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# TRANSITIVITY, IDENTITY CONSERVATION AND EQUIVALENCE CONSERVATION OF A SOLID CONTINUOUS QUANTITY

by

GARY KEITH HUMPHREY
B.A. (Hons.) University of New Brunswick, 1972

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
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in the Department
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Psychology

We accept this thesis as conforming to the
required standard

Louis J. Moran

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THE UNIVERSITY OF BRITISH COLUMBIA
December, 1975

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# ABSTRACT

An investigation into the distinction between identity conservation and equivalence conservation, as presented by Elkind (1967) was examined in the content area of solid continuous quantity. One group of subjects received the tasks as outlined by Elkind (Group I) while another group of subjects received modified versions of the tasks (Group II). Each conservation task was presented at two levels of transformation; moderate and extreme. In addition transitivity of solid continuous quantity was examined in relationship to conservation.

The sample consisted of 144 subjects; 48 Kindergarten, Grade one and Grade two students. Half of the subjects within each grade level were assigned to Group I, the other half was assigned to Group II. Within each group half of the children were male and half were female.

An analysis of variance performed on the conservation tasks indicated that identity and equivalence conservation were of equal difficulty. The main effects of Group and Age were significant and the interaction of Sex x Grade was significant. The criterion factor of judgment only vs. judgment plus explanation was found to have a significant effect, with more trials passed with a judgment only criterion. Data were scored according to two different procedures; one procedure required that subjects be consistent in their answers in each phase of the task in order to receive non-zero scores. This procedure employed a three-point scale with values of 0, 1, and 2. The other procedure used a scale with values ranging from 0 to 6 inclusive. Subjects were given a point for each of the six questions answered correctly in the conservation tasks, regardless of the consistency of the answers. The method with the 0, 1, and 2 scale showed that identity and equivalence

conservation were equally difficult, while the method which employed the 0-6 scale showed that identity was easier than equivalence. It was shown that the latter method yielded these results because of an artifact in the questions asked. Furthermore it was shown that scale scores which resulted from an application of the 0-6 scale were an ambiguous reflection of the level of concept attainment.

An analysis of variance was performed on the transitivity tasks. The main effects for Group and Age were significant. The transitivity tasks were significantly easier than all conservation tasks at all grade levels. The implications of this and the co-occurrence of identity and equivalence conservation were discussed in relation to Elkind's (1967) analysis.

Tanya MacBeth Watkins

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# INTRODUCTION

The traditional conservation task was devised to assess whether children understand that perceptual deformations of objects do not produce changes in the quantitative properties of the objects (Piaget, 1952; Piaget and Inhelder, 1974). For example a ball of clay may have its shape changed to that of a flat disc, or "pancake", but this leaves quantitative properties of the object, such as its mass, weight, or volume, unchanged.

In the traditional format for assessing conservation a child is first shown two objects (e.g., A and B) that are quantitatively and perceptually similar. One of the objects (e.g., B) is then subjected to a perceptual transformation (e.g., to $B^1$). Finally the child is asked to make some quantitative comparison between the standard or untransformed object and the transformed object (e.g., between A and $B^1$). In more concrete terms a child might be presented with two clay balls identical in size, shape and quantity of clay. The shape of one of the balls is changed to that of a pancake. The child is then asked such questions as: Is there the same amount of clay in the pancake as there is in the ball? Does one have more clay? The answers given to questions of this type determine whether the child is said to conserve.

Elkind (1967) pointed to certain methodological problems in the traditional conservation task. The task was designed to assess children's understanding of the invariance of quantitative properties of objects across irrelevant perceptual transformations. Success on the task should imply that the invariance is understood, whereas failure should mean it is not. However according to Elkind's analysis a child could fail the task

for reasons other than a failure to grasp the quantitative invariance of objects in this situation. A schematic example of the task follows:

A=B (The objects are initially equal on all quantitative and perceptual dimensions)

$B \rightarrow B^1$ (Object B has its shape changed to $B^1$)

$A?B^1$ (The child is questioned about the quantitative relationship holding between A and $B^1$)

The first statement, A=B, can be viewed as the first premise in a simple deductive argument. The second statement can also be thought of as a premise in an argument such that $B=B^1$ on the relevant quantitative dimension. Finally given A=B and $B=B^1$ then it necessarily follows that $A=B^1$, hence the last statement can be seen as a conclusion. Children could fail the task because they forgot the first premise, or because they believe that the relevant quantitative property of B changed when its shape was changed to $B^1$. Even if children remember that A=B and understand that $B=B^1$, they may not be able to coordinate this information to reach the conclusion that $A=B^1$ (see Elkind, 1967).

That children fail the task because they forget the initial equality of A and B seems unlikely in view of Bryant's (1974) observations. Bryant (1974) points out that Bruner, et al (1966) have shown that children who would normally fail conservation tasks remember the appearance of the display before the transformation. Also, using a task very similar to number conservation tasks Bryant (1972) demonstrated that children who did poorly on these tasks performed well in a control condition which required that they remember what the relations between two rows of counters were before a perceptual transformation.

A more likely reason for failure on the traditional task, according to Elkind's analysis, is that children do not understand that $B=B^1$. This, Elkind claims, is really what the task was devised to assess, but does so ambiguously. If the children succeed on the task it can be inferred that they understand that $B=B^1$; however failure may occur for reasons other than the child's understanding of the relation between B and $B^1$. Elkind proposed that a much more direct technique be employed to assess whether children understand that quantitative properties of single objects remain the same after perceptual transformations. A child would be shown a single object, the shape of the object would then be changed and finally the child would make a judgment about some quantitative relation holding before and after the transformation (e.g., Is there the same amount of clay in this pancake as there was when it was shaped like a ball?). Elkind has referred to the recognition that quantitative properties of single objects remain invariant across perceptual transformations as identity conservation. The traditional task measures what Elkind calls equivalence conservation.

According to Elkind's analysis a child must have the concept of identity, as well as the ability to reason in a simple deductive manner, in order to succeed on the traditional task format. He suggested that there may be a developmental lag between identity and equivalence conservation with identity conservation being a prior cognitive acquisition. Hooper (1969b, p. 236) argued similarly; "since equivalence conservation requires the additional deduction sequence, it should be a later cognitive achievement than identity conservation."

Hooper's study (1969b) was one of the first published reports

to provide evidence which showed that identity conservation occurs prior to equivalence conservation. Identity and equivalence conservation were assessed in the content area of discontinuous quantity (i.e., small seeds placed in glass beakers). Ninety-six subjects of mean ages 6, 7, and 8 years were used in a between subjects design. Hooper (1969b, p. 248) concluded that "identity conservation may be viewed as a necessary but not sufficient prerequisite for adequate equivalence conservation performance. Further evidence that identity conservation precedes equivalence conservation in the area of discontinuous quantity was obtained by Hooper (1969a) in a study of low socio-economic-status subjects aged 5 1/2 to 6 1/2 years.

Schwarty and Scholnick (1970) investigated identity and equivalence conservation in 40 children of nursery and kindergarten age. Glasses equal in diameter and differing in diameter were partially filled with candies. Subjects were required to make direct comparisons, identity judgments and equivalence judgments both when the containers had the same diameter and when they differed. When the glasses were of equal diameter there were no significant differences among identity judgments, equivalence judgments and direct comparisons. However, when the containers differed in diameter identity judgments were easier than both equivalence judgments and direct comparisons.

Papalia and Hooper (1971) worked with 60 subjects at ages 4, 5 and 6 years. Each subject was given a battery of tasks designed to measure qualitative identity, quantitative identity and equivalence conservation of discontinuous quantity and number. It should be noted that qualitative identity differs from the notion of identity (i.e., quantitative) developed by Elkind. Qualitative identity refers to a child's recognition that it is

the same clay even though its shape has been changed; this does not mean that the child necessarily believes that it is the same amount. The latter depends upon the concept of quantitative identity (see Brainerd and Hooper, 1975; Hooper, 1969b; Papalia and Hooper, 1971, Piaget, 1968). Qualitative identity concepts were found to develop prior to quantitative identity concepts, which in turn developed prior to equivalence concepts in the area of discontinuous quantity. There was no conclusive evidence regarding the order of emergence of the various number concepts.

Elkind and Schoenfeld (1972) used 22 four year olds and 22 six year olds to investigate the problem in the content areas of length, liquid, mass and number. Their general conclusion was that identity conservation was easier than equivalence conservation but the difference was most pronounced in the younger children.

Brainerd and Hooper (1975) investigated the identity - equivalence issue with 60 four year olds, 60 six year olds and 60 eight year olds. All subjects were given identity and equivalence tasks in the content areas of length and weight. Identity was acquired prior to equivalence conservation, especially at the lower age levels. In a similar study Toniolo and Hooper (1975) investigated the identity-equivalence issue in the content areas of length and weight. In addition to the tasks from the Brainerd and Hooper (1975) study tasks measuring transitivity of length and weight were given to 60 four year olds, 60 six year olds and 60 eight year olds. The results supported the notion that identity is acquired prior to equivalence conservation.

The results of other studies have failed to provide support for the developmental priority of identity over equivalence conservation.

Northman and Gruen (1970) did not obtain the hypothesized sequence for liquid quantity in 60 second and third graders. Moynahan and Glick (1972) presented 96 kindergarten and first-grade children with identity and equivalence tasks involving number, length, continuous quantity and weight. Identity preceded equivalence only under length transformations. On the number, quantity and weight tasks identity and equivalence conservation were found to co-occur. Murray (1970) failed to find the developmental sequence with 33 kindergarten and first-grade subjects in the content areas of weight and number. Finally, Koshinsky and Hall (1973) used 72 kindergarten and second-grade subjects in an experiment replicating Hooper's study (1969b) with the exception that a within subject design was used. They failed to find the sequence.

As noted above, according to Elkind's analysis, the main reasons for failure on the equivalence tasks would be the lack of the identity concept or the inability to make transitive inferences. Moynahan and Glick (1972) have suggested that the reason for their not finding evidence of the sequence is that the ability to make transitive inferences was so readily available to the subjects in their study that the identity and equivalence tasks were of equal difficulty, even though the equivalence task has an inference requirement. Similarly, Northman and Gruen (1970) proposed that the ability to make transitive inferences occurs at about the same time as the operations necessary for identity conservation, hence identity and equivalence tasks are of equal difficulty. Further, the research of Bryant and Trabasso (1971) implies that children as young as four years of age, which is below the usual age for attainment of conservation, can make transitive inferences involving length provided they are given memory support.

Brainerd (1973) has reviewed Piaget's theoretical position regarding the order of emergence of transitivity, classification and conservation (i.e., equivalence). According to Brainerd it is not at all clear what predictions should be derived from the various statements made by Piaget concerning transitivity and conservation. His writings can be interpreted as predicting that (a) conservation and transitivity should emerge synchronously or, (b) conservation should precede transitivity developmentally. Brainerd has also reviewed the contradictory results concerning the order of emergence of these two concepts. He draws attention to the methodological insensitivities in many of the transitivity tasks used to assess the order of emergence of these two concepts. His own data support the order of emergence as being transitivity prior to conservation.

If it is true that transitivity emerges prior to equivalence conservation in all or most content areas, then provided that Elkind's analysis is accepted, several questions regarding the results of the studies supporting the priority of identity over equivalence conservation can be raised. The problems are concerned with the order of acquisition of transitivity and identity conservation. The specific problem which formed the basis of the present study was the order of acquisition of transitivity, identity conservation and equivalence conservation. It was reasoned that if transitivity precedes equivalence conservation as Brainerd (1973) indicates and if identity precedes equivalence conservation then transitivity would develop prior to, concurrent with, or after identity conservation. If it were found that transitivity develops prior to or concurrent with identity conservation then it would be necessary to question whether equivalence conservation is a later cognitive acquisition than identity conservation,

for according to Elkind's analysis (1967) it is the lack of the transitive reasoning ability which accounts for failure on the traditional or equivalence task. If, however, this is present as a skill in subjects who pass identity and fail equivalence Elkind's analysis should be seriously questioned. Indeed the only order of emergence that would be congruent with Elkind's analysis and the evidence which suggests identity develops prior to equivalence is that identity conservation precedes transitivity which in turn precedes equivalence conservation. Then it could be argued that the reason for failure on the equivalence task, when the identity task has been passed successfully, is the lack of the ability to form transitive inferences and if all subjects have been assessed on all three tasks this may be supported by empirical evidence.

There may however be other reasons for a subject to pass identity tasks and fail equivalence tasks. According to Piaget a very important factor in the assessment of conservation is that of perceptual conflict. Piaget believes that for conservation to be assessed properly there should be a conflict between the subject's immediate perceptual experiences and his intellectual operations. Thus in the traditional assessment format the objects, after a perceptual transformation, may look sufficiently different that one object may appear quantitatively different from the other. However, if the children are reasoning correctly they understand that if the objects had the same amount to begin with, they still have the same amount if only the shape of one of the objects has been changed. Piaget and Inhelder (1974, p. 10) state "the problem of conservation reflects a conflict between direct experience or perceptions and rational operations". It is clear that this conflict should be present within the task situation in order to provide a measure of conservation as Piaget conceives it. In

another place he states "the direct and immediate pouring of a liquid from two identical glasses, one remaining untouched as a means of comparison is not the same thing as pouring a liquid from a single receptor into others" (Piaget, 1967, p. 533). The identity task, as described previously, removes this perceptual conflict between the transformed and untransformed stimulus and as such may remove a source of difficulty encountered by subjects in the equivalence task. This could also account for the difference between the developmental acquisition of identity and equivalence conservation.

The role of perceptual conflict has been further emphasized by Piaget in the case of children in a transitional stage of conservation acquisition. A small perceptual change in the transformed object may not produce the same amount of perceptual conflict as would a more extreme transformation. Piaget and Inhelder (1974, p. 12) state, in the context of discussing children in a transitional state of conservation acquisition that "in small scale transformations the child's mind can surmount the perceptible appearances thanks to a grasp of the operations, but as soon as the deformations go beyond a certain limit, direct intuition comes to prevail over operational intelligence and conservation is again called into question".

The present study was undertaken to delineate the relative importance of the logical (according to Elkind's analysis) and perceptual components in the solution of identity and equivalence conservation tasks. The order of emergence of transitivity, identity and equivalence conservation was assessed in the content area of continuous solid quantity. The identity and equivalence tasks were presented as outlined above with regard to Elkind's analysis, and in addition a modified version of each task was

given. Thus there were two identity tasks, one with perceptual conflict absent and one with this conflict present. Similarly there were two equivalence tasks, one with the conflict absent and one with it present. Each of the conservation tasks was administered under a "moderate" and an "extreme" degree of perceptual transformation.

# METHOD

## Subjects

Subjects were drawn from kindergarten, first and second grade in schools located in a broadly lower middle class neighbourhood. There were 24 males and 24 females at each grade level. Four kindergarteners and two first graders had to be replaced because of failure on the pretest. The mean ages for the Kindergarten, Grade one and Grade two groups were 5 years, 11 months (S.D.= 4 months), 6 years, 10 months (S.D.= 4 months), and 7 years, 10 months (S.D.= 5 months) respectively. A total of 144 subjects completed the study.

## Materials

Blue clay balls (play dough) were used to assess conservation and both blue and red balls of clay were used to assess transitivity. White balls and yellow balls were used in the pretest. The materials were displayed approximately in the center of a sheet of white cardboard 81 x 61 cm. which was on a small rectangular wooden table. Two small plastic bowls one yellow and one red, were also used in the transitivity tasks. Only those materials in use during any particular task were in the subject's sight.

## Procedure

Each child was taken individually to the experimental room and was seated at the small rectangular table opposite the experimenter. The experimenter described the situation as a game in which some questions about clay balls would be asked.

In addition to the equivalence task outlined by Elkind (1967), a modification of the equivalence task similar to Hooper's (1969b) equivalence I task was used. In this task the initial equality of the two objects was established. Then prior to any conservation questions or transformations the standard stimulus was removed from the subject's sight. This made the task comparable to the identity task described above in terms of both the memory requirements and the perceptual information available to the subject. Although the source of perceptual conflict (as conceived by Piaget) was removed the logical requirements for the proper solution of the two equivalence tasks should have been the same. The traditional task was referred to as equivalence A and the modified task as equivalence B.

A modification of the identity task as outlined by Elkind (1967) was also included in the present study. In this modified task a standard comparison object which was quantitatively and perceptually identical to the object to be transformed was in the subject's view during the course of the task presentation. All questions asked were identical to those asked in the other identity condition. The modified task introduced perceptual conflict since there were two objects, one transformed the other untransformed, in the subject's field of view. This made the task perceptually identical to the traditional (equivalence A) conservation task. However since the questions asked were the same as those asked in the other identity task it should not have required the deductive ability for proper solution. The modified task was referred to as identity B and the identity task described by Elkind as identity A.

Each of the conservation tasks was presented under two levels of transformation, moderate and extreme. The cross sectional diameter of the ball used in all conservation tasks was 4.45 cm. Under the moderate

transformation the ball was flattened changing the diameter to approximately 6.35 cm.; this was referred to as a "fat cookie". The ball was pressed into a "pancake" with a diameter of approximately 14 cm. under the extreme transformation. In all conservation tasks the moderate transformation preceded the extreme.

Four tasks were given to each subject to assess their ability to form transitive inferences. The tasks can be described in schematic form using the symbol ">" to stand for more clay and "=" to stand for the same amount of clay. Each of the tasks involved three balls of clay and can be schematically represented as follows: (A) A=B=C, (B) A>B=C, and (C) A=B>C, and (D) A>B>C. These tasks were similar to some of the tasks used by Murray and Youniss (1968), Youniss and Murray (1970) and Brainerd (1973).

In addition to the tasks described above a pretest was given to each subject in order to assess understanding of the relational terms more, less and same amount.

The children were divided into two groups: Group I received the pretest, the four transitivity tasks and identity A and equivalence A under both the moderate and extreme transformations. Group II received the pretest, the four transitivity tasks and identity B and equivalence B under both levels of transformation. The order in which the identity, equivalence and transitivity tasks occurred was fully randomized across subjects.

Pretest

There were four different tasks in the pretest. Two balls of clay differing in size were used in each of the first two presentations. The degree of difference in the amount of clay between the two balls was less in

the second presentation than in the first. Subjects were asked the following questions: (1) Do these two balls of clay have the same amount of clay, do they each have just as much? (2) Does one have more clay? (3) Which one has more clay? (The subject was instructed to point.) (4) Does one have less clay? (5) Which one has less clay?

The third part of the pretest involved three balls of clay differing in size. The questions asked were: (1) Do these three balls all have the same amount of clay, do they each have just as much? (2) Does one ball have more clay than the other two? (3) Which one? (4) Does one ball have less clay than the other two? (5) Which one?

The fourth part of the pretest involved four balls of clay, two differing in size and two identical. The only question asked of the subject was: (1) Which two of these four balls look like they have the same amount of clay?

Conservation Tasks

Each of the conservation tasks included three phases: prediction, judgment and explanation. (See Brainerd & Brainerd, 1972; Brainerd & Hooper, 1975; and Elkind, 1961)

Identity A. One blue ball of clay was placed on the white cardboard in front of the subject. In the prediction phase the experimenter asked the following questions: (1) If I press this ball into the shape of a fat cookie (pancake) will it have the same amount of clay as it has now? (2) Will it have more clay than it has now? (3) Will it have less clay than it has now? In the judgment phase the ball was transformed and the subject was asked: (1) Does this fat cookie (pancake) have the same amount of clay

as it had when it was shaped like a ball? (2) Does it have more clay now than it had before? (3) Does it have less clay now than it had before? (The order of the questions involving the terms more, less and same was randomized for the prediction and judgment phase of all conservation tasks.) Finally the child was asked to explain his/her answer to the judgment phase by answering the questions: Why do you say it has (more, less or the same)? How do you know it has (more, less, or the same)?

Identity B. The presentation of this task was identical to that of identity A except for the fact that two clay balls were in the subject's view. Also, before the questions were asked the quantitative equivalence of the two balls was established by having the child agree that the two balls had the same amount of clay. All of the questions were identical to those asked in the identity A task.

Equivalence A. Two balls were placed on the white cardboard sheet and their initial quantitative equivalence was established by having the child agree that the two balls had the same amount of clay. In the prediction phase the experimenter asked: (1) If I press this ball (E pointed to one of the balls) into a fat cookie (pancake) will this ball (E pointed to standard) have the same amount of clay as the fat cookie (pancake)? (2) Will one of them have more clay? (3) Will one of them have less clay? Then in the judgment phase one ball was transformed and the following questions were asked: (1) Do the ball and the fat cookie (pancake) have the same amount of clay? (2) Does one have more? (3) Does one have less? Finally the children were required to explain their responses by answering the questions: Why do you say that one has (more, less or the same amount)?

Equivalence B. Two balls were placed on the white cardboard sheet and their initial equivalence was established. Before the prediction phase began one ball was placed out of sight behind a screen. The same questions were asked as in equivalence A, except that reference was made to the ball behind the screen when necessary.

Transitivity. Two balls A and B were first placed on the table. The child was then told that one ball (E pointed to A which was always red) had the same amount (in cases (A) and (C) of the transitivity tasks described above) or more (in the cases of (B) and (D) described above) than the other ball B which was always blue. The red ball (A) was then put under a small yellow or red bowl. Another red ball (C) was then placed on the table and the child was told that the blue ball (B) had the same amount (in cases (A) and (B) or more than C (in cases (C) and (D)). C was then placed under the other bowl and B was removed from sight. The following questions were then asked: (1) Do the balls under the two bowls have the same amount of clay, do they each have just as much? (2) Does one have more? (3) Which one? (4) Does one have less? (5) Which one? The questions were asked in different orders.

## Scoring

Pretest. Subjects were given a score of 1 or 0 depending on their answers to each of the questions asked during the pretest. Since there were 16 questions in total the maximum score was 16. Only subjects who scored 15 or 16 were allowed to proceed in the study.

Conservation. Three questions were asked in the prediction phase and three questions were asked in the judgment phase. If a child was correct on all three questions in the prediction phase he/she was given a score of 1, similarly if a child was correct on all three questions in the judgment phase he/she was given a score of 1. These scores could then be added to give a composite score for both phases. Children who were correct on both phases obtained a score of 2, children correct on only one phase obtained a score of 1, and children incorrect on both phases were given a score of 0. When children's scores depended only on the prediction and judgment phases the scores were said to be based on a judgment only criterion. When a judgment plus explanation criterion was used a child was given a score of 2 if he/she was correct on both prediction and judgment phases and gave an explanation which could be placed in an acceptable category (see Appendix A). If a child was correct on both the prediction and judgment phases, but gave an inadequate explanation he/she received a score of 1. All explanations were tape recorded.

Transitivity. Children were given a score of 1 if they answered all questions correctly; otherwise they received a score of 0.

## Results

### Conservation

The frequency and percentage of subjects passing the various conservation tasks on the basis of a judgment only criterion is given in Table 1. It is apparent that while very few Kindergarten subjects passed the tasks considerably more Grade 1 and Grade 2 children were successful. It is also evident from Table 1 that children receiving the identity task as outlined by Elkind (1967) and the traditional conservation task (Group I) performed better on all conservation tasks than those children who received the modified tasks (Group II). There was very little difference in the number of subjects passing identity tasks and equivalence tasks within each group. Twenty-seven subjects in Group I passed the identity task under both levels of transformation and 27 passed the equivalence tasks under both levels of transformation. In Group II 13 subjects passed both identity tasks and 16 passed both equivalence tasks.

Conservation task scores were subjected to a 2x2x3x2x2 analysis of variance in which the variables were Group (Group I, Group II), Sex, Age (Kindergarten, Grade 1, Grade 2), Task Type (Identity, Equivalence) and Transformation level (Moderate, Extreme). As can be seen from Table 2 the only main effects to reach significance were Group ($F=6.02$; $df=1,132$, $p<.025$) and Age ($F=11.92$; $df.=2,132$; $p<.001$). The mean score for children in Group I was significantly greater than the mean score for Group II. Duncan's New Multiple Range Statistic indicated that only the difference between the scores of children in kindergarten and Grade 2 were statistically significant ($p<.05$). No other age differences reached statistical significance.

TABLE 1

Frequency and Percentage of Subjects Passing the Conservation Tasks when a Criterion of Judgment Only was Used.

| | IDENTITY | | EQUIVALENCE | | IDENTITY | EQUIVALENCE |
|---|---|---|---|---|---|---|
| | Moderate | Extreme | Moderate | Extreme | Moderate & Extreme | Moderate & Extreme |
| Group I | No. % | No. % | No. % | No. % | No. % | No. % |
| Kindergarten | | | | | | |
| Males | 2 (16.7) | 2 (16.7) | 1 ( 8.3) | 2 (16.7) | 2 (16.7) | 1 ( 8.3) |
| Females | 1 ( 8.3) | 1 ( 8.3) | 3 (25.0) | 2 (16.7) | 0 ( 0.0) | 1 ( 8.3) |
| Combined | 3 (12.5) | 3 (12.5) | 4 (16.7) | 4 (16.7) | 2 ( 8.3) | 2 ( 8.3) |
| Grade 1 | | | | | | |
| Males | 8 (66.7) | 9 (75.0) | 8 (66.7) | 8 (66.7) | 8 (66.7) | 8 (66.7) |
| Females | 7 (58.3) | 7 (58.3) | 6 (50.0) | 7 (58.3) | 7 (58.3) | 6 (50.0) |
| Combined | 15 (62.5) | 16 (66.7) | 14 (58.3) | 15 (62.5) | 15 (62.5) | 14 (58.3) |
| Grade 2 | | | | | | |
| Males | 4 (33.3) | 5 (41.7) | 5 (41.7) | 4 (33.3) | 4 (33.3) | 4 (33.3) |
| Females | 7 (58.3) | 8 (66.7) | 7 (58.3) | 9 (75.0) | 6 (50.0) | 7 (58.3) |
| Combined | 11 (45.8) | 13 (54.2) | 12 (50.0) | 13 (54.2) | 10 (41.7) | 11 (45.8) |
| Group I Total | | | | | | |
| Males | 14 (38.9) | 16 (44.4) | 14 (38.9) | 14 (38.9) | 14 (38.9) | 13 (36.1) |
| Females | 15 (41.7) | 16 (44.4) | 16 (44.4) | 18 (50.0) | 13 (36.1) | 14 (38.9) |
| Combined | 29 (40.3) | 32 (44.4) | 30 (41.7) | 32 (44.4) | 27 (37.5) | 27 (37.5) |

TABLE 1 (cont'd)

| | IDENTITY | | EQUIVALENCE | | IDENTITY | EQUIVALENCE |
|---|---|---|---|---|---|---|
| | Moderate | Extreme | Moderate | Extreme | Moderate & Extreme | Moderate & Extreme |
| | No. % | No. % | No. % | No. % | No. % | No. % |
| Group II | | | | | | |
| Kindergarten | | | | | | |
| Males | 1 ( 8.3) | 2 (16.7) | 0 ( 0.0) | 1 ( 8.3) | 1 ( 8.3) | 0 ( 0.0) |
| Females | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 2 (16.7) | 0 ( 0.0) | 0 ( 0.0) |
| Combined | 1 ( 4.2) | 2 ( 8.3) | 0 ( 0.0) | 3 (12.5) | 1 ( 4.2) | 0 ( 0.0) |
| Grade 1 | | | | | | |
| Males | 2 (16.7) | 3 (25.0) | 3 (25.0) | 3 (25.0) | 2 (16.7) | 3 (25.0) |
| Females | 3 (25.0) | 2 (16.7) | 2 (16.7) | 2 (16.7) | 2 (16.7) | 1 ( 8.3) |
| Combined | 5 (20.8) | 5 (20.8) | 5 (20.8) | 5 (20.8) | 4 (16.7) | 4 (16.7) |
| Grade 2 | | | | | | |
| Males | 3 (25.0) | 4 (33.3) | 4 (33.3) | 4 (33.3) | 3 (25.0) | 4 (33.3) |
| Females | 5 (41.7) | 7 (58.3) | 8 (66.7) | 9 (75.0) | 5 (41.7) | 8 (66.7) |
| Combined | 8 (33.3) | 11 (45.8) | 12 (50.0) | 13 (54.2) | 8 (33.3) | 12 (50.0) |
| Group II Total | | | | | | |
| Males | 6 (16.7) | 9 (25.0) | 7 (19.4) | 8 (22.2) | 6 (16.7) | 7 (19.4) |
| Females | 8 (22.2) | 9 (25.0) | 10 (27.8) | 13 (36.1) | 7 (19.4) | 9 (25.0) |
| Combined | 14 (19.4) | 18 (25.0) | 17 (23.6) | 21 (29.2) | 13 (18.1) | 16 (22.2) |
| Total Sample | | | | | | |
| Males | 20 (27.8) | 25 (34.7) | 21 (29.2) | 22 (30.6) | 20 (27.8) | 20 (27.8) |
| Females | 23 (31.9) | 25 (34.7) | 24 (33.3) | 31 (43.1) | 20 (27.8) | 23 (31.9) |
| Combined | 43 (29.9) | 50 (34.7) | 45 (31.3) | 53 (36.8) | 40 (27.8) | 43 (29.9) |

Group I - Received the Identity Task as Outlined by Elkind (1967) and the Traditional Conservation Task referred to as the Equivalence Task by Elkind.

Group II - Received the Modified Identity and Equivalence Tasks.

TABLE 2

Summary of Group x Sex x Grade x Task Type x Level of Transformation Analysis of Variance

| Source | DF | MS | F |
|---|---|---|---|
| **Between Subjects** | | | |
| Group (A) | 1 | 14.38 | 6.02 ** |
| Sex (B) | 1 | 1.09 | 0.45 |
| Grade (C) | 2 | 28.44 | 11.92 **** |
| AB | 1 | 0.14 | 0.06 |
| AC | 2 | 6.48 | 2.72 |
| BC | 2 | 8.72 | 3.65 * |
| ABC | 2 | 0.13 | 0.05 |
| Error Between | 132 | 2.39 | |
| **Within Subjects** | | | |
| Task Type D(A) | 2 | 0.64 | 0.28 |
| BD(A) | 2 | 0.20 | 0.87 |
| CD(A) | 4 | 0.95 | 0.41 |
| BCD(A) | 4 | 0.26 | 1.09 |
| D x SS w/in gps. | 132 | 0.23 | |
| Level of Trans. F | 1 | 0.43 | 0.33 |
| AF | 1 | 0.17 | 0.01 |
| BF | 1 | 0.17 | 0.01 |
| CF | 2 | 0.11 | 0.82 |
| ABF | 1 | 0.43 | 0.33 |
| ACF | 2 | 0.21 | 1.62 |
| BCF | 2 | 0.14 | 1.06 |
| ABCF | 2 | 0.30 | 2.34 |
| F x SS w/in gps. | 132 | 0.13 | |
| FD(A) | 2 | 0.29 | 0.21 |
| BFD(A) | 2 | 0.27 | 1.87 |
| BCFD(A) | 4 | 0.57 | 0.40 |
| FD(A) x SS w/in gps. | 132 | 0.14 | |

* $P<.05$
** $P<.025$
**** $P<.001$

The only interaction to reach significance was the interaction of Sex x Grade ($F=3.65$; $dF=2,132$; $p<.05$). A Newman Kuels test indicated that the mean for girls in Grade 2 was significantly greater than the mean for girls in Kindergarten ($p<.01$). The difference between boys in Kindergarten and boys in Grade 1 was significant ($p<.05$) according to Duncan's New Multiple Range Statistic. Duncan's test was used when the difference failed to read statistical significance according to the Neuman Kuels test.

The frequence and percentage of subjects who passed the various conservation tasks with a criterion of judgment plus-explanation is shown in Table 3. Group I can be seen to have performed better than Group II. Also, fewer children in Kindergarten than in Grade 1 or Grade 2 passed the tasks when a judgment plus explanation criterion was used. A comparison of Tables 1 and 3 reveals that when explanations were included in the criterion fewer subjects passed all conservation tasks than when a criterion of judgment only was used. With a criterion of judgment only, 40 subjects in both groups, passed the identity tasks under both levels of transformation and 43 subjects passed both equivalence tasks. However with a criterion of judgment plus explanation only 28 subjects passed both identity tasks and 33 passed both equivalence tasks. An additional analysis of variance which included criterion (judgment only vs. judgment plus explanation) as a factor indicated that the judgment plus explanation criterion resulted in significantly lower scores on the conservation tasks ($F=30.73$; $df=1,132$; $p<.001$).

The number of subjects passing identity tasks and equivalence tasks with a criterion of judgment only is presented in Table 4 and with

TABLE 3

Frequency and Percentage of Subjects Passing the Conservation Tasks When a Criterion of Judgment Plus Explanation was Used

| | IDENTITY | | EQUIVALENCE | | IDENTITY | EQUIVALENCE |
|---|---|---|---|---|---|---|
| | Moderate | Extreme | Moderate | Extreme | Moderate & Extreme | Moderate & Extreme |
| | No. % | No. % | No. % | No. % | No. % | No. % |
| Group I | | | | | | |
| Kindergarten | | | | | | |
| Males | 1 ( 8.3) | 1 ( 8.3) | 1 ( 8.3) | 2 (16.7) | 1 ( 8.3) | 1 ( 8.3) |
| Females | 0 ( 0.0) | 1 ( 8.3) | 2 (16.7) | 1 ( 8.3) | 0 ( 0.0) | 1 ( 8.3) |
| Combined | 1 ( 4.2) | 2 ( 8.3) | 3 (12.5) | 3 (12.5) | 1 ( 4.2) | 2 ( 8.3) |
| Grade 1 | | | | | | |
| Males | 6 (50.0) | 7 (58.3) | 8 (66.7) | 7 (58.3) | 5 (41.7) | 7 (58.3) |
| Females | 4 (33.3) | 4 (33.3) | 4 (33.3) | 5 (41.7) | 4 (33.3) | 4 (33.3) |
| Combined | 10 (41.7) | 11 (45.8) | 12(50.0) | 12 (50.0) | 9 (37.5) | 11 (45.8) |
| Grade 2 | | | | | | |
| Males | 3 (25.0) | 5 (41.7) | 4 (33.3) | 3 (25.0) | 3 (25.0) | 3 (25.0) |
| Females | 6 (50.0) | 7 (58.3) | 7 (58.3) | 9 (75.0) | 5 (41.7) | 7 (58.3) |
| Combined | 9 (37.5) | 12 (50.0) | 11 (45.8) | 12 (50.0) | 8 (33.3) | 10 (41.7) |
| Group I Total | | | | | | |
| Males | 10 (27.8) | 13 (36.1) | 13 (36.1) | 12 (33.3) | 9 (25.0) | 11 (30.6) |
| Females | 10 (27.8) | 12 (33.3) | 13 (36.1) | 15 (41.7) | 9 (25.0) | 12 (33.3) |
| Combined | 20 (27.8) | 25 (34.7) | 26 (36.1) | 27 (37.5) | 18 (25.0) | 23 (31.9) |

TABLE 3 (cont'd)

| | Moderate | | Extreme | | Moderate | | Extreme | | Moderate & Extreme | | Moderate & Extreme | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Group II | | | | | | | | | | | | |
| Kindergarten | | | | | | | | | | | | |
| Males | 1 | ( 8.3) | 2 | (16.7) | 0 | ( 0.0) | 1 | ( 8.3) | 1 | ( 8.3) | 0 | ( 0.0) |
| Females | 0 | ( 0.0) | 0 | ( 0.0) | 0 | ( 0.0) | 1 | ( 8.3) | 0 | ( 0.0) | 0 | ( 0.0) |
| Combined | 1 | ( 4.2) | 2 | ( 8.3) | 0 | ( 0.0) | 2 | ( 8.3) | 1 | ( 4.2) | 0 | ( 0.0) |
| Grade 1 | | | | | | | | | | | | |
| Males | 2 | (16.7) | 3 | (25.0) | 2 | (16.7) | 2 | (16.7) | 2 | (16.7) | 2 | (16.7) |
| Females | 3 | (25.0) | 1 | ( 8.3) | 1 | ( 8.3) | 1 | ( 8.3) | 1 | ( 8.3) | 0 | ( 0.0) |
| Combined | 5 | (20.8) | 4 | (16.7) | 3 | (12.5) | 3 | (12.5) | 3 | (12.5) | 2 | ( 8.3) |
| Grade 2 | | | | | | | | | | | | |
| Males | 3 | (25.0) | 4 | (33.3) | 3 | (25.0) | 3 | (25.0) | 3 | (25.0) | 3 | (25.0) |
| Females | 4 | (33.3) | 3 | (25.0) | 5 | (41.7) | 6 | (50.0) | 3 | (25.0) | 5 | (41.7) |
| Combined | 7 | (29.2) | 7 | (29.2) | 8 | (33.3) | 9 | (37.5) | 6 | (25.0) | 8 | (33.3) |
| Group II Total | | | | | | | | | | | | |
| Males | 6 | (16.7) | 9 | (25.0) | 5 | (13.9) | 6 | (16.7) | 6 | (16.7) | 5 | (13.9) |
| Females | 7 | (19.4) | 4 | (11.1) | 6 | (16.7) | 8 | (22.2) | 4 | (11.1) | 5 | (13.9) |
| Combined | 13 | (18.1) | 13 | (18.1) | 11 | (15.2) | 14 | (19.4) | 10 | (13.9) | 10 | (13.9) |
| Total Sample | | | | | | | | | | | | |
| Males | 16 | (22.2) | 22 | (30.5) | 18 | (25.0) | 18 | (25.0) | 15 | (20.8) | 16 | (22.2) |
| Females | 17 | (23.6) | 16 | (22.2) | 19 | (26.4) | 23 | (31.9) | 13 | (18.1) | 17 | (23.6) |
| Combined | 33 | (22.9) | 38 | (26.4) | 37 | (25.7) | 41 | (28.5) | 28 | (19.4) | 33 | (22.9) |

a criterion of judgment plus explanation in Table 5. It is evident from a comparison of Tables 4 and 5 that more subjects passed both tasks with a criterion of judgment only than with a criterion of judgment plus explanation. Thirty-five subjects passed both identity and equivalence tasks at the moderate level of transformation with a criterion of judgment only, while 25 passed with a criterion of judgment plus explanation. At the extreme level 44 subjects passed both tasks with a criterion of judgment only and 34 passed with a criterion of judgment plus explanation. When both levels of transformation are combined it can be seen that 35 subjects passed all tasks with a criterion of judgment only and 23 subjects passed with a criterion of judgment plus explanation.

Three subjects passed both identity tasks and failed both equivalence tasks and 3 subjects passed both equivalence tasks and failed both identity tasks with a criterion of judgment only as is evident from Table 4. An examination of Table 5 shows that 2 subjects passed both identity tasks and failed both equivalence tasks and 1 subject passed both equivalence tasks and failed both identity tasks with a criterion of judgment plus explanation. It can also be seen from Table 4 that 14 subjects passed either the moderate (8 subjects) or extreme (6 subjects) identity tasks, but failed the corresponding equivalence tasks, while 21 subjects passed either the moderate (13 subjects) or extreme (8 subjects) equivalence tasks but failed the corresponding identity tasks. With a criterion of judgment plus explanation, as in Table 5, 13 subjects passed either the moderate (8 subjects) or extreme (5 subjects) identity tasks but failed the corresponding equivalence tasks and 19 subjects passed either the moderate (12 subjects) or extreme (7 subjects) equivalence tasks and failed the corresponding identity tasks.

TABLE 4

Number of Subjects Passing Identity and Equivalence Tasks at Each Grade Level when a Criterion of Judgment Only was Used.

| | Passed Both | | | Failed Both | | | Passed Ident. Failed Equiv. | | | Passed Equiv. Failed Ident. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | E | M&E | M | E | M&E | M | E | M&E | M | E | M&E |
| Group I | | | | | | | | | | | | |
| Kinder-garten | 1 | 3 | 1 | 18 | 20 | 18 | 2 | 0 | 0 | 3 | 1 | 0 |
| Grade 1 | 14 | 14 | 14 | 9 | 8 | 8 | 1 | 2 | 1 | 0 | 0 | 0 |
| Grade 2 | 9 | 12 | 9 | 10 | 10 | 10 | 2 | 1 | 1 | 3 | 1 | 0 |
| Group I Total | 24 | 29 | 24 | 37 | 38 | 36 | 5 | 3 | 2 | 6 | 2 | 0 |
| Group II | | | | | | | | | | | | |
| Kinder-garten | 1 | 1 | 1 | 23 | 20 | 20 | 0 | 1 | 0 | 0 | 2 | 0 |
| Grade 1 | 2 | 4 | 2 | 16 | 18 | 16 | 3 | 1 | 1 | 3 | 1 | 1 |
| Grade 2 | 8 | 10 | 8 | 12 | 10 | 10 | 0 | 1 | 0 | 4 | 3 | 2 |
| Group II Total | 11 | 15 | 11 | 51 | 48 | 46 | 3 | 3 | 1 | 7 | 6 | 3 |
| Total Sample | 35 | 44 | 35 | 88 | 86 | 82 | 8 | 6 | 3 | 13 | 8 | 3 |

M = Moderate Level of Transformation
E = Extreme Level of Transformation

TABLE 5

Number of Subjects Passing Identity and Equivalence Tasks at Each Grade Level When a Criterion of Judgment Plus Explanation was Used.

| | Passed Both | | | Failed Both | | | Passed Ident. Failed Equiv. | | | Passed Equiv. Failed Ident. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | E | M&E | M | E | M&E | M | E | M&E | M | E | M&E |
| Group I | | | | | | | | | | | | |
| Kindergarten | 1 | 2 | 1 | 21 | 21 | 20 | 0 | 0 | 0 | 2 | 1 | 0 |
| Grade 1 | 9 | 11 | 8 | 11 | 12 | 11 | 1 | 0 | 0 | 3 | 1 | 1 |
| Grade 2 | 7 | 10 | 7 | 11 | 10 | 10 | 2 | 2 | 1 | 4 | 2 | 0 |
| Group I Total | 17 | 23 | 16 | 43 | 43 | 41 | 3 | 2 | 1 | 9 | 4 | 1 |
| Group II | | | | | | | | | | | | |
| Kindergarten | 0 | 1 | 0 | 23 | 21 | 21 | 1 | 1 | 0 | 0 | 1 | 0 |
| Grade 1 | 1 | 3 | 1 | 17 | 20 | 17 | 4 | 1 | 1 | 2 | 0 | 0 |
| Grade 2 | 7 | 7 | 6 | 16 | 14 | 14 | 0 | 1 | 0 | 1 | 2 | 0 |
| Group II Total | 8 | 11 | 7 | 56 | 55 | 52 | 5 | 3 | 1 | 3 | 3 | 0 |
| Total Sample | 25 | 34 | 23 | 99 | 98 | 93 | 8 | 5 | 2 | 12 | 7 | 1 |

The frequency and percentage of subjects giving adequate explanations on identity conservation, equivalence conservation and all conservation tasks are given in Tables 6, 7 and 8 respectively. The classification scheme for the various types of explanations is described in Appendix A. It can be seen from the tables that the number of adequate explanations given by Grade 2 subjects was greater than the number given by Grade 1 subjects which in turn was greater than the number given by Kindergarten subjects. It can be seen from Table 8 that the addition-subtraction and statement of operations categories account for approximately 67% of the explanations given by Kindergarten subjects on all tasks. Four categories used by Grade 1 subjects account for 88.3% of their responses; addition-subtraction, statement of operations, reference to previous state and inversion. These same four categories plus the use of the "more than one category" category account for 91.8% of the second graders' explanations. However the "more than one category" category is composed totally of composite explanations from the other four categories. The three categories of reciprocity, sameness (same stimulus) and sameness (same quantity) account for only 9.6% of the explanations overall. The category of compensation was never used.

Comparison of Tables 6 and 7 reveals that the categories of statement of operations, reference to previous state, and inversion were used more frequently on equivalence tasks than on identity tasks. The addition-subtraction category was used more frequently on identity tasks than on equivalence tasks.

TABLE 6

Frequency and Percentage of Subjects Giving Adequate Explanations for all Identity Conservation Tasks

| | Group I | | | Group II | | | Group I and Group II | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | KDG. | GR. 1 | GR. 2 | KDG. | GR. 1 | GR. 2 | KDG. | GR. 1 | GR. 2 | | |
| | No. % | No. % | No. % | No. % | No. % | No. % | No. % | No. % | No. % | No. | % |
| Addition - Subtration | 2 (50.0) | 8 (38.1) | 3 (11.5) | 2 (66.7) | 3 (27.3) | 4 (22.2) | 4 (57.1) | 11 (34.4) | 7 (15.9) | 22 | (26.5) |
| Statement of Operations | 0 (0.0) | 9 (42.9) | 10 (38.5) | 0 (0.0) | 3 (27.3) | 5 (27.8) | 0 (0.0) | 12 (37.5) | 15 (34.1) | 27 | (32.5) |
| Reference to Previous state | 0 (0.0) | 0 (0.0) | 2 ( 7.7) | 0 (0.0) | 3 (27.3) | 4 (22.2) | 0 (0.0) | 3 (9.4) | 6 (13.6) | 9 | (10.8) |
| Inversion | 0 (0.0) | 1 (4.8) | 1 ( 3.8) | 0 (0.0) | 0 ( 0.0) | 1 (5.6) | 0 (0.0) | 1 (3.1) | 2 (4.5) | 3 | (3.6) |
| Reciprocity | 0 (0.0) | 0 (0.0) | 0 ( 0.0) | 0 (0.0) | 1 ( 9.1) | 0 (0.0) | 0 (0.0) | 1 (3.1) | 0 (0.0) | 1 | (1.2) |
| Compensation | 0 (0.0) | 0 (0.0) | 0 ( 0.0) | 0 (0.0) | 0 ( 0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 | (0.0) |
| Sameness (same stimulus) | 2 (50.0) | 1 (4.8) | 0 ( 0.0) | 0 (0.0) | 1 ( 9.1) | 0 (0.0) | 2 (28.6) | 2 (6.3) | 0 (0.0) | 4 | (4.8) |
| Sameness (same quantity) | 0 (0.0) | 2 (9.5) | 5 (19.2) | 0 (0.0) | 0 ( 0.0) | 0 (0.0) | 0 (0.0) | 2 (6.3) | 5 (11.4) | 7 | (8.4) |
| More than one category | 0 (0.0) | 0 (0.0) | 4 (19.2) | 1 (33.3) | 0 ( 0.0) | 4 (22.2) | 1 (14.3) | 0 (0.0) | 9 (20.5) | 10 | (12.0) |
| No. and % of Explanations | 4(100.0) | 21(100.0) | 26(100.0) | 3(100.0) | 11(100.0) | 18(100.0) | 7(100.0) | 32(100.0) | 44(100.0) | 83 | (100.0) |

TABLE 7

Frequency and Percentage of Subjects Giving Adequate Explanations for all Equivalence Conservation Tasks

| | GROUP I | | | GROUP II | | | GROUP I AND GROUP II | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | KDG. | GR. 1 | GR. 2 | KDG. | GR. 1 | GR. 2 | KDG. | GR. 1 | GR. 2 | |
| | No. % | No. % | No. % | No. % | No. % | No. % | No. % | No. % | No. % | No. % |
| Addition-Subtraction | 2 (28.6) | 6 (25.0) | 3 (12.0) | 1 (25.0) | 1 (10.0) | 3 (17.6) | 3 (27.3) | 7 (20.6) | 6 (14.3) | 16 (18.4) |
| Statement of Operations | 2 (28.6) | 7 (29.2) | 9 (36.0) | 3 (75.0) | 5 (50.0) | 6 (35.3) | 5 (45.5) | 12 (35.3) | 15 (35.7) | 32 (36.8) |
| Reference to Previous state | 2 (28.6) | 5 (20.8) | 5 (20.0) | 0 ( 0.0) | 3 (30.0) | 6 (35.3) | 2 (18.2) | 8 (23.5) | 11 (26.2) | 21 (24.1) |
| Inversion | 0 ( 0.0) | 3 (12.5) | 2 ( 8.0) | 0 ( 0.0) | 1 (10.0) | 1 ( 5.9) | 0 ( 0.0) | 4 (11.8) | 3 ( 7.1) | 7 (16.7) |
| Reciprocity | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Compensation | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| [illegible]ness (same stimulus) | 0 ( 0.0) | 1 ( 4.2) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 1 ( 2.9) | 0 ( 0.0) | 1 ( 2.4) |
| Sameness (same quantity) | 1 (14.3) | 2 ( 8.3) | 2 ( 8.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 1 ( 9.1) | 2 ( 5.9) | 2 ( 4.8) | 5 (11.9) |
| More than one category | 0 ( 0.0) | 0 ( 0.0) | 4 (16.0) | 0 ( 0.0) | 0 ( 0.0) | 1 ( 5.9) | 0 ( 0.0) | 0 ( 0.0) | 5 (11.9) | 5 (11.9) |
| No. and % of Explanations | 7(100.0) | 24(100.0) | 25(100.0) | 4(100.0) | 10(100.0) | 17(100.0) | 11(100.0) | 34(100.0) | 42(100.0) | 87(100.0) |

TABLE 8

Frequency and Percentage of Subjects Giving Adequate Explanations for all Conservation Tasks

| | GROUP I | | | GROUP II | | | GROUP I AND GROUP II | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | KDG. | GR. 1 | GR. 2 | KDG. | GR. 1 | GR. 2 | KDG. | GR. 1 | GR. 2 | TOTAL |
| | No. % | No. % | No. % | No. % | No. % | No. % | No. % | No. % | No. % | No. % |
| Addition - Subtraction | 4 (36.4) | 14 (31.2) | 6 (11.8) | 3 (42.9) | 4 (18.2) | 7 (20.6) | 7 (38.9) | 18 (26.9) | 13 (15.3) | 38 (22.4) |
| Statement of Operations | 2 (18.2) | 16 (35.6) | 19 (37.3) | 3 (42.9) | 8 (36.4) | 11 (32.4) | 5 (27.8) | 24 (35.9) | 30 (35.3) | 59 (34.7) |
| Reference to Previous state | 2 (18.2) | 5 (11.1) | 7 (13.8) | 0 ( 0.0) | 6 (27.3) | 10 (29.5) | 2 (11.1) | 11 (16.5) | 17 (20.0) | 30 (17.6) |
| Inversion | 0 ( 0.0) | 4 ( 8.9) | 3 ( 5.9) | 0 ( 0.0) | 2 ( 9.1) | 1 ( 3.0) | 0 ( 0.0) | 6 ( 9.0) | 4 ( 4.7) | 10 ( 5.9) |
| Reciprocity | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 1 ( 4.6) | 0 ( 0.0) | 0 ( 0.0 | 1 ( 1.5) | 0 ( 0.0) | 1 ( 0.6) |
| Compensation | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Sameness (same stimulus) | 2 (18.2) | 2 ( 4.4) | 0 ( 0.0) | 0 ( 0.0) | 1 ( 4.6) | 0 ( 0.0) | 2 (11.1) | 3 ( 4.5) | 0 ( 0.0) | 5 ( 2.9) |
| Sameness (same quantity) | 1 ( 9.1) | 4 ( 8.9) | 7 (13.8) | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) | 1 ( 5.6) | 4 ( 6.0) | 7 ( 8.3) | 12 ( 7.1) |
| More than one category | 0 ( 0.0) | 0 ( 0.0) | 9 (17.7) | 1 (14.3) | 0 ( 0.0) | 5 (14.7) | 1 ( 5.6) | 0 ( 0.0) | 14 (16.5) | 15 ( 8.8) |
| No. and % of Explanations | 11(100.0) | 45(100.0) | 51(100.0) | 7(100.0) | 22(100.0) | 34(100.0) | 18(100.0) | 67(100.0) | 85(100.0) | 170(100.0) |

Scoring with a 0-6 scale

The frequency and percentage of subjects scoring from 0-6 on the various conservation tasks is given in Table 9. The scores were derived by assigning subjects a 1 for each correct answer involving the relational terms "same", "more" and "less" used in both the prediction and judgment phases. This is the scoring scheme employed by Brainerd and Hooper (1975) and Toniolo and Hooper (1975). Subjects were given an 0 for each incorrect answer. Since there were six questions in all, excluding explanations, a maximum score of 6 was possible. As can be seen from the table, subjects received a score of 0 on 69 (24%) of the identity tasks and on 124 (44.3%) of the equivalence tasks. There were 57 (19.8%) tasks on which subjects received a score of 1 and 26 (9.0%) tasks on which subjects received a score of 2 on identity conservation. On the equivalence conservation tasks subjects received a score of 1 on 32 (11.1%) of the tasks and a score of 2 on 9 (3.1%) of the tasks. Subjects received a score of 3 on 13 (4.5%) of both the identity and equivalence conservation tasks. There were 16 (5.6%) identity conservation tasks on which subjects received a score of 4, and 14 (4.9%) tasks on which subjects received a score of 5. On the equivalence conservation tasks subjects received a score of 4 on 5 (1.7%) tasks and a score of 5 on 5 (1.7%) tasks. Ninety-three (32.3%) identity conservation tasks were answered perfectly and 100 (34.7%) equivalence conservation tasks were answered perfectly.

An additional analysis of variance performed on the data scored with a 0-6 scale in the manner presented in Table 9 indicated that performance on the equivalence tasks was significantly better than perform-

TABLE 9

Frequency and Percentage of Tasks On
Which Subjects Obtained the Specified Values

| Score Obtained | 0 | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Group I** | | | | | | | | | | | | | | |
| Identity Moderate | 13 | (18.1) | 11 | (15.3) | 8 | (11.1) | 2 | ( 2.8) | 5 | ( 6.9) | 4 | ( 5.6) | 29 | (40.3) |
| Identity Extreme | 19 | (26.4) | 7 | ( 9.7) | 6 | ( 8.3) | 2 | ( 2.8) | 4 | ( 5.6) | 2 | ( 2.8) | 32 | (44.4) |
| **Group II** | | | | | | | | | | | | | | |
| Identity Moderate | 15 | (20.8) | 21 | (29.2) | 6 | ( 8.3) | 7 | ( 9.7) | 7 | ( 9.7) | 2 | ( 2.8) | 14 | (19.4) |
| Identity Extreme | 22 | (30.6) | 18 | (25.0) | 6 | ( 8.3) | 2 | ( 2.8) | 0 | ( 0.0) | 6 | ( 8.3) | 18 | (25.0) |
| Total for Identity | 69 | (24.0) | 57 | (19.8) | 26 | ( 9.0) | 13 | ( 4.5) | 16 | ( 5.6) | 14 | ( 4.9) | 93 | (32.3) |
| **Group I** | | | | | | | | | | | | | | |
| Equivalence Moderate | 24 | (33.3) | 11 | (15.3) | 1 | ( 1.4) | 5 | ( 6.9) | 0 | ( 0.0) | 1 | ( 1.4) | 30 | (41.7) |
| Equivalence Extreme | 30 | (41.7) | 3 | ( 4.2) | 3 | ( 4.2) | 2 | ( 2.8) | 1 | ( 1.4) | 1 | ( 1.4) | 32 | (44.4) |
| **Group II** | | | | | | | | | | | | | | |
| Equivalence Moderate | 31 | (43.1) | 11 | (15.3) | 3 | ( 4.2) | 5 | ( 6.9) | 3 | ( 4.2) | 2 | ( 2.8) | 17 | (24.6) |
| Equivalence Extreme | 39 | (54.2) | 7 | ( 9.7) | 2 | ( 2.8) | 1 | ( 1.4) | 1 | ( 1.4) | 1 | ( 1.4) | 21 | (29.2) |
| Total for Equivalence | 124 | (44.3) | 32 | (11.1) | 9 | ( 3.1) | 13 | ( 4.5) | 5 | ( 1.7) | 5 | ( 1.7) | 100 | (34.7) |

ance on identity tasks (F=8.85; dF=1,132; $p<.01$).

Transitivity

The general performance pattern on the transitivity tasks for each grade within each group is presented in Table 10. The total number of subjects who passed each task varied little among the four tasks. Considering the total sample 76 subjects passed task A, 74 passed task B, 84 passed task C, and 77 subjects passed task D. Within group totals on each of the four tasks were very similar, however more subjects in Group I passed tasks A, B and D and more in Group II passed task C.

Transitivity tasks were subjected to a 2x2x3x4 analysis of variance in which the variables were Group (Group I, Group II), Sex, Age (Kindergarten, Grade 1, Grade 2), and Task Type (A, B, C, and D). As can be seen from Table 11 the only main effects to reach significance were the main effects for group (F=6.84; dF=1,132; $p<.01$) and grade (F=22.30; dF=2,132; $p<.001$)[1]. Group I performed significantly better than Group II. Newman Kuels tests performed on the grade means showed that Grade 2 children scored significantly higher than children in Grade 1 ($p<.01$) and Kindergarten ($p<.01$), who did not differ.

The frequency and percentage of subjects passing specified numbers of transitivity tasks is given in Table 12. As can be seen from the table only a very small percentage (4.2% of the total sample) failed all transitivity tasks. At the other extreme only 11.1% of the total sample passed all transitivity tasks. The percentage of subjects who passed a number of tasks between these extremes decreases from 95% who passed 1

TABLE 10

Number and Percentage of Subjects
Passing the Four Transitivity Tasks

| Task Schema | Task A A=B=C | | Task B A>B=C | | Task C A=B>C | | Task D A>B>C | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| Group I | | | | | | | | |
| Kindergarten | | | | | | | | |
| Males | 3 | (25.0) | 8 | (66.7) | 7 | (58.3) | 3 | (25.0) |
| Females | 5 | (41.7) | 6 | (50.0) | 8 | (66.7) | 9 | (75.0) |
| Combined | 8 | (33.3) | 14 | (58.3) | 15 | (62.5) | 12 | (50.0) |
| Grade 1 | | | | | | | | |
| Males | 10 | (83.3) | 3 | (25.0) | 3 | (25.0) | 7 | (58.3) |
| Females | 6 | (50.0) | 5 | (41.7) | 7 | (58.3) | 7 | (58.3) |
| Combined | 16 | (66.7) | 8 | (33.3) | 10 | (41.7) | 14 | (58.3) |
| Grade 2 | | | | | | | | |
| Males | 7 | (58.3) | 12 | (100.0) | 9 | (75.0) | 9 | (75.0) |
| Females | 11 | (91.7) | 9 | (75.0) | 7 | (58.3) | 9 | (75.0) |
| Combined | 18 | (75.0) | 21 | (87.5) | 16 | (66.7) | 18 | (75.0) |
| Group 1 Total | | | | | | | | |
| Males | 20 | (55.6) | 23 | (63.9) | 19 | (52.8) | 19 | (52.8) |
| Females | 22 | (61.1) | 20 | (55.6) | 22 | (61.1) | 25 | (69.4) |
| Combined | 42 | (58.3) | 43 | (59.7) | 41 | (56.9) | 44 | (61.1) |

TABLE 10 (cont'd)

| Group II | Task A | | Task B | | Task C | | Task D | |
|---|---|---|---|---|---|---|---|---|
| Kindergarten | | | | | | | | |
| Males | 5 | (41.7) | 4 | (33.3) | 4 | (33.3) | 2 | (16.7) |
| Females | 2 | (16.7) | 4 | (33.3) | 8 | (66.7) | 3 | (25.0) |
| Combined | 7 | (29.2) | 8 | (33.3) | 12 | (50.0) | 5 | (20.8) |
| Grade 1 | | | | | | | | |
| Males | 6 | (50.0) | 4 | (33.3) | 6 | (50.0) | 5 | (41.7) |
| Females | 3 | (25.0) | 5 | (41.7) | 7 | (58.3) | 8 | (66.7) |
| Combined | 9 | (37.5) | 9 | (37.5) | 13 | (54.2) | 13 | (54.2) |
| Grade 2 | | | | | | | | |
| Males | 9 | (75.0) | 9 | (75.0) | 9 | (75.0) | 7 | (58.3) |
| Females | 9 | (75.0) | 5 | (41.7) | 9 | (75.0) | 8 | (66.7) |
| Combined | 18 | (75.0) | 14 | (58.3) | 18 | (75.0) | 15 | (62.5) |
| Group II Total | | | | | | | | |
| Males | 20 | (55.6) | 17 | (47.2) | 19 | (52.8) | 14 | (38.9) |
| Females | 14 | (38.9) | 14 | (38.9) | 24 | (66.7) | 19 | (52.8) |
| Combined | 34 | (47.2) | 31 | (43.1) | 43 | (59.7) | 33 | (45.8) |
| Total Sample | | | | | | | | |
| Males | 40 | (55.6) | 40 | (55.6) | 38 | (52.8) | 33 | (45.8) |
| Females | 36 | (50.0) | 34 | (47.2) | 46 | (63.9) | 44 | (61.1) |
| Combined | 76 | (52.8) | 74 | (51.4) | 84 | (58.3) | 77 | (53.5) |

TABLE 11

Summary of Group x Sex x Grade x Type of Transitivity Task Analysis of Variance

| SOURCE | DF | MS | F |
|---|---|---|---|
| **Between subjects** | | | |
| Group (A) | 1 | 1.46 | 6.84 *** |
| Sex (B) | 1 | 0.85 | 0.40 |
| Grade (C) | 2 | 4.76 | 22.30 **** |
| AB | 1 | 0.14 | 0.66 |
| AC | 2 | 0.23 | 1.08 |
| BC | 2 | 0.17 | 0.79 |
| ABC | 2 | 0.68 | 0.32 |
| Error Between | 132 | 0.21 | |
| **Within subjects** | | | |
| Task Type (D) | 3 | 0.13 | 0.58 |
| AD | 3 | 0.28 | 1.25 |
| BD | 3 | 0.57 | 2.50 |
| CD | 6 | 0.45 | 1.97 |
| ABD | 3 | 0.20 | 0.86 |
| ACD | 6 | 0.29 | 1.28 |
| BCD | 6 | 0.41 | 1.81 |
| ABCD | 6 | 0.30 | 1.34 |
| Error Within | 396 | 0.23 | |

*** $\underline{P}<.01$
**** $\underline{P}<.001$

TABLE 12

Number and Percentage of Subjects Passing Only the Specified Number of Transitivity Tasks

| | 0 Tasks | | One or More Tasks | | Two or More Tasks | | Three or More Tasks | | Four Tasks | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Group I | | | | | | | | | | |
| Kindergarten | | | | | | | | | | |
| Males | 0 | ( 0.0) | 12 | (100.0) | 6 | (50.0) | 3 | (25.0) | 0 | ( 0.0) |
| Females | 0 | ( 0.0) | 12 | (100.0) | 9 | (75.0) | 4 | (33.3) | 3 | (25.0) |
| Combined | 0 | ( 0.0) | 24 | (100.0) | 15 | (62.5) | 7 | (29.2) | 3 | (12.5) |
| Grade 1 | | | | | | | | | | |
| Males | 1 | ( 8.3) | 11 | (91.7) | 8 | (66.7) | 2 | (16.7) | 1 | ( 8.3) |
| Females | 1 | ( 8.3) | 10 | (83.3) | 8 | (66.7) | 5 | (41.7) | 1 | ( 8.3) |
| Combined | 2 | ( 8.3) | 21 | (87.5) | 16 | (66.7) | 8 | (33.3) | 2 | ( 8.3) |
| Grade 2 | | | | | | | | | | |
| Males | 0 | ( 0.0) | 12 | (100.0) | 11 | (91.7) | 9 | (75.0) | 5 | (41.7) |
| Females | 0 | ( 0.0) | 12 | (100.0) | 12 | (100.0) | 10 | (83.3) | 2 | (16.7) |
| Combined | 0 | ( 0.0) | 24 | (100.0) | 23 | (95.8) | 19 | (79.2) | 7 | (29.2) |
| Group I Total | | | | | | | | | | |
| Males | 1 | ( 2.8) | 35 | (97.2) | 25 | (69.4) | 15 | (41.7) | 6 | (16.7) |
| Females | 1 | ( 2.8) | 34 | (94.4) | 29 | (80.6) | 19 | (52.8) | 6 | (16.7) |
| Combined | 2 | ( 2.8) | 69 | (95.8) | 54 | (75.0) | 34 | (47.2) | 12 | (16.7) |

Table 12 (cont'd)

| | 0 Tasks | | One or More Tasks | | Two or More Tasks | | Three or More Tasks | | Four Tasks | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Group II | | | | | | | | | | |
| Kindergarten | | | | | | | | | | |
| Males | 2 | (16.7) | 10 | (83.3) | 4 | (33.3) | 2 | (16.7) | 0 | ( 0.0) |
| Females | 1 | ( 8.3) | 11 | (91.7) | 5 | (41.7) | 0 | ( 0.0) | 0 | ( 0.0) |
| Combined | 3 | (12.5) | 21 | (87.5) | 9 | (37.5) | 2 | ( 8.3) | 0 | ( 0.0) |
| Grade 1 | | | | | | | | | | |
| Males | 1 | ( 8.3) | 11 | (91.7) | 8 | (66.7) | 2 | (16.7) | 0 | ( 0.0) |
| Females | 0 | ( 0.0) | 12 | (100.0) | 8 | (66.7) | 3 | (25.0) | 0 | ( 0.0) |
| Combined | 1 | ( 4.2) | 23 | (95.8) | 16 | (66.7) | 5 | (20.8) | 0 | ( 0.0) |
| Grade 2 | | | | | | | | | | |
| Males | 0 | ( 0.0) | 12 | (100.0) | 12 | (100.0) | 8 | (66.7) | 2 | (16.7) |
| Females | 0 | ( 0.0) | 12 | (100.0) | 10 | (83.3) | 7 | (58.3) | 2 | (16.7) |
| Combined | 0 | ( 0.0) | 24 | (100.0) | 22 | (91.7) | 15 | (62.5) | 4 | (16.7) |
| Group II Total | | | | | | | | | | |
| Males | 3 | ( 4.2) | 33 | (91.7) | 24 | (66.7) | 12 | (33.3) | 2 | ( 5.6) |
| Females | 1 | ( 1.4) | 35 | (97.2) | 23 | (63.9) | 10 | (27.8) | 2 | ( 5.6) |
| Combined | 4 | ( 2.8) | 68 | (94.4) | 47 | (65.3) | 22 | (30.6) | 4 | ( 5.6) |
| Total Sample | | | | | | | | | | |
| Males | 4 | ( 5.6) | 68 | (94.4) | 49 | (68.1) | 27 | (37.5) | 8 | (11.1) |
| Females | 2 | ( 2.8) | 69 | (95.8) | 52 | (72.2) | 29 | (40.3) | 8 | (11.1) |
| Combined | 6 | ( 4.2) | 137 | (95.1) | 101 | (70.1) | 56 | (38.9) | 16 | (11.1) |

or more, to 70.1% who passed 2 or more, to 38.9% who passed 3 or more. The decline in the number of subjects who passed 1 or more to the number who passed 3 or more was less in the case of Grade 2 than in Kindergarten or Grade 1.

The frequency and percentage of subjects who passed or failed transitivity tasks and passed or failed identity conservation tasks, equivalence conservation tasks and all conservation tasks are given in Tables 13, 14, and 15 respectively. The overall results indicate that many more subjects passed transitivity tasks and failed conservation tasks than failed transitivity tasks but passed conservation tasks. Summing the number of subjects who passed 2, 3 or 4 transitivity tasks yields the number who passed 2 or more tasks. Similarly summing the number of subjects who failed 2, 3 or 4 transitivity tasks gives the number of subjects who failed 2 or more transitivity tasks. When this is done it can be seen from Table 13 that 65 subjects (45.1%) passed 2 or more transitivity tasks but failed the identity conservation tasks, but only 15 subjects (10.4%) failed 2 or more transitivity tasks and passed the identity tasks. The comparable figures from Table 14 are 64 subjects (44.4%) who passed 2 or more transitivity tasks and failed the equivalence conservation tasks and 20 subjects (13.9%) who failed 2 or more transitivity tasks but passed the equivalence conservation tasks. An examination of Table 15 shows that 70 subjects (48.6%) passed 2 or more transitivity tasks and failed both types of conservation task, while only 13 subjects (9.0%) passed both types of conservation task and failed 2 or more transitivity tasks.

TABLE 13

Number and Percentage of Subjects Passing and Failing Transitivity Tasks and Identity Conservation Tasks. (Criterion of Judgment Only).

| No. of Transitivity Tasks | Number of subjects passing the conservation tasks but failing the specified number of Transitivity tasks. | | | | | | | | | | Number of subjects failing the conservation tasks but passing the specified number of Transitivity tasks. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | 1 | | 2 | | 3 | | 4 | | 0 | | 1 | | 2 | | 3 | | 4 | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Group I** | | | | | | | | | | | | | | | | | | | | |
| Kindergarten | 0 | (0.0) | 1 | (4.2) | 0 | (0.0) | 1 | (4.2) | 0 | (0.0) | 0 | (0.0) | 9 | (37.5) | 7 | (29.2) | 3 | (12.5) | 3 | (12.5) |
| Grade 1 | 2 | (8.3) | 5 | (20.8) | 5 | (20.8) | 3 | (12.5) | 0 | (0.0) | 2 | (8.3) | 3 | (12.5) | 3 | (12.5) | 1 | (4.2) | 0 | (0.0) |
| Grade 2 | 4 | (16.1) | 6 | (25.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 1 | (4.2) | 4 | (16.7) | 6 | (25.0) | 3 | (12.5) |
| **Total** | 6 | (8.3) | 12 | (16.7) | 5 | (6.9) | 4 | (5.6) | 0 | (0.0) | 2 | (2.8) | 13 | (18.1) | 14 | (19.4) | 10 | (13.9) | 6 | (8.3) |
| **Group II** | | | | | | | | | | | | | | | | | | | | |
| Kindergarten | 0 | (0.0) | 1 | (4.2) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 3 | (12.5) | 12 | (50.0) | 7 | (29.2) | 1 | (4.2) | 0 | (0.0) |
| Grade 1 | 0 | (0.0) | 1 | (4.2) | 2 | (8.3) | 1 | (4.2) | 0 | (0.0) | 1 | (4.2) | 6 | (25.0) | 9 | (37.5) | 4 | (16.7) | 0 | (0.0) |
| Grade 2 | 3 | (12.5) | 2 | (8.3) | 3 | (12.5) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 2 | (8.3) | 4 | (16.7) | 9 | (37.5) | 1 | (4.2) |
| **Total** | 3 | (4.2) | 4 | (5.6) | 5 | (6.9) | 1 | (1.4) | 0 | (0.0) | 4 | (5.6) | 20 | (27.8) | 20 | (27.8) | 14 | (19.4) | 1 | (1.4) |
| **Total Sample** | 9 | (6.3) | 16 | (11.1) | 10 | (6.9) | 5 | (3.5) | 0 | (0.0) | 6 | (4.2) | 33 | (22.9) | 34 | (23.6) | 24 | (16.7) | 7 | (4.9) |

TABLE 14

Number and Percentage of Subjects Passing and Failing Transitivity Tasks and Equivalence Conservation Tasks (Criterion of Judgment Only).

| | Number of subjects passing the conservation tasks but failing the specified number of transitivity tasks | | | | | | | | | | Number of subjects failing the conservation tasks but passing the specified number of transitivity tasks | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | 1 | | 2 | | 3 | | 4 | | 0 | | 1 | | 2 | | 3 | | 4 | |
| No. of transitivity tasks | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Group I | | | | | | | | | | | | | | | | | | | | |
| Kindergarten | 0 | (0.0) | 0 | (0.0) | 1 | (4.2) | 1 | (4.2) | 0 | (0.0) | 0 | (0.0) | 9 | (37.5) | 6 | (25.0) | 4 | (16.7) | 3 | (12.5) |
| Grade 1 | 2 | (8.3) | 4 | (16.7) | 5 | (20.8) | 3 | (12.5) | 0 | (0.0) | 2 | (8.3) | 3 | (12.5) | 3 | (12.5) | 2 | (8.3) | 0 | (0.0) |
| Grade 2 | 4 | (16.7) | 5 | (20.8) | 2 | (8.3) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 1 | (4.2) | 2 | (8.3) | 7 | (29.2) | 3 | (12.5) |
| Total | 6 | (8.3) | 9 | (12.5) | 8 | (11.1) | 4 | (5.6) | 0 | (0.0) | 2 | (2.8) | 13 | (18.1) | 11 | (15.3) | 13 | (18.1) | 6 | (8.3) |
| Group II | | | | | | | | | | | | | | | | | | | | |
| Kindergarten | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 3 | (12.5) | 12 | (50.0) | 7 | (29.2) | 2 | (8.3) | 0 | (0.0) |
| Grade 1 | 0 | (0.0) | 1 | (4.2) | 1 | (4.2) | 1 | (4.2) | 1 | (4.2) | 0 | (0.0) | 6 | (25.0) | 10 | (41.7) | 4 | (16.7) | 0 | (0.0) |
| Grade 2 | 3 | (12.5) | 4 | (16.7) | 4 | (16.7) | 1 | (4.2) | 0 | (0.0) | 0 | (0.0) | 1 | (4.2) | 3 | (12.5) | 7 | (29.2) | 1 | (4.2) |
| Total | 3 | (4.2) | 5 | (6.9) | 5 | (6.9) | 2 | (2.8) | 1 | (1.4) | 3 | (4.2) | 19 | (26.4) | 20 | (27.8) | 13 | (18.1) | 1 | (1.4) |
| Total Sample | 9 | (6.3) | 14 | (9.7) | 13 | (9.0) | 6 | (4.2) | 1 | (0.7) | 5 | (3.5) | 32 | (22.2) | 31 | (21.5) | 26 | (18.1) | 7 | (4.9) |

TABLE 15

Number and Percentage of Subjects Passing and Failing Transitivity Tasks and all Conservation Tasks (Criterion of Judgment Only)

| No. of Transitivity Tasks | Number of subjects passing the conservation tasks but failing the specified number of transitivity tasks. | | | | | | | | | | Number of subjects failing the conservation tasks but passing the specified number of transitivity tasks. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | 1 | | 2 | | 3 | | 4 | | 0 | | 1 | | 2 | | 3 | | 4 | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Group I** | | | | | | | | | | | | | | | | | | | | |
| Kindergarten | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 1 | (4.2) | 0 | (0.0) | 0 | (0.0) | 9 | (37.5) | 7 | (29.2) | 4 | (16.7) | 3 | (12.5) |
| Grade 1 | 2 | (8.3) | 4 | (16.7) | 5 | (20.8) | 3 | (12.5) | 0 | (0.0) | 2 | (8.3) | 3 | (12.5) | 3 | (12.5) | 2 | (8.3) | 0 | (0.0) |
| Grade 2 | 4 | (16.7) | 5 | (20.8) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 1 | (4.2) | 4 | (16.7) | 7 | (29.2) | 3 | (12.5) |
| Total | 6 | (8.3) | 9 | (12.5) | 5 | (6.9) | 4 | (5.6) | 0 | (0.0) | 2 | (2.8) | 13 | (18.1) | 14 | (19.4) | 13 | (18.1) | 6 | (8.3) |
| **Group II** | | | | | | | | | | | | | | | | | | | | |
| Kindergarten | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 3 | (12.5) | 12 | (50.0) | 7 | (29.2) | 2 | (8.3) | 0 | (0.0) |
| Grade 1 | 0 | (0.0) | 1 | (4.2) | 1 | (4.2) | 0 | (0.0) | 0 | (0.0) | 1 | (4.2) | 7 | (29.2) | 10 | (41.7) | 4 | (16.7) | 0 | (0.0) |
| Grade 2 | 3 | (12.5) | 2 | (8.3) | 3 | (12.5) | 0 | (0.0) | 0 | (0.0) | 0 | (0.0) | 2 | (8.3) | 4 | (16.7) | 9 | (37.5) | 1 | (4.2) |
| Total | 3 | (4.2) | 3 | (4.2) | 4 | (5.6) | 0 | (0.0) | 0 | (0.0) | 4 | (5.6) | 21 | (29.2) | 21 | (29.2) | 15 | (20.8) | 1 | (4.0) |
| **Total Sample** | 9 | (6.3) | 12 | (8.3) | 9 | (6.3) | 4 | (2.8) | 0 | (0.0) | 6 | (4.2) | 34 | (23.6) | 35 | (24.3) | 28 | (19.4) | 7 | (4.9) |

# Discussion

## Conservation

Taken together the results of the present study are in general agreement with the results of studies which indicate that identity conservation and equivalence conservation co-occur in a developmental sense. Performance on identity conservation tasks was not significantly different from performance on equivalence conservation tasks. There was very little difference in the number of subjects who passed identity conservation tasks and equivalence conservation tasks within each group. Also of importance is the fact that there were not more subjects who passed identity conservation tasks and failed equivalence conservation tasks than the number who passed equivalence conservation tasks and failed identity conservation tasks. Significantly more Grade 2 than Kindergarten subjects passed the conservation tasks. Very few Kindergarten subjects passed either identity conservation or equivalence conservation tasks and there were no Kindergarten subjects who passed both identity conservation tasks and failed equivalence conservation tasks.

The effect of the two levels of transformation was insignificant. This result is in agreement with other studies which have used more than one level of transformation. Hooper (1969a) and Koshinsky and Hall (1973) found that varying the level of transformation of discontinuous objects in glass cylinders did not have a significant effect. This would seem to contradict Piaget and Inhelder's (1974) view of the importance of the level of transformation, although it is also possible that the differential

between the moderate and extreme was not great enough.

The group which received the identity task outlined by Elkind (1967) and the traditional conservation tasks (Group I) performed consistently better than the group which received the modification (Group II) for all conservation tasks. It is possible, however, that this resulted from some overall difference in the ability of the groups rather than the differential effects of the tasks. This interpretation is based on the fact that Group II also was inferior in performance on the transitivity tasks even though they were the same tasks administered to Group I. It is not clear what factors could account for the superior performance of Group I since many precautions were taken to insure that assignment to the groups was done randomly. Subjects were chosen randomly from their classes, with the result that subjects in different classes at the same grade level were equally likely to be placed in Group I as in Group II. There was random testing across time of day to ensure that one group would not be tested at any single time period. The number of subjects who were successful on the transitivity tasks was the same whether the tasks were administered before any conservation tasks, between conservation tasks (i.e., between identity and equivalence tasks) or after the conservation tasks. This was true within each group, hence a differential multiple treatment interference effect (Campbell and Stanley, 1963; p. 6) cannot account for the difference between groups.

The most frequent explanation categories used when justifying responses were addition-subtraction, statement of operations, reference to previous state and more than one category. Toniolo and Hooper (1975)

found that addition-subtraction was the single most frequently used category. In the present study the statement of operations category was used most frequently with the addition-subtraction category being the second most frequently used category. Hooper (1969a) and Toniolo and Hooper (1975) found that addition-subtraction was the category most frequently used on identity conservation, whereas Papalia and Hooper (1971) found that reference to the previous state was used most frequently. The most frequently used category on the equivalence tasks was reference to the previous state in both the Hooper (1969a) and Papalia and Hooper (1971) studies. Toniolo and Hooper (1975) found that addition-subtraction was the most frequently used category on equivalence tasks. In the present study statement of operations was the most frequently used category on both types of tasks.

The second most frequently used explanation category for identity tasks differed from that used for equivalence tasks. The statement of operations category was most frequent for identity tasks and the reference to previous state category was most frequent for equivalence tasks. This is in agreement with Toniolo and Hooper (1975) who found the same pattern of results with the second most frequently used category for the different conservation tasks.

In agreement with Hooper (1969a), Papalia and Hooper (1971) and Toniolo and Hooper (1975) the present study indicates that inversion and reciprocity are categories that are used very infrequently. The category of compensation was never used in the present study, which is in agreement with the results of Toniolo and Hooper (1975), who obtained only one explanation of this type.

A comparison of Tables 1 and 3, Tables 4 and 5, and Tables 13 and 14 supports Brainerd's (1973) contention that a judgment plus explanation criterion is much more stringent than a judgment only criterion. The number of subjects considered to have passed the conservation tasks with a criterion of judgment plus explanation is consistently less than the number who passed with a criterion of judgment only. These results are in agreement with those of Brainerd and Hooper (1975) and Toniolo and Hooper (1975) in that the criterion chosen affected performance on the conservation tasks to a statistically significant degree.

It is important at this point to discuss two recent studies which support the thesis that identity conservation is acquired prior to equivalence conservation. Both Brainerd and Hooper (1975) and Toniolo and Hooper (1975) present evidence to show that identity conservation of length and weight precede equivalence conservation of length and weight. These two studies were very similar to the present one and hence deserve close discussion particularly since it is possible that the results of these studies are artifactual.

In both studies a scoring technique which assigned values from 0 to 6 on the conservation tasks was used. Three questions were asked in the prediction phase employing the terms "more", "less" and "same" and three questions employing these same three relational terms were asked in the judgment phase. Three terms were employed in each phase in order to insure that children had to both agree and disagree with the experimenter in order to be correct. Rothenberg (1969) has reported on a tendency for children to agree with what an experimenter says more frequently than they disagree. Each time one of the questions was answered correctly a score

of 1 was assigned and each incorrect response was scored 0. Since there were six questions on each task a maximum score of 6 was possible and all values between 0 and 6 could be obtained.

It is very important to note that there was a difference between the questions employed in identity conservation tasks and equivalence conservation tasks. This difference may account for the supposed developmental priority of identity conservation over equivalence conservation. To illustrate let us assume that there is a subject who consistently believes that a perceptual transformation changes the relevant quantitative feature of a clay ball causing it to weigh more. The same point would apply to subjects who consistently believe that an object weighs less. The following questions are taken from the conservation of weight tasks employed by Toniolo and Hooper (1975):

Identity Format

1. Prediction: Placing the green clay ball in the middle of the table 8 - 10 inches from the S, the E asks the following questions:

a. If I were to roll this clay ball into a hotdog would the piece of clay still have the same weight?

Yes _____ No 0 I don't know _____ No response _____

b. If I were to roll this clay ball into a hotdog would the piece of clay weigh more?

Yes 0 No _____ I don't know _____ No response _____

c. If I were to roll this clay ball into a hotdog would the piece of clay weigh less?

Yes _____ No 1 I don't know _____ No response _____

2. Deformation: The E then rolls the ball into a hotdog, and asks the following questions:

a. Does this piece of clay weigh the same as before?

Yes _____ No 0 I don't know _____ No response _____

b. Does this piece of clay weigh more than before?

Yes 0 No _____ I don't know _____ No response _____

c. Does this piece of clay weigh less than before?

Yes _____ No 1 I don't know _____ No response _____

Equivalence Format

1. Prediction: Taking the balls from the S and placing them on the table side-by-side 8 - 10 inches from the S, the E asks the following questions while pointing to one of the stimuli:

a. If I were to flatten this clay ball into a pancake, would the two pieces of clay still have the same weight?

Yes _____ No 0 I don't know _____ No response _____

b. If I were to flatten this clay ball into a pancake would one of the pieces of clay weigh more?

Yes 0 No _____ I don't know _____ No response _____

c. If I were to flatten this clay ball into a pancake would one of the pieces of clay weigh less?

Yes 0 No _____ I don't know _____ No response _____

2. Deformation: The E then flattens the clay ball into a pancake and asks the following questions:

a. Do these two pieces of clay weigh the same as before?

Yes _____ No 0 I don't know _____ No response _____

b. Does one of the pieces weigh more than before?

Yes 0 No _____ I don't know _____ No response _____

c. Does one of the pieces weigh less than before?

Yes 0 No _____ I don't know _____ No response _____

Notice that the child would receive a score of 2 for these answers on the identity task. This is because the child believes that the ball will have more clay when it is rolled into a hotdog. Consequently in the prediction and judgment (deformation) phase when asked if the ball will have less when it is a hotdog the child answers "no" for he/she believes it will have more. However a score of 1 will be given for each phase because, in one sense, the answer is correct it will not have less. The analogous questions in the equivalence task do not lead to such scores. When the subject is asked in the prediction phase if one object will have less he/she replies that one will, i.e., the ball. Similarly in the judgment phase the subject will reply that one object has less.

Scores obtained in this manner, employed the 0-6 scale, were subjected to an analysis of variance by Brainerd and Hooper (1975) and by Toniolo and Hooper (1975). A statistically significant difference between identity conservation and equivalence conservation was obtained and attributed to the developmental priority of the identity conservation concept over the equivalence conservation concept. My preceding analysis which shows that scores on identity conservation tasks would be greater than scores on equivalence conservation tasks because of the differences in questions employed on the two tasks suggests that the significant differences obtained in the analysis of variance are artifactual.

It is important to note that the differences observed in the

Toniolo and Hooper (1975) study between identity conservation and equivalence conservation were much less pronounced when a dichotomous pass/fail criterion was used. According to this criterion subjects were said to have passed a task if they were correct on all questions in both the prediction and judgment phases. Any other pattern of responses was counted as a failure. Preschool, kindergarten and third grade subjects were assessed and when an analysis of variance of the scores obtained with a 0-6 scale was done a significant main effect was obtained for the Identity X. Equivalence factor in both length and weight measures. A significant Grade Level x Conservation Task Type interaction was also obtained. However when the pass/fail criterion was used, only the kindergarten and total sample weight cases indicated that identity conservation was easier than equivalence conservation.

Unfortunately the same kinds of questions were used for the conservation tasks in the present study as in Brainerd and Hooper (1975), and Toniolo and Hooper (1975), as were several of the other methodological prescriptions of Brainerd and Hooper (1975). However the scoring technique used in the present study obviates the criticisms directed at the other studies. A three-point scale with values of 0, 1 and 2 was employed. This scale reflects the level of concept attainment more clearly than does a 0-6 scale. To illustrate let us assume that there are two hypothetical subjects X and Y who both obtain scores of 3 using the 0-6 scale. If these numerical magnitudes accurately reflect a subject's level of concept attainment then subject X and subject Y should be considered to be at the same level of conceptual development on the particular task. Suppose, however, that the distribution of scores for the 0-6 scale is as follows:

| | Prediction | | | Judgment | | | Total |
|---|---|---|---|---|---|---|---|
| | Same | More | Less | Same | More | Less | |
| Sub. X | 1 | 1 | 1 | 0 | 0 | 0 | 3 |
| Sub. Y | 1 | 0 | 0 | 0 | 1 | 1 | 3 |

On the scoring technique used in the present study the scores would be as follows:

| | Prediction | | | Judgment | | | Total |
|---|---|---|---|---|---|---|---|
| | Same | More | Less | Same | More | Less | |
| Sub. X | 1 | 1 | 1 | 0 | 0 | 0 | |
| | | 1 | | | 0 | | 1 |
| Sub. Y | 1 | 0 | 0 | 0 | 1 | 1 | |
| | | 0 | | | 0 | | 0 |

On the 0-6 scoring scheme subject X and Y would be judged equal in terms of concept attainment, however, on the 0, 1, 2 scoring scheme subject X shows a higher level of concept attainment than subject Y. The 0, 1, 2 scoring scheme demands that subjects be consistent in their answers within each phase in order to obtain scores other than 0. This is done because the questions involving the three relational terms are not independent. Given that a subject believes a transformed object to have the same amount of clay as before the transformation he/she should also believe that it does not have more or less, in order to be consistent. This constraint of consistency in responding is absent in the case of the 0-6 scale as subjects can obtain part values for their answers. To illustrate the importance of this consistency constraint, consider all

possible patterns of respondings to one phase of the equivalence conservation task. An example is presented in Table 16. Since this example is concerned with only one phase of the conservation task scores can range from 0 to 3 inclusive. Only two patterns of responding, those to the left of the dotted line, can be considered to be consistent patterns of responses. All six other possible patterns, to the right of the dotted line, are inconsistent. What this means will become clearer below, but first let us consider another type of example, one in which numerals are assigned to responses. In many types of mental measurement situations part-values are assigned to a subject's responses if some questions are answered incorrectly. For instance, if a subject is asked to define the meaning of 10 words and gives 7 acceptable definitions, we may assign the number 7 to those responses. Assuming, of course, that the words have been assigned equal weights. Another subject who gave 5 appropriate definitions would be assigned a score of 5. We can say (based on the relative magnitude of the numerals assigned to the responses) that the subject scoring 7 performed better (i.e., gave more correct definitions) than the subject scoring 5. Furthermore, all other subjects can be ordered accordingly.

Now consider what happens in the conservation situations outlined above in Table 16. Three of the inconsistent patterns of responding will be assigned a 1 and three will be assigned a 2. Following the logic of the previous example, it would appear, within an order of error, that the three patterns assigned a 2 would evidence the same level of conceptual development which would in turn be considered to show more evidence of the concept than patterns being assigned a 1. There is one important difference,

TABLE 16

Possible Patterns of Responding

| | Consistent | | Inconsistent | | | | | |
|---|---|---|---|---|---|---|---|---|
| Same | Y | N | N | Y | N | Y | Y | N |
| More | N | Y | N | N | N | Y | Y | Y |
| Less | N | Y | Y | Y | N | N | Y | N |
| Assigned Score | 3 | 0 | 1 | 2 | 2 | 2 | 1 | 1 |

Y = Yes N = No

however, between the conservation situation and the example of word definitions. The three questions asked in the conservation task employ relational terms which are dependent on each other in order to lead to a consistent response pattern. However, the word definitions are not dependent in the same sense. To make this point clearer, consider the first pattern of responses to the right of the dotted line in Table 16. A subject giving this set of responses would say that both balls are not the same weight, one ball does not weigh more and one ball does weigh less. Clearly this subject is being inconsistent since he/she is asserting that mutually exclusive propositions are holding about the same object. In fact, all of the patterns of responding which have been labeled inconsistent are of this nature. Even those subjects which have been assigned a 2 have been inconsistent in this manner, but these subjects are supposedly relatively close to having the concept in question. The problem with the assignment of all of these part-values is that in one sense the subject is partially correct in that he/she has answered one or two questions correctly but how can this be interpreted? The questions are not independent in the sense that answers can stand on their own without reference to the other answers. Moreover, since a reasoning skill (in a broad sense) is being measured consistency in reasoning is important.

The criticisms of the Brainerd and Hooper (1975) and Toniolo and Hooper (1975) studies can be summarized as follows. Greater care should be taken to insure that the questions on each of the tasks are equivalent in terms of difficulty. It is also important that the questions should be structured so that answers can be scored in an unambiguous

manner. The scale of 0-6 leads to an ambiguous reflection of the level of concept attainment largely because of the difficulty in interpreting score values of 1 through 5. The present method of scoring using a 0, 1, 2 scale is, unfortunately, only slightly more refined than a pass/fail criterion, but it is not open to the problems of interpretation that occur with the 0-6 technique.

The importance of these criticisms can be appreciated when the data from the present study are scored with the 0-6 scale. There were many [illegible] than on the equivalence tasks. The difference between identity and equivalence tasks was also statistically significant when an analysis of variance of scores obtained with this scale was run.

Transitivity

Subjects in Kindergarten and Grade 1 performed equally well on the transitivity tasks, while subjects in Grade 2 performed better than both Kindergarten and Grade 1 subjects. As on the conservation tasks Group I performed better than Group II on the transitivity tasks.

There was no difference in performance on the various transitivity tasks. A study by Murray and Youniss (1969) has indicated that some transitivity paradigms are easier than others. They presented tasks of the form A>B=C, A=B>C and A>B>C to Kindergarten, Grade 1 and Grade 2 children. They found that the A>B>C paradigm was easier than either of the other two paradigms, however the A>B=C, and A=B>C forms of the task did not differ significantly. Their tasks differed from those used in

the present study in that none of the objects were hidden and transitivity of length was investigated.

Almost all of the subjects in the present study passed 1 or more of the transitivity tasks. A large proportion of subjects passed 2 or more tasks. Many subjects passed transitivity tasks, but failed conservation tasks, while very few subjects passed conservation tasks and failed transitivity tasks. These results are in agreement with those of Brainerd (1973) and Toniolo and Hooper (1975) regarding the acquisition of transitivity and conservation.

## Conclusion

The results of the present study and those of Toniolo and Hooper (1975) cast considerable doubt on Elkind's (1967) analysis about the role of transitivity in the typical conservation task. Transitivity, as a mental operation, develops prior to both identity conservation and equivalence conservation, at least in the content areas of solid continuous quantity, length and weight, hence the absence of this concept cannot be involved in an explanation of failure on the traditional task. This would only be the case, however, if it is shown that identity precede equivalence conservation developmentally. If, however, as the present study indicates, identity and equivalence conservation co-occur then Elkind's analysis could still hold true in the sense that transitivity is indeed important for the proper solution of the traditional conservation task but since all subjects who pass identity tasks have the concept, they can also pass equivalence tasks. It is difficult to see how Elkind's analysis could be investigated empirically unless a particular content area was found in which subjects

do not have transitivity, but can pass identity conservation tasks. If subjects passed identity tasks but failed equivalence conservation tasks this would support the analysis. If, however subjects passed identity tasks and passed equivalence conservation tasks this would contradict the analysis. It is highly unlikely that such a content area will be found considering the results of the present study and those of Bryant and Trabasso (1971), Brainerd (1973), and Toniolo and Hooper (1975) which show transitivity to be a relatively primitive operation which develops prior to conservation. Moreover even if such a content area were found Elkind's original analysis would be considerably weakened as it was meant to apply to all conservation tasks irrespective of content area.

## Footnotes

[1]These effects should be treated with caution since a "two-point scale" (0,1) was used in the analysis. In an analysis of the effects of the length of a score scale on the significance level of the F-test Hsu and Feldt (1969) point out that when a two-point scale is involved a sample size of 50 or more should be used. However since the group effect is the result of a sample size of 72 and the grade effect a sample size of 48 this prescription has not been seriously violated. Further, considering the robustness of the effects it is highly unlikely that these factors did not have a significant influence.

[2]This classification scheme has been adopted from Toniolo and Hooper (1975).

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# Appendix A[2]

## Explanation Categories for Conservation Tasks

1) Addition-Subtraction: nothing has been added to or subtracted from the transformed stimulus.

2) Statement of Operations: assertion that the transformation did not affect the quantity in question.

   Example: You just flattened it down (it's still the same amount).

3) Reference to Previous State: standard stimulus and transformed stimulus have the same amount because the standard stimulus and comparison stimulus had the same amount before the transformation.

   Example: They (the objects) were the same amount before, so they are still the same now.

4) Inversion: when object can be returned to its state prior to transformation.

   Example: You can roll it back into a ball and it will have the same amount.

5) Reciprocity: when standard stimulus can be made to resemble the transformed stimulus.

   Example: You can flatten that (the standard) and they will have the same amount.

6) Compensation: one dimension of the transformed stimulus is compensated by the other dimension.

   Example: The pancake is bigger around, but it is also flatter.

7) Sameness (same stimulus): assertion that stimulus as a whole entity is the same piece of clay.

Example: It is still just the same clay as before.

8) Sameness (same quantity): assertion that the stimulus has the same amount as before.

Example: It still has just the same amount of clay.

9) More than one category: use of two or more of the above categories in a composite explanation.

Example of 1) and 2): You just flattened it down, you didn't take any away.

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