that the children were to be tested on would have been presented as formal school experiences to the children prior to the time of the study.

Procedure

The testing began on May 18, 1970 at both schools. Three trained examiners did the testing, with one examiner at the Carter school and two at the Perkerson school. The testing was completed on May 25, 1970 at Perkerson and on May 29, 1970 at Carter. Each child was tested individually at three different times for approximately fifteen minutes per session. On each occasion, before any testing was begun, each examiner was instructed to put the child at east by talking briefly with him and allowing a short time for play with the sticks used in the testing. The examiner and the subject sat at a table across from each other during all of the testing sessions. A piece of white cardboard approximately thirty inches long and eighteen inches wide was placed on the table between the examiner and subject. On all of the tests, the objects were on the cardboard while the subject was giving responses regarding their relative lengths. When the objects were not being used, they were kept in a partitioned tray beside the examiner and out of sight of the child.

To ascertain that the subjects understood the various terms to be used in the conservation and transitivity tests, a Knowledge of Terms Test (KTT)

was administered first. This test, which took approximately five minutes to administer, was constructed by the investigators and consisted of nine items. A pile of sticks, ranging in length from seven to nine inches and of various colors, was placed in front of the subject. The examiner placed another stick near the center of the table and the child was asked to select from his pile a stick that was the same length as the single stick. This procedure was repeated with the child next asked to select a stick that was shorter and finally a stick that was longer than the single stick. These three items were designed to make certain the subject understood the meaning of the terms "same length as," "longer than," and "shorter than."

All of the sticks were then placed in a single pile and the subject was asked to pick a red stick, then a green stick, and finally a blue stick from the pile. These three items were designed to insure the subject understood the meaning of the terms used to describe the colors of the objects in the tests. All the sticks were removed from the table and a red stick and a green stick differing in length by approximately one-fourth inch were then placed before the child. He was then asked the final three questions on the test, which were designed to make certain the subject knew the three relations were mutually exclusive. That is, if the red stick was longer than the green stick, then it could not be either shorter than nor the same length as the green stick. In order for the subject to continue in the study, he had to get all nine of the items correct on this test. As a result of this procedure, some subjects were eliminated from further testing and the percentages of the subjects who understood the various terms were found.

The administration of the Conservation of Length Relations Test (CLRT), which took approximately ten minutes, was begun immediately. This test was constructed by the investigator and consisted of nine items designed to

measure the subject's ability to establish a length relation between two objects and maintain it regardless of any length-preserving transformations on either of the objects. The same three perceptual situations and relations were used in this test as were used in the transitivity test. One item was written for each perceptual situation and relation. On the basis of this test each subject was classified into one of three levels of conservation ability. The levels were defined as follows: (1) a "high level" if a subject got at least two items correct on each length relation; (2) a "low level" if there was not more than one length relation on which the subject got two or more items correct; (3) a "medium level" if the subject had not been classified into either the "high" or "low" levels.

The materials used in this test were red and green sticks, approximately eight inches in length and one-fourth inch in diameter, and pieces of opaque cloth. For the "longer than " and "shorter than" questions, the sticks differed in length by approximately one-fourth inch. The nine items, each containing four questions, were given in random order for each child. Two sticks, one red and one green, were placed in front of the subject and beside each other so that at least one pair of their endpoints coincided. The first question on each item was designed to make sure the subject could establish that particular length relation. For example, "Is the red stick longer than the green stick?" would be the first question for the relation "longer than." After the relation had been established, the examiner moved one of the sticks a distance of approximately twenty-four inches in the case of the neutral situation. For the conflict situation, one of the sticks was moved to form a " ⊢ " with the other, with the placement of the sticks being such as to favor the incorrect response. In the screening situation, as soon as the relation had been established the stick that was not to be moved was covered with a piece of opaque cloth and then the other stick was moved a distance of approximately twenty-four

inches and covered. For all items, the final three questions were asked immediately following the transformation. The questions, asked in random order, were: (1) "Is the red stick the same length as the green stick?"; (2) "Is the red stick shorter than the green stick?"; (3) "Is the red stick longer than the green stick?"

In order to get an item correct, the subject had to respond correctly on all four questions of each item. The subject had to make two "no" responses and one "yes" response on the last three questions to get the item correct. Since these questions were asked in random order, the subject could not establish any pattern for the correct responses. The probability of getting any given item correct by guessing is .125. This is true because the subject could give a response of either "yes" or "no" for each of the questions and hence the probability of guessing a correct answer is .5. Therefore the possibility of getting the three questions correct by guessing is $(.5)^3$ or .125. The subject scored one point for each correct item and no points for an incorrect one.

The Transitivity of Length Relations Test (TLRT) was constructed by the investigators and consisted of twenty-seven items designed to measure the subject's ability to use the transitive property of the three length relations in the three perceptual situations. For each of the three relations, there were nine items consisting of three items in each of the three situations.

The materials used were the same as the ones previously described with the addition of blue sticks; red, blue, and green soda straws; and red, blue, and green pipe cleaners. This test was administered at two different sessions each lasting approximately fifteen minutes. At one session the subject was given thirteen items and at the other, fourteen. One half of the subjects were randomly assigned to take the thirteen item part first, the other one half to take the fourteen item set first.

For each situation in each relation, there were three items, all very

similiar. One question involved the movement of the blue comparison stick from left to right, another from right to left, while the third involved the same movement of the objects as one of the others, but the materials were soda straws. The items, each consisting of five questions, were given in a different random order to each subject.

For the "neutral" situation, the red and green objects were placed in front of the subject at a distance from each other of approximately twenty-four inches. The blue object was then placed beside one of the others with one pair of their endpoints coinciding. The first two questions on each item were designed to insure the subject could establish the particular length relation. For example, "Is the red straw the same length as the blue straw?" would be the first question for the relation "same length as." After this relation had been established, the examiner moved the blue object beside the green object and asked the second question. For the example above, the question was: "Is the blue straw the same length as the green straw?" The blue object was then removed from the table and the final three questions were asked immediately. These questions were asked in random order and were the same as the final three questions on each item of the conservation test.

The procedure for the "conflict" situation was the same as for the "neutral," except that initially the red and green objects were placed forming a "|___" rather than being spaced apart. The placement was such as to favor the wrong response; that is, the shorter object (if the objects were not the same length) was placed in the horizontal position. For the "screening" situation, the procedure was also very similar to the "neutral." In this case, the red and green objects were never on the table at the same time unless one or both were covered by the opaque cloth. The blue object and one of the other objects were placed in front of the subject and, as in the other situations, stion to establish the relation was asked. One object was covered and

then the third object was placed on the table and the blue object was placed beside it and the same second question was asked as in the other situations. The last object that had been placed on the table was then covered and the blue object was removed and the same final three questions, as before, were asked.

Two different scoring schemes were used and the data was analyzed using each one. This was done to determine the influence, if any, of the two scoring procedures on the effects of the different variables. For the first scheme, the one that will be primarily used in the discussion of the results, the subject had to respond correctly on all five questions to get an item correct. If the item was correct, one point was given, and if incorrect, no points were scored. Just as on the conservation test, all subjects responded correctly on the first two questions on each item. The subject had to make two "no" responses and one "yes" response on the last three questions to get the item correct, hence the probability of getting any given item correct by guessing is .125, as stated before when discussing the conservation test. On some of the items the red objects were longer than the green and on some the green were longer. This prevented the subject from cuing on the color of the object to give the correct response.

For the second scoring scheme, the subject was given two points for each item on which all his responses were correct. In addition, one point was scored for each item on which the subject correctly established the two premises and then gave a "yes" response to the correct conclusion, but also gave an incorrect "yes" response to one of the other questions. However, no points were scored if all responses to the last three questions were "yes," since it is known that some children at this age give a pattern of all "yes" responses. To illustrate, the following would be an example of a response

pattern for which one point would be scored. The subject has correctly established that the red stick is longer than the blue stick and the blue stick is longer than the green stick and then correctly concludes that the red stick is longer than the green stick. He answers "yes" to the question asking if the red stick is the same length as the green stick and "no" to the question asking if the red stick is shorter than the green stick.

Data Analysis

Tests statistics, including reliability coefficients (KR-20), were computed for the conservation and transitivity tests utilizing a computer program (Wolf, Klopfer, 1963) and are shown in Table 1.

Insert Table 1 about here

The main purpose of the "Knowledge of Terms Test" was to eliminate subjects from the study who did not understand the various terms used in the other tests, so no test statistics were necessary. Two grade levels and three levels of ability to conserve length relations comprised the classification variables for the study. A research design, outlined by Kirk (1968), using repeated measures on two variables (in this case relation and perceptual situation) was used whereby the main effects (fixed factors) of (1) grade level, (2) relation, (3) level of conservation, and (4) situation and all possible interactions were tested for significance. In addition, t-tests were performed on the scores of the subjects to detect any differences in performance of the children on the conservation and transitivity tests at the two schools and to detect any difference in performance on the conservation test of the two grade levels.

Results of the Study

Table 2 shows the percent of subjects getting one or more items incorrect on the KTT by grade and school. As can be seen from the table, the first grade children had a better understanding of the terms than the kindergartners and more students from the Carter school were eliminated than the students from Perkerson. Both results were expected. Overall, fourteen of the ninety-six subjects were eliminated, which was approximately 15 percent of the total.

Insert Table 2 about here

Table 3 contains the number of subjects that were classified into each of the three levels of conservation ability. It is seen that the ratio of first graders classified into the "high" level of conservation ability was greater than the ratio of kindergartners, while the ratio of kindergartners in the "low" level was greater than the ratio of first graders.

Insert Table 3 about here

In order to examine more closely the effect of grade level on conservation ability, a t-test for significance of difference between means was used. The results are shown in Table 4. A t value of 2.55 was found which is significant at the .05 level.

Insert Table 4 about here

The performance of the subjects in the two schools on the conservation test was also of interest. The results in Table 5 shows there is no significant difference in the performance of the subjects between the two schools.

Insert Table 5 about here

To determine the effects of the four variables of situation, grade level, relation, and level of conservation ability on the use of the transitive property, sixty of the subjects were used in the repeated measures design previously outlined. There were six groups identified, composed of three levels of conservation ability within each of the two grade levels. Subjects were randomly eliminated until each group was reduced to ten. The complete analysis of variance for all main effects and interactions is summarized in Table 6.

Insert Table 6 about here

An inspection of Table 6 shows that grade level was significant at the .05 level and conservation ability was highly significant at the .01 level. To test the difference between all possible pairs of means for conservation levels, the Newman-Keuls (Winer, 1962) method was used. The differences in means for all conservation levels were significant at the .01 level. The F-ratio was not significant at the .05 level for either the main effect of relations or for any of the interactions. The overall F test to detect differences in the means of the three situations was significant beyond the .01 level. The Newman-Keuls method was again used and showed the differences between the means for the neutral situation and the other situations were significant at the .01 level, but the means for the screening and conflict situations were not significantly different. The means for significant main effects are included in Table 7.

Insert Table 7 about here

In order to ascertain the effect, if any, on the variables due to a different scoring method, an analogous ANOVA was performed using the second scheme. In Table 8, the complete analysis is summarized. A comparison of Table 8 with Table 5 shows there were no important differences in the two analyses using the different scoring schemes.

Insert Table 8 about here

Several decisions were made in considering a best plan for attempting to ascertain whether a child's ability to conserve a length relation is a necessary and/or sufficient condition for him to use the transitive property of that relation. First, precision would be increased by considering the question for each relation for each child rather than attempting to give an overall classification of the child's ability to use the transitive property. Second, since the conservation test was scored in a manner analogous to the first scoring scheme used for the transitivity test, more comparable scores would result using the first scheme. Third, in order to be considered as being able to conserve a relation or to use the transitive property of that relation, a subject would have to get at least two-thirds of the items correct on that relation. For the conservation test this meant a score of either two or three and for the transitivity test, a score of six or more. The probability of meeting criterion by guessing is .043 for each test. Each of the three relations for each subject was investigated the results of which are given in Tables 9 and 10.

Insert Table 9 about here

Insert Table 10 about here

Inspection of Table 9 shows that ability to conserve a length relation is not a sufficient condition for using the transitive property of the same relation. Of the total of 152 times that a relation was conserved only in 67 cases (44 percent) was this followed by the successful use of the transitive property of that relation. The question dealing with necessity is more difficult to answer. In 12 cases out of 94 (13 percent), the transitive property was used successfully when the relation had not been conserved. These 12 cases were investigated more closely with the following results. Two of the cases involved the same subject, hence a good possibility exists of measurement error in assessing this subject's conservation ability. In nine of the remaining ten cases, the subject had one of the three conservation items correct indicating some knowledge of conservation principles. Only in one case did the subject get all the conservation items incorrect on a relation and then score six or more correct on that relation on the transitivity test. However, even after considering these special cases, an unequivocal answer cannot be given to this question.

The second scoring scheme was used in investigating response consistency. The performance of the children was investigated in each of the nine possible combinations of relation and situation. There were three items for each combination. Each correct item was scored two points; hence, a subject's possible score was six for each of the nine combinations. A decision was made that a score of 4, 5, or 6 on any combination would be considered sufficient

evidence to say the subject could use the transitive property of that relation in that particular situation. To allow a subject scoring four on a combination to meet criterion is debatable, since by allowing this score the probability of meeting criterion by guessing is .079. However, when the different possible ways of obtaining this score are investigated the decision seems more reasonable. One possibility would be two of the three items scored completely correct. The other is that one item is completely correct and the other two are partially correct. In both cases, the subject had demonstrated considerable ability to use the transitive property.

Insert Table 11 about here

An inspection of Table 11 shows a wide range of performance of the subjects for the different combinations of relation and situation. For the kindergarten children, the range was from 54 percent for the neutral situation for the relations "longer than" and "shorter than" down to 27 percent for either "longer than" in a screening situation or "shorter than" in a conflict situation. The range for the first graders went from a high of 76 percent for "same length as" in a screening situation to a low of 31 percent for "longer than" in a screening situation. When the two grade levels are combined, the percentages ran from 62 for "longer than" in a neutral situation to 29 for "longer than" in a screening situation. It is noted that the high and low percent are both for the same relation.

Discussion

Consistent individual behavior was not found to be characteristic of most of the children in this study. This was evidenced by the fact that when any three items on the transitivity test dealing with the same combination of

relation and situation were considered together, there were 393 cases (53 per cent) out of a total of 738 in which the subject got either one or two of the three items correct. Since the items were almost identical, this was a surprising result. This seems to indicate that many of the children were in what Piaget would term a transitional stage in their intellectual development. Almost paradoxically, when the group behavior was considered the performances were very consistent. This was seen from the fact that none of the eleven interactions were significant.

The difference in performance for the different situations was highly significant. Children in both grade levels and in all three conservation levels were able to use the transitive property in the neutral situation in many more instances than in either the screening or conflict situation. It was expected that the conflict situation would be considerably more difficult than the others due to the illusion effect. This was true for the equivalence relation "same length as," but for both order relations the screening situation was more difficult. (Even though the relation x situation interaction was not significant, it warrants discussion). There may have been two contributing factors. First, since the objects had to be covered in the screening situation before the final three questions were asked, there was a slightly longer period of time between establishing the premises and giving the conclusions in this situation than for the others, which may have given the child more opportunity to forget the premises. Second, in the case of the equivalence relation the child had only to remember the red object was the same length as the green object, whereas for the order relations, the child had to remember the relation and also which of the objects was the longer or shorter. It seems clear from these results that for many of the children their understanding of the transitive property is not sufficient to withstand the effect of an illusion. Only two kindergarten and five first grade children out of a total of 82 subjects could be

classified as being able to use the transitive property if to meet criterion at least two-thirds of the items or each of the three relations had to be correct. However, 16 kindergarten and 33 first grade children met the criterion of at least two-thirds of the items correct on at least one relation. It appears that a determination of an age at which X percent of children are able to use the transitive property is not a fruitful endeavor because such an ability appears to be highly task specific.

The first grade children performed significantly better than the kindergarten children on the use of the transitive property across all conservation levels, relations, and situations. Since none of the children had formal experiences with the principles investigated in the study, this difference was due mainly to an age effect. However, it should be noted that the first graders mean score was only 52 percent and the kindergartners was only 42 percent, which indicates, along with the performance data, that in neither grade level is it safe to assume most of the children can use the transitive property of the length relations.

The difference in performance for each of the conservation levels was highly significant. This differing performance was consistent across all grade levels, relations, and situations. The differences were in the expected direction with the high level group performing best and the low level group showing the poorest performance. A significant correlation of .67 was found between total score on the conservation test and total score on the transitivity test. The ability to conserve a length relation was clearly not a sufficient condition for the use of the transitive property. When considered in a context of measurement errors, the results did not contradict the necessity part of the question.

The performance of the first graders was significantly higher on the

conservation test than that of the kindergarten children. Of the first graders, 44 per cent were classified into the high level of conservation ability whereas only 27 per cent of the kindergartners were in the high level. Forty-six per cent of the kindergartners and 24 per cent of the first graders were classified into the low level. It is clear that it would be erroneous to assume that a majority of children in either kindergarten or first grade are capable of conserving length relations.

The basis of the recommendations to include equivalence and order relations in the study of mathematics by very young children is based on a premise that it is through equivalence relations that important abstractions in mathematics originate. For example, set equivalence leads to number divorced from any particular set; an amount of money can be based on the relation "buys as much as" (twenty-five cents is not a quarter nor 25 pennies); or "holds as much liquid as" may be used to develop notion of a quart, etc. Order relations can be viewed as expressing the direction of the difference relation which is associated with each equivalence relation. For example, if object A is not the same length as object B, then the objects can be ordered using the order relation "shorter than." Curriculum workers who follow such recommendations must be cognizant of data such as that presented in this study even though it is status data. Because transitivity is task specific for kindergarten and first grade children and is contingent, with a high probability, on whether or not the child can conserve the relations involved, before one could realistically expect such abstractions as noted above to occur, care should be exercised to insure that the ability of the children to use the transitive property is operative at least across tasks used in learning experiences. Certainly if children cannot conserve relations involved, there is little chance of abstractions occurring. Whether children who can conserve relation but who cannot use transitivity of those relations can

easily be led to make transitive inferencesis a question on which little evidence is available. Given that transitivity of particular relations can easily be induced in conservers of those relations who do not naturally use transitivity, whether such children can apply transitivity in as wide a variety of tasks as children in which transitivity naturally develop is also an open question.

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Table 1

Tests Statistics

(N=82)

Test	Mean	S. D.	Reliability
CLRT	5.38	2.52	.75
TLR1	12.37	6.24	.87

Table 2

Percent of Subjects Eliminated By Grade and School

School	Grade K	Grade First	Total
Carter	35	7	21
Perkerson	13	0	7

Table 3

Number of Subjects By Grade and Conservation Level

Grade	Conservation Level		
	High	Medium	Low
K	10	10	17
First	20	14	11

Table 4

Comparison of Mean Conservation Scores Between Grades

Grade	N	Mean	S.D.	Difference In Means	d.f.	t
K	37	4.62	2.53	-	-	-
First	45	6.00	2.36	-	-	-
Total	82	5.38	2.52	1.38	80	2.55*

*(p<.05)

Table 5

Comparison of Mean Conservation Scores Between Grades

School	N	Mean	S.D.	Difference in Means	d.f.	t
Carter	40	5.29	2.72	-	-	-
Perkerson	42	5.48	2.32	-	-	-
Total	82	5.38	2.52	.19	80	.34

Table 6

ANOVA For The Total Transitivity Test Score

Source of Variation	d.f.	M.S.	F
Between Subjects			
Grade Level (A)	1	12.15	4.12*
Conservation (C)	2	47.07	15.96**
AC	2	1.24	<1.00
Subj. w. groups	54	2.95	
Within Subjects			
Relations (B)	2	.87	<1.00
AB	2	.12	<1.00
ABC	4	1.62	1.22
BX Subj. w. groups	108	1.33	
Situations (D)	2	8.98	14.03**
AD	2	.28	<1.00
CD	4	.77	1.20
ACD	4	.06	<1.00
DX Sub. w. group	108	.64	
BD	4	.91	1.82
ABD	4	.45	<1.00
BCD	8	.75	1.50
ABCD	8	.40	<1.00
BD X Subj. w. groups	216	.50	

*(p<.05) **(p<.01)

Table 7

Mean Percents: Significant Main Effects

Situation	Neutral	Screening	Conflict
Mean	56	43	42

Conservation Level	High	Medium	Low
Mean	64	48	30

Grade	Kindergarten	First
Mean	42	52

Table 8

ANOVA Table For Second Scoring Scheme

Source of Variation	d.f.	M.S.	F
Between Subjects			
Grade Level (A)	1	26.66	2.90#
Conservation (C)	2	95.82	10.42**
AC	2	1.91	<1.00
Subj. w. groups	54	9.20	
Within Subjects			
Relations (B)	2	2.50	<1.00
AB	2	.29	<1.00
BC	4	8.14	1.55
ABC	4	5.93	1.13
BX Subj. w. groups	108		
Situations (D)	2	30.54	13.05**
AD	2	.63	<1.00
CD	4	3.13	1.34
ACD	4	.43	<1.00
C X Subj. w. group	108	2.34	
BD	4	2.82	1.60
ABD	4	2.16	1.23
BCD	8	2.51	1.43
ABCD	8	2.10	1.19
BD X Subj. w. groups	216		

#(p<.10) **(p<.01)

Table 9

Contingency Tables: Conservation By Transitivit· For Each Relation

	Same Length		Longer Than		Shorter Than	
	T	~T	T	~T	T	~T
C	31	26	16	32	20	27
~C	2	23	5	29	5	30

Table 10

Contingency Tables: Conservation By Transitivity

	K		First		Total	
	T	~T	T	~T	T	~T
C	20	38	47	47	67	85
~C	2	51	10	31	12	82

Table 11

Percent of Subjects Meeting Criterion on Transitivity: Relation by Perceptual Situation by Grade

Grade	Situation	Relation		
		Same Lenth As	Longer Than	Shorter Than
K	Neutral	54	54	51
	Screening	41	27	30
	Conflict	38	35	27
F	Neutral	67	69	64
	Screening	76	31	42
	Conflict	51	51	47
Total	Neutral	61	62	59
	Screening	60	29	37
	Conflict	45	44	38