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ABSTRACT

The purpose of the present study was to determine if a developmental sequence could be established for the appearance of conservation. A series of four dimensional tasks and a conservation task were administered to 25 kindergarten girls and 25 kindergarten boys. The dimensional tasks tested understanding of comparative and superlative terms along one and two dimensions and the ability to define the relevant dimension in a given situation. A scalogram analysis indicated the existence of a developmental sequence consisting of understanding relational terms along one dimension, defining the relevant dimension, coordinating relational terms along two dimensions, and conservation. The sequence was valid for girls, but was only a "quasi-scale" rather than a true sequence for boys due to more variability in the boys' response pattern. (ED)

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THE ROLE OF RELATIONAL CONCEPTS IN THE ACQUISITION OF CONSERVATION

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One of the most studied aspects of Piaget's theory of cognitive development has been conservation. Initially, much of the research was focused on cross-cultural and cross-sectional studies to verify the existence and generality of the stages of development posited by Piaget. The second stage of research was concentrated on efforts to experimentally induce conservation through some type of training procedure (e.g. Beilin, 1965; Gelman, 1969). However, very few of the studies obtained even a modicum of success.

The next approcch taken was to analyze carefully what skills were necessary in order to be able to conserve. Some of the research was directed at specific types of conservation. Kingsley and Hall (1967), for example, did a task analysis of the skills necessary for conservation of weight and then trained their subjects in these skills. Others looked at more general skills, such as language ability, understanding of relational terms, recognition of identity and equivalence (e.g. Zimiles, 1965).

There are a number of factors that some theoretical observers believe play important roles in the development of various logical structures. One of the most important is that of language. Language is important as a semantic vehicle for the transmission of concepts as well as a system of symbolically representing logical relations through linguistic structure. The use of comparative and superlative constructions is a prime example of this latter function of language. "More" and "most," are representative of the linguistic counterparts of the rudimentary ideas of quantity. When these language elements are present in the child and he can make appropriate use of them in behavioral representations, we interpret the use of "more" and "most" as an indication that the child has at least rudimentary quantitative knowledge.

Another factor in the development of logical operations is the ability to handle more than one dimension at a time. In many types of concrete and formal operations tasks it is necessary to differentiate dimensions in terms of relevancy to the immediate problem, and it may be necessary to coordinate two dimensions, or it may be necessary to determine the relationship between shifts in one dimension with shifts in another. Explanations involving compensation on one dimension for changes in another, as in conservation of substance and conservation of continuous quantity, are examples of situations that require the ability to coordinate simultaneously more than one dimension.

In discussing the role of language in concrete operations Piaget (1969) described differences in the language used by the conserving child and the non-conserving child. The non-conserving child tends to use only gross terms such as "this is big, that is little," whereas the conserving child uses comparative terms, as "this is bigger than that," "that is more," etc. Moreover, the non-conserving child uses only one dimension at a time, whereas the conserving child uses two, such as "this is longer and thinner."

Studies by Inhelder et al (1966) verified differences between conserving and non-conserving children in the spontaneous use of relational terms such as short/long, as well as differences in the ability to handle pairs of dimensional terms. Peisach (1973) demonstrated that for a child to conserve he must be able to comprehend relational terms.

A synthesis of prerequisite skills for conservation as delineated by Piaget, others of the Genevan school, and Americans thus indicate that a child has to have an understanding of relational concepts, he has to be able to differentiate dimensions, and he has to be able to coordinate two dimensions.

Wales and Campbell (1970) in a study unrelated to conservation looked at the linguistic aspects of the development of comparison. As in the conservation studies, Wales and Campbell found a definite progression in the development of comparison from undifferentiation to complete differentiation. It was clear that initially children could handle those items where only one dimension varied. Items which involved ignoring an irrelevant dimension were more difficult. The most difficult items were those in which two dimensions had to be attended to.

The developmental literature seems to provide a basis for the view that there is a sequential development of skills, first in handling the comparative terms themselves, and then along dimensions, and finally conservation.

The purpose of the present study was to determine if a developmental sequence can be established for the appearance of these skills. It was hypothesized that the sequence would be as follows: a) the ability to understand comparative relationships with understanding of superlative or "set" endings developmentally preceding that of comparative or "er" endings; b) the ability to handle comparative relations in situations where two dimensions vary but only one is relevant. The relevant dimension in this case was specifically designated by the experimenter. c) The ability of the child himself to define which of two dimensions is the relevant dimension in a particular instance; d) the ability of the child to coordinate the variations in two dimensions. For example, given a set of objects that vary on two dimensions, such as length and width, the child can determine which one is both longer and wider than the others, or both shorter and narrower than the others. e) The ability of the child to conserve.[1]

METHOD

Subjects

Fifty kindergarten children, twenty-five girls and twenty-five boys, were randomly selected from four kindergarten classrooms in a white, middle-class, suburban elementary school for participation in this study. The ages of the subjects ranged from 65 months to

78 months with a mean age of 70.7 months, s.d. of 4.11 months.

Procedure

A series of tas'.s was administered to the subjects in two randomly ordered sessions of approximately 20 minutes each. In one session the Goldschmid-Bentler Concept Assessment Kit--Conservation, Forms A and C, was administered to the subjects. In the other session a series of four dimensional tasks was administered. The tasks were as follows: a relevant dimension task, a unidimensional task where only the relevant dimension varied, a unidimensional task where two dimensions varied but only one was relevant, and a bidimensional task where two dimensions varied and both were relevant.

In the relevant dimension task, the subjects were told a little story abour three brothers on a walk. At six points in the story the subject was shown a drawing depicting two or three items ans was asked the select the item appropriate to the situation. In the other three tasks, the subject was shown a set of objects and asked to choose the one that was "widest," "shortest," "fattest," etc. The number of dimensions that varied were different in each task.

RESULTS

A scalogram analysis was used to determine if a developmental sequence could be established. Two analyses were made: a) a hypothesized sequence was imposed on the data as an expected order for the developmental sequence and that statistical consequences were examined; and b) the computer was allowed to generate its own scale based on the data. The results are given in Tables 1, 2 and 3. The computer-generated sequence reversed the order that had been hypothesized for the first two tasks. The computer-generated sequence had a coefficient of reproducibility of .90 and a coefficient of scalability of .53, both of which are above the minimum levels necessary for verification of a hierarchical sequence.

While there were no significant differences in the means and standard deviations for any of the tasks between the boys and girls, the scalogram analysis did indicate that the developmental sequence was well established for girls but not for boys. The coefficients for the boys did not reach the minimums set and indicated a quasi-scale for the boys rather than a true sequence. The difference seemed to be due to the bidimensional task and the relevant-dimension task. The bidimensional task was clearly more difficult for the girls. The boys, however, showed a great deal more variability on the two tasks.

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TABLE 1

Number of subjects passing each task

	Combined N = 50	Boys N = 25	Girls N = 25
Conservation	7	3	4
Bidimensional Task	15	7	8
Relevant Dimension Task	24	11	13
Unidimensional Task II	48	24	24
Unidimensional Task I	43	22	21

TABLE 2

Two forms of scalogram analysis as employed in this study

	Hypothesized Sequence	Computer-Generated Sequence
	Conservation	Conservation
	Bidimensional Task	Bidimensional Task
	Relevant Dimension	Relevant Dimension
	Unidimensional II	Unidimensional I
	Unidimensional I	Unidimensional II
Coefficient of Reproducibility	.86	.90
Coefficient of Scalability	.38	.53

TABLE 3

Scalogram coefficients for boys, girls, and combined group for computer-generated sequence

	Boys	Girls	Combined
Coefficient of Reproducibility	.87	.92	.90
Coefficient of Scalability	.36	.66	.53