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ABSTRACT

The purpose of the study was to determine whether kindergarten children could perform successfully on Piagetian class inclusion tasks and whether their performance was a function of the types of conditions under which the task was presented. Children were asked to classify items based on a physical attribute not visually perceptible (painted wooden beads and painted metal squares) or a physical attribute visually perceptible in the materials (candy suckers and paper circles). Classifications were also made according to the function of the items (things to eat, things to play with). Results generally supported Piaget's research. Children could classify on the basis of function more easily than when a physical attribute was used as the basis of classification. Results are discussed in terms of the children's use of numbers in solving these classification problems. (SBT)

AN INVESTIGATION OF THE PERFORMANCE OF KINDERGARTEN CHILDREN ON QUANTITATIVE CLASS INCLUSION TASKS

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The purpose of the study reported here today was to determine whether kindergarten children, under conditions considered to be favorable, could perform successfully on class inclusion tasks, as defined by Piaget. The writer was interested in finding conditions which would facilitate the young primary-age child's achievement on these tasks. This study was concerned with the following problem: Is the performance of five and six year old children on quantitative class inclusion tasks a function of the types of conditions under which the task is presented?

In Piaget's classic experiment, the child was shown a box containing twenty wooden beads, most of which were brown and the remaining few white. After preliminary discussion, the child was asked the quantitative class inclusion question: Are there more brown beads or more wooden beads? Children under seven or eight years of age were unable to answer correctly. (Piaget, 1952, Ch. 7.)

An analysis of the Geneva experiments on class inclusion revealed several conditions which might facilitate the young child's achievement of class inclusion. The first concerned the visual perceptibility of physical attributes. In the wooden beads experiment one might reasonably assume that the beads were wooden stringing beads widely used as toy objects for young children. If so, these beads are painted, and,

therefore, the attribute upon which the classification needs to be made, woodness, is not perceptually available to the child. The fact that the criterial attribute is not perceptually available may focus the young child's attention on the parts and prevent possible "decentering" from occurring. In tasks concerned with physical attributes, would the child's responses be the same if the criterial attribute was perceptible? Example: Using green and red paper circles, are there more green circles or more paper circles? In a classroom situation the criterial attribute would be perceptible. This procedure is consistent with the results of other investigators who, in concept formation studies, found a relationship between the perceptual situation and concept formation. (Russell, 1956, p. 244.)

A second condition was concerned with the meaningfulness of concepts. In an experiment in which the classes ducks plus birds equal animals were used, Inhelder and Piaget (1969) explained that this task proved more difficult than other class inclusion tasks because the children's concepts of animal classes were not well-defined. A question was raised in the study reported here as to how differentiated, global or vague the concepts of wood, flowers, and species of flowers are for young children; these concepts comprised the classes of other experiments. In the writer's experience in working with young children in the classroom, it was found that the composition attribute of woodness may not be as commonly known by this age level child as one might assume. In their investigation of object sorting, Goldman and Levine (1963) found that concepts concerned with material were used as a basis for groups by only a very small number of kindergarten and first grade children; the use of

such concepts increased as education increased.

No doubt most five and six year old children know what a flower is, but in contrast with other objects, such as food, toys, and clothes, their concept of flower is less differentiated. Brown (1958) points out that the young child does not possess the full category of abstract terms such as flowers. On the basis of the writer's experience, children of this age have little knowledge of the names of species of flowers; some further indication of this is suggested by the word association survey of Entwisle (1966). Of 480 kindergarten and first grade children, only 33 children gave species names in response to the stimulus word flowers. Would the child's response on the class inclusion task have been the same if the subclass and the inclusive class used had more substantial meaning for the child? Example: using pictures of dresses and sweaters: are there more dresses or more clothes?

A third condition concerned the basis for classification. In their study of equivalence transformation, Bruner and Olver found that of the six year old children who formed a genuine category or class, the majority did so on the basis of the common function concerned with all the items. The investigators report that two kinds of functional classifications occurred: (1) "intrinsic functional"--based on the use or purpose of the object--"what they do," and (2) "extrinsic functional"--based on the actions directed toward the objects--"what can be done to them." (Bruner and Olver, 1963, pp. 137-138; Bruner, et. al., 1966, p. 72.) The results of the investigation supported the premise: "Under enactive representation, things should be seen as alike on the basis of a common role in some action." (Ibid., p. 68.)

Goldman and Levine (1963) also found that, along with perceptible attributes, the use of function as a basis of classification was common with young children. In the investigations of class inclusion under discussion here, the opportunity to use function as a basis of classification was not presented to the young child. Since there is evidence that the functional mode of classification is characteristic of this age level, it seems appropriate to investigate this factor in relation to the young child's performance on class inclusion tasks. Would the child's performance differ if the opportunity to classify on a functional basis was presented? Example (Extrinsic Functional): using cookies and candy: are there more cookies or more things to eat? Example (Intrinsic Functional): using cars and tricycles: are there more cars of more things that move?

A fourth condition concerned the spatial arrangement of materials. During the last several decades, there has been an emphasis on using concrete materials and aids with primary children. This emphasis includes organizing a spatial arrangement of the materials that is perceptually supportive in relation to the learning involved; this has been especially evident in the teaching of arithmetic. The arrangements used in the class inclusion experiments did not necessarily make the relationship of the whole and part perceptually available. By setting up an Euler diagram-like arrangement, i.e., a circle within a circle, perhaps the child's perception of this relationship might be facilitated because the arrangement depicts the inclusion. In addition, a number of situations in the environment depict inclusion and could be used with materials appropriate to them. Example: a cupboard, a utensil box

within a drawer, a clothes rack in a closet: Are there more dresses or more clothes? With this kind of spatial arrangement, would the young child be able to construct the class inclusion in Piaget's quantitative terms?

In addition to these four variables, this study also investigated the effects of removing color contrast in materials and the effects of using materials more representative of a genuine class; explanation of these follows as we look at the test.

It was hypothesized that the experimental conditions would be more favorable for young children and, consequently, would incite greater frequencies of correct responses than the comparison conditions.

Method

One hundred twenty children were randomly selected from the total kindergarten populations of two schools and were randomly assigned to one of three testing conditions in each school. The study employed four experimental conditions, two in each school, and a common comparison testing condition was used in each school. In the comparison conditions, the classification was based upon a physical attribute which was not visually perceptible in the materials (painted wooden beads and painted metal squares). In two of the experimental conditions, the classification was based upon a physical attribute which was visually perceptible in the materials (candy suckers and paper circles in one condition, and circles and squares of a single color in the other). In the two remaining experimental conditions, the basis of classification was the function of the items (cookies and candy = things to eat; blocks and cars = things to play with). An Euler diagram-like arrangement of

materials was used with three of the experimental conditions. In the other experimental condition and in the two comparison conditions, a mixed, irregular arrangement of materials was used.

Testing Conditions

Testing Condition 1. Criterial Attribute Visually Perceptible.
Materials: (Subitem a) candy suckers identical in size and shape--10 yellow, 3 red. (Subitem b) paper circles identical in size--9 green, 4 black.
Preliminary Question: Are all these candy suckers (paper circles)?
Quantitative Question: Are there more yellow suckers or more candy suckers? Are there more green circles or more paper circles?

Testing Condition 2. Extrinsic Functional.
Materials: (Subitem a) 10 identical small cookies, 3 identical pieces of candy. (Subitem b) 9 identical blocks, 4 identical toy cars.
Preliminary Question: Are all these things to eat (things to play with)?
Quantitative Inclusion Question: Are there more cookies or more things to eat: Are there more blocks or more things to play with?

The spatial arrangement in Testing Conditions 1 and 2 resembled Euler diagrams; the larger subclass was enclosed in a circle of yarn corresponding in color to the item of this subclass, and braided yarn corresponding in color to both subclasses was used to encircle the inclusive class.

Testing Condition 3. (Standard of Comparison)
Criterial Attribute Not Visually Perceptible.
Materials: (Subitem a) wooden stringing beads, 10 yellow, 3 red. (Subitem b) painted metal squares, 9 green, 4 black.

Preliminary Question: Are all these wooden beads (metal squares)? Quantitative Inclusion Question: Are there more yellow beads or more wooden beads? Are there more green squares or more metal squares?

An irregular, mixed arrangement of materials was used.

Testing Condition 4. (Standard of Comparison) Identical to Testing Condition 3.

Testing Condition 5. Criterial Attribute Visually Perceptible - Removal of Color Contrast

Materials: (Subitem a) green paper forms--10 circles, 3 squares; no variation in size. (Subitem b) black paper forms--9 squares, 4 circles; no variation in size. Preliminary Question: Are all these green (black)?

Quantitative Inclusion Question: Are there more round ones or more green ones? Are there more square ones or more black ones?

In this testing condition an irregular, mixed arrangement of materials was used.

Testing Condition 6. Extrinsic Functional - Genuine Class

Materials: (Subitem a) 10 non-identical cookies, 3 non-identical pieces of candy. (Subitem b) 9 non-identical blocks, 4 non-identical toy cars. Preliminary Question: Are all these things to eat (things to play with)? Quantitative Inclusion Question: Are there more cookies or more things to eat? Are there more blocks or more things to play with?

The items were arranged so as to resemble an Euler diagram, but no yarn or other circles were used to enclose the materials.

Scoring

Only the quantitative class inclusion question was used in assessing the differences among testing conditions. The main analysis was done on the first subitem, item a. A secondary analysis was also performed in relation to subitem b, and the results were almost identical to those of the main analysis.

Results

In the tasks wherein the basis of classification was an attribute of composition, having that attribute visually observable did not improve the kindergarten children's achievement on class inclusion tasks.

The use of materials which have substantial meaning for young children did not, in and of itself, constitute a sufficient condition for successful achievement on the tasks. The tasks proved to be difficult for most of the children.

The Euler diagram-like arrangement of materials did not improve the kindergarten children's performance on the class inclusion tasks.

Neither the removal of color contrast nor the use of a genuine class substantially affected the results.

In general, the results of this study support Piaget's research; however, two significant findings are of particular interest. First, when the data were organized by basis of classification, significantly more correct responses occurred in the functional tests than in tests using physical attributes as a basis of classification. (See Table 1.) Thus, it was concluded that the functional basis of classification constituted a more favorable condition for the kindergarten children's achievement of class inclusion than did the tasks in which a physical

attribute was used as the basis of classification. Bruner and Olver (1963) suggest that classification on the basis of function may be the first way of organizing properties into nonperceptible units of similarity; this suggests that a functional basis of classification may have the effect of facilitating decentering on the part of the child. According to Piaget, decentering is necessary for the child to conserve the whole and part simultaneously, as required by the quantitative class inclusion question.

The second significant result of special interest concerns counting behavior that was observed during the administration of the treatments in both schools. Twenty-four of the one hundred twenty children overtly evidenced that they were counting, and they appeared to count a subclass distinct from the other subclass. Their behavior indicated to this writer that they were comparing disjoint sets by counting, and this kind of comparison would not facilitate the construction of class inclusion. All of the children who counted responded incorrectly; none of the children who responded correctly evidenced counting behavior. There was a significant association between degree of correctness and counting. (See Table 2) These data indicate that counting the subsets impedes successful performance on class inclusion tasks.

This finding does not support Piaget's premise that number and class are complementary developments. Rather this result would support Dodwell's research, in which no clear relation was found between the development of class inclusion and cardinal number as measured by one-to-one correspondence tasks. (Dodwell, 1962) Further research is needed to clarify the relation between number and class.

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TABLE 1

COMPARISON OF FUNCTIONAL AND PHYSICAL ATTRIBUTES AS BASES OF CLASSIFICATION IN RELATION TO THE FREQUENCY OF CORRECT AND INCORRECT RESPONSES

	Bases of Classification	
Responses	Physical Attributes Tests 1a, 3a, 4a, 5a	Functional Tests 2a, 6a
-	64	25
+	16	15

$\underline{X}^2 = 3.40$ $\underline{df} - 1$ $\underline{p} < .05$

TABLE 2

ASSOCIATION BETWEEN DEGREE OF CORRECTNESS ON CLASS INCLUSION TASKS AND COUNTING AND NOT COUNTING

Responses on Class Inclusion Tasks (Subitem a)	Counted	Did Not Count
Incorrect	24	65
Correct	0	31

$\underline{X}^2 = 7.23$ $\underline{df} = 1$ $\underline{p} < .005$