THE DEVELOPMENT OF NUMBER CONCEPTS: AN EXAMINATION OF PIAGET'S THEORY WITH YORUBA-SPEAKING NIGERIAN CHILDREN

by

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A study based on Piaget's theory was carried out with Nigerian children to examine the validity of certain aspects of the theory and the relevance to Nigerian education.

Piaget's theory of cognitive development, and particularly, the number concept, was discussed. It was noted that Piaget's main aim is to discover characteristics of mental structures in different stages of development. Also, for Piaget, number concept is another aspect of logical thinking, thus, the developmental stages are the same for logical thinking and number concepts. The logical abilities of seriation and classification are said to be essential for a true understanding of number.

The present study employed a standardized interview schedule based on Piaget's tasks to investigate four questions. The first question related to Piaget's contention that conservation, seriation and classification develop concurrently. The second examined the relationship of the development of number concepts to intelligence, as measured by the Goodenough-Harris Drawing Test. Another question was raised to examine the performances of children from modern and traditional homes. Also, a question was included to examine the effect of sex differences on the development of number concepts.

The subjects were pupils of seven primary schools, which were classified into three categories on the basis of whether their student population came from the more modern or the more traditional sectors of the Ibadan community. Information collected by means of personal data sheets was used for initial screening. Finally, 110 of those children, who spoke Yoruba as their mother tongue, were selected from modern and traditional homes, defined on the basis of the educational level of the mother.

An interview schedule, consisting of nine conservation, seriation and classification tasks, was used to investigate the questions. Interviews were conducted in the schools. Data were analyzed on the basis of patterns of performance.

The results of the study upheld Piaget's theory generally. The contention that seriation, conservation and classification develop simultaneously, was only partially supported. There was slight relationship between intelligence and the performance on number tasks. The children from modern homes performed better than their traditional counterparts. Slight sex differences were noted.

These results were discussed in relation to the roles of experience and maturation. The children's explanations were also examined. Implications of the findings for education and research were discussed.

Acknowledgements

In our lives, the end point of one event marks the beginning of another, and also, a continuing aspect of a more extensive process. It is convenient to regard the work reported here as the end of a project, and the official terminal phase of a student's career. But, it is a part of a continuing process of academic development, which had been initiated and is nurtured by my family, friends, teachers and institutions. Anything said here can merely hint at my gratitude to them and they will forgive me if space permits me to mention only a few.

My thanks go to Professor Millie Almy, who has with great interest, understanding and insight, inspired and steered this study to its final conclusion. I am grateful to Professors Arthur T. Jersild and Anne McKillop-Robertson for their help and suggestions since the inception of this project. But above all, my greatest debt to these three is for the confidence which they have given me that with a "little learning" and humility, a novice can begin to sail the uncharted sea of developmental psychology in Nigeria. I also wish to express my deep appreciation to Professor Rosedith Sitgreaves for her advice regarding the analysis and interpretation of the data; and to Mrs. Felice Gordis for her help in categorizing the data.

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I--PROBLEM AND BACKGROUND

There have been few psychological studies in Africa and much of the research has been concerned with the question of how and why Africans are different from other peoples. As Doob[1] has pointed out, the main approach has been a sequential one, "under condition A, Africans do B; Europeans under the same condition, do or do not do B." Greenfield[2] too has commented on how Piaget's research that has been extended to nonwestern cultures tends to focus on the "time 'lag' in the development of 'foreign' children in contrast to children in Geneva or Pittsburgh or London." Two of the difficulties that researchers in Africa have to encounter are the inability to find comparable samples of Africans on which to base the cross-cultural generalizations and the confounding societal and environmental differences among groups.

Some researchers, starting with the premise that the African peoples are in a stage of transition, have tried to follow and delineate the differences between groups at different stages of transition. This has partly been brought about by the very urgent questions and problems that educationists and planners for the African countries are facing. Increasingly, African countries are

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[1] Leonard W. Doob, Psychology. In Robert A. Lystad, (Ed.), The African world: a survey of social research. New York: Frederick A. Praeger, Publishers, 1965. Pp. 374-375.

[2] Patricia M. Greenfield, On culture and conservation. In Jerome S. Brüner et al. Studies in cognitive growth. New York: John Wiley & Sons, Inc., 1966. p. 226.

participating in international affairs. This involvement confronts them with two issues. The first relates to the need for understanding and appreciating western and other civilizations which they encounter in their dealing with the outside world. The second concern relates to how the pattern of development, set in motion by the confrontation of European and African cultures in the colonial era, can be adequately channeled. The desirable goal is an integration of the two cultures without undue loss to the African's heritage.

A quotation from a policy paper of the Western Region of Nigeria underscores the African's wish to understand advances that have been made in the scientific field.

> ...knowledge of the material universe and of the application of this knowledge is the clear difference between our indigenous cultures and European civilization. If true progress is to be made, we must start with elementary knowledge of things above us, around us and below us and follow with a study of matter. We may then endeavour to apply those properties known so that life for us may be pleasanter. The science of food will then have a meaning and a dish of peas for twins will not be given as a superstitious prescription but a dietetic necessity. Aeroplanes and cars will become ingenious applications of the motor and not the mental excretions of super-men. No superstition will attach to photographic images, and people will buy and make photographic cameras and films knowing fully well that they are applying the principle that silver salts are affected by light.[1]

Thus, it is necessary that the African children study "foreign" concepts. The question of how intrinsically different the African is

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[1] Extract from the Ministry of Education, Western Region, Nigeria, Proposals for an education policy for the Western Region, Nigeria. In L. G. Cowan, J. O'Connell & D. G. Scanlon (Eds.), Education and nation building in Africa. New York: Frederick A. Praeger, Publishers. 1965. p. 156.

from other peoples is investigated alongside the important issue of how best he can be made to learn the necessary concepts with a minimum of wastage and strain.

Studies have provided some evidence that schooling and the nature of the environment within a given culture are significant factors influencing African children's thinking. Greenfield[1] found that the thinking of Senegalese school children was more similar to that of American children than to the thinking of their unschooled counterparts from the same country. However, Price-Williams[2] reported a contrary finding in his study of Tiv children's classification abilities. Commenting on this finding, Kellaghan[3] argues that the nature of the school is important and therefore, the experiences of the Tiv children in a "bush school" may not be much different from those of their unschooled counterparts. Studying children in Ghana, Jahoda[4] found that urban and rural environments influenced the development of abstract thinking. More recently, Abiola[5] reported that the nature of the home

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1 Patricia M. Greenfield, On culture and conservation. In Jerome S. Bruner et al. Studies in cognitive growth. New York: John Wiley & Sons, Inc., 1966. Pp. 225-256.

2 D. R. Price-Williams, Abstract and concrete modes of classification in a primitive society. Brit. J. educ. Psychol., 1962, 32, Pp. 50-61.

3 T. Kellaghan, Psychological research in West Africa. Paper read to the British Psychological Society at the Royal Irish Academy, Bublin, May, 1962.

4 Gustav Jahoda, Assessment of abstract behavior in a non-Western culture. J. abnorm. soc. Psychol., 1956, 53, Pp. 237-243.

5 E. T. Abiola, The nature of intellectual development in Nigerian children. Teacher Education, 1965, 6, Pp. 37-57.

from which preschool Nigerian children come is related to the development of conceptual processes.

These findings seem to point to the fact that a change in young children's thinking results when stimulation, different from those provided in the traditional culture, are introduced in an urban, school or home environment. In the traditional culture, answers are already provided to explain strange phenomena that children usually encounter. Folk tales, the verdict of elders and other acceptable traditional beliefs provided commonsense and sometimes mythical explanations. Now, with increased modernization, other types of explanations and abilities are required. The present study was an attempt to investigate the effect of different environments on the development of certain abilities in a section of Nigerian elementary school children.

Recent psychological studies in Africa, particularly those in cognitive development, reflect the increased attention given to the theories of Piaget. Before outlining the main theoretical formulations of Piaget, certain aspects of his work that have much relevance to the study of the African child are discussed.

For Piaget, the more mature forms of thinking are those that encompass acquired knowledge, especially in the scientific fields. He has studied categories of established science, such as those of space, time, causality, number and logical classes as they develop in the child. Since the children in Africa are increasingly being expected to learn these concepts, albeit at different levels, it is pedagogically useful to evaluate their thinking along the lines suggested by Piaget. In spite of variations in research techniques and materials, Piaget's theories seem to be upheld in non-western countries where they have been used. (Jahoda;[1] Hyde;[2] Price-Williams.[3]) That these techniques are validly and easily adaptable is advantageous for educational and psychological researchers, particularly since other existing western instruments, such as intelligence tests, are not culture free, and are, therefore, unsuitable for use with the younger African school children.

Cognitive Development

In Piaget's theory, cognitive development is described in terms of changes in intellectual "structures." These structures refer to systems of intellectual organizations created through the individual's attempt to give meaning to his world. An intellectual act reflects the individual's level of mental organization, at any given moment. It is Piaget's primary aim to uncover characteristics of the organizing process as they emerge in different stages of development.

There are three main invariant stages in the development of intellectual structures. These are outlined in several publications of Piaget, including The origins of intelligence in children[4] and other

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[1] Gustav Jahoda, Child animism: II A study in West Africa. J. soc. Psychol., 1956, 47, Pp. 213-222.

[2] D. M. Hyde, An investigation of Piaget's theories of the development of the concept of number. Unpublished Ph.D. thesis, University of London, 1959.

[3] D. R. Price-Williams, A study concerning concepts of conservation of quantities among primitive children. Acta Psychologica, 1961, 18, Pp. 297-305.

[4] Jean Piaget, The origins of intelligence in children. New York: International Universities Press, Inc., 1952.

publications by the Geneva psychologists.[1,2,3] The earliest stage of sensori-motor operations involves mechanisms which are reflexive in origin but their activities lead to the realization that objects can be permanent. Then there is another stage of "concrete operations." This is a period of elaboration and structuration, in which age seven is an important milestone. At about age seven, the intellectual structure of the child enables him to understand certain basic concepts such as number and space. But such understanding is not yet separated from its concrete content. The final stage, which comes during adolescent years, is characterized by the ability to engage in thoughts that are no longer bound to the situation and objects but which make possible the generation of hypotheses and the deduction of consequences contingent on them.

The period of concrete operations has been widely studied partly because the new orientation in thinking coincides with the novel learnings and experiences in school. This new method of thinking about problems, Piaget maintains, is readily observable in the handling of problems involving number and class.

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1 Jean Piaget, The psychology of intelligence. Patterson, New Jersey: Littlefield, Adams & Co., 1960.

2 Bärbel Inhelder & Jean Piaget, The growth of logical thinking from childhood to adolescence. New York: Basic Books, 1958.

3 Bärbel Inhelder, Some aspects of Piaget's genetic approach to cognition. In William Kessen & Clementina Kuhlman (Eds.), Thought in the young child. Monogr. Soc. Res. Child Develpm., 1962, 27, No. 2. (Whole No. 83) Pp. 19-40.

The Number Concept

For Piaget, a thorough grasp of the notion of number develops alongside an understanding of other logical abilities. Number is regarded as a union of ordering and class. To count the number of elements in a set, in order to arrive at its cardinal value, it is necessary to disregard the properties that make them dissimilar and regard each object as a unit. Thus, when a child is required to count the fruits on a table, he has to disregard the perceptual, distinguishing characteristics pertaining to the orange, the banana and pear and think of each as a unit of one fruit. In counting them, he is classifying and grouping the set of fruits to which he assigns a cardinal number. So, number has a class component. But, the objects so enumerated have an order. To arrive at the correct cardinal value of the fruits, the child must realize that having counted the first orange, he cannot regard it as equivalent to the other oranges which have not yet been counted. That orange is different by the treatment, i.e. counting, that he has given it. Thus the objects are arranged in a series and given an order as he counts one first, then another and another. This is an ordination process.

A similar situation arises when the child is dealing mentally with numbers. He has to be able to place "four" in relation to other numbers. It is greater than "three" but less than "five" and also, it is included in "five." For Piaget then, number has a peculiar status, "it is at the same time a class and an asymmetrical relation, the units of which it is composed being simultaneously added because they are equivalent, and seriated because they are different one from another."[1] A further elaboration states that "number cannot be reduced to class alone, but is a synthesis of class inclusion plus ordering."[2]

A study of such a broadbased concept of number involves Piaget in the study of other logical abilities. These abilities according to Piaget, develop concurrently. Without an understanding of one, the child is handicapped in his attempt to deal with the other. The following sections describe the nature of the abilities related to an understanding of number.

Conservation

Piaget states that prior to age seven, the child's ideas of quantity and number are influenced by the appearance and physical properties of objects. Understanding tends to be largely dependent on perceptual factors. From about age seven onwards, there is evidence that a new way of thinking has emerged. The child, at this stage, is no longer so dependent on appearances for his judgment. He attends to the relations between physical properties of objects and between the objects themselves.

This change in the thinking of the child can be seen in the development of physical concepts, and is reflected in the attainment

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[1]Jean Piaget, The child's conception of number. London, Routledge & Kegan Paul Ltd. 1952. p. 184.

[2]Jean Piaget, Mother structures and the notion of number. In Richard E. Ripple & Verne N. Rockcastle (Eds.) Piaget rediscovered: a report of the conference on cognitive studies and curriculum development. Ithaca: School of Educ., Cornell Univer., March, 1964. p. 39.

of "conservation," which Piaget considers a "necessary condition for any mathematical understanding."[1] Conservation refers to the ability to understand that certain properties of objects, e.g. number, area, and quantity remain invariant in the face of external transformations. For instance, a child who realizes that a given number of beads remains the same whether put into a tall, narrow glass or a shallow dish, is said to have conserved on that task. The younger child, who relies on perceptual cues, tends to assert that the beads in the tall glass are more because the contents stand higher than in the shallow dish. He has not grasped the idea that a rearrangement of the two numerically equivalent sets does not alter the original number.

According to Piaget, two distinct strategies are manifested by the conserving and nonconserving child. The nonconserving child's approach entails a "centring" on one dimension of the task at a time. Thus, in the example cited, the child focuses on the increased height of the glass and forgets the dimension of width. Some others assert that the number of beads in the shallow dish is more, because they concentrate only on the width of the dish. Shortly before attainment of conservation, the children in the transitional stage, show inconsistent evidence of attention given to both properties. "This transition from a single centring to two successive centrings heralds the beginnings of the operation: once he reasons with respect to both relations at the same time, the child will in fact deduce

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[1]Jean Piaget, The child's conception of number. London: Routledge & Kegan Paul Ltd. 1952. p. 3.

conservation."[1] Alternatively, the child in the transitional stage may want to rearrange the objects, and reverse the situation to one in which he could more readily accept equivalence, since he still needs a perceptual confirmation of his judgment.

A conserving child adopts a strategy that coordinates two dimensions of the object. He clearly sees that increase in height compensates for decrease in width, and thus, he reasons with both properties simultaneously. "Thought is no longer tied to particular states of the object, but is obliged to follow successive changes with all their possible detours and reversals; and it no longer issues from a particular viewpoint of the subject, but co-ordinates all the different viewpoints in a system of objective reciprocities."[2]

Cardination

Cardination involves the ability to give true equivalence to sets. Piaget studies the development of cardinal values in problems requiring the ability to relate sets of objects particularly in a one-to-one correspondence. The interest is in the ability of the child to eliminate interfering perceptual qualities of the elements in making the comparisons. Stripped of the physical features of the

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[1] Jean Piaget, The psychology of intelligence. Patterson, New Jersey: Littlefield, Adams & Co., 1950. p. 131.

[2] Jean Piaget, Mother structures and the notion of number. In Richard E. Ripple & Verne N. Rockcastle (Eds.), Piaget rediscovered: a report of the conference on cognitive studies and curriculum development. Ithaca: School of Educ., Cornell Univer., March, 1964. p. 38.

[3] In this study, no section of the interview schedule was devoted to only cardination problems, but tests of conservation and ordination involved an understanding of equivalence of sets.

individual elements, each is regarded as a unit and compared with another unit in the second set. For instance, a child is requested to construct a set of beds equivalent in number to a given set of dolls. He must realize that the beds represent separate but equivalent units and match these with the units in the set of dolls. Piaget refers to this as a "non-qualitative type of correspondence where any element can correspond to any other element independent of their qualities."[1] This is different from "qualified correspondence" where an "element is made to correspond with another element which has similar qualities."[2]

Again, there are three levels of difficulty depending on the arrangement of objects and the degree to which the children are "provoked" to see the correspondence between elements. The younger children, influenced by such physical properties as size and configuration, make global comparisons which are numerically inaccurate. The older children, who understand the relationship, base their responses on the numerical quality of the sets, and maintain equivalence through any rearrangements of the objects. There are also children who are inconsistent in their acceptance of equivalence.

Seriation and Ordination

Seriation refers to the ability to build objects into a transitive, asymmetrical sequence. For instance, a child is given a

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[1] Jean Piaget, Mother structures and the notion of number. In Richard E. Ripple & Verne N. Rockcastle (Eds.) Piaget rediscovered: a report of the conference on cognitive studies and curriculum development. Ithaca: School of Educ., Cornell Univer., March, 1964. p.38.

[2] Jean Piaget, Mother structures and the notion of number. p.38.

set of eight blocks varying in size from the smallest, A, to the largest, H. He is required to seriate these. The problem involves discovering the relationship $A < B < C < \ldots < H$. The younger child, unable to seriate, groups the small and the large items indiscriminately. A child using the intuitive strategy, has difficulty in conceiving, Piaget believes, both a direct (>) and an inverse (<) relation between objects. For instance, the relationship that block B is both larger than A and smaller than C is not understood. His reaction pattern consists of making comparisons of two objects at a time. Piaget describes the process in an experiment where the children were required to construct a series of sticks from one to ten. He writes, "the child at the second stage does not immediately master the whole set of relations necessary for seriation but discovers them gradually by dint of empirical trial and error. Thus, he ... begins with 9, 10, 8, then measure 10 and 8 against one another, then 9 and 8."[1]

Ordination refers to the process of recognizing the positions of objects in a series such as that described in the previous paragraph. Piaget discusses an experiment of dolls and sticks in which the child constructed a series according to the order of magnitude with the largest doll being assigned the longest walking stick. He then required the child to match a particular stick to a doll after he disrupted the perceived correspondence.

From their responses, the children could be classified into three categories. Some were deceived by the new configuration, others had

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[1] Jean Piaget, The child's conception of number. London: Routledge & Kegan Paul Ltd., 1952. p. 104.

to rearrange the objects to convince themselves of the correctness of their intuitive responses; yet others relied on numerical positioning. These realized that the fourth man ought to have the fourth walking stick.

Classification

Piaget discusses the relation between class and number in several sections of The childs conception of number.[1] He believes that notions of class and number develop concurrently. There are two aspects of classification that have direct relevance to an understanding of number, namely, grouping and class inclusion.

Although Piaget discusses many experiments on classes, only the ones on class inclusion are described here. Directly related to number is the notion of "additive composition of classes." This refers to a part-whole relationship of sets. To understand number, the child is expected to know that if $A + A' = B$, the reciprocal relationships, $B > A$ and $B > A'$, must follow logically. A typical experiment presented the child with brown and white, wooden beads. The brown beads were obviously more in number than the white ones. In a series of questions, the investigator tried to find out whether the child understood that a string of wooden beads would be longer than a string of brown beads.

The responses fall into three stages again. The main problem of the younger child is that, while he centers his attention on the class of brown beads, he loses sight of the total class of wooden beads, and so, tends to compare only the class of brown beads with

[1] Jean Piaget, The child's conception of number. London: Routledge & Kegan Paul Ltd., 1952.

the complementary class of white beads. "The difficulty is that by centring on A, he destroys the whole, B, so that part A can no longer be compared with the other part A'. So there is again non-conservation of the whole for lack of mobility in the successive centralisations of thought."[1] The older children who understand, have no difficulty in maintaining the different aspects of the relationships in their minds.

Summary

In Piaget's theory, then, the development of conservation and of the related abilities discussed, is essential to the attainment of rational thought. There are generally three stages in the development of these abilities. There is the stage when the child is still intuitive but groping for a method, and there is the operational stage, when the child fully grasps the relationships that exist between aspects of the problem posed. From about age seven, the children begin to consider these relationships in a systematic manner and discard the dependence on situational, perceptual features. Such changes manifest the structures of concrete operations. The general trend is from one of uncoordinated perceptions to a more complex, flexible but coherent system.

Related Studies

Piaget's studies concerning the development of number concepts will be briefly reviewed. A selected number of other studies is also

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[1] Jean Piaget, The psychology of intelligence. Patterson, New Jersey: Littlefield Adams & Co., 1960. p.133.

discussed. Most of these studies are concerned with validating Piaget's findings on the sequence of stages. Some investigators have tried to find the relationship of Piaget's tasks with other measures of intellectual ability. Other researchers have focused their attention on factors that influence the development of the concepts that Piaget proposes. For example, they have considered the roles of environment and experience.

Piaget's Studies

Piaget's studies of the development of number and related abilities are comprehensively described in The child's conception of number[1] although several accounts are to be found elsewhere.[2] Many protocols and theoretical discussions are provided on conservation, the formation of ordered series, and logical and arithmetical aspects of class. The researches are descriptive and there are hardly any quantitative analyses of the data. But, in all the discussions, the children's responses are related to Piaget's stage model of intellectual development. Many children are interviewed, but the exact wording of questions varies from one child to another, even though the investigator adheres to a definite set of concrete tasks.

The children in Piaget's sample provide sufficent evidence to conclude that his "results do, in fact, show that number is orga-

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[1] Jean Piaget, The child's conception of number. London: Routledge & Kegan Paul, 1952.

[2] Jean Piaget & Bärbel Inhelder, Le développement des quantités chez l'enfant. Neuchâtel: Delachaux et Niestlé, 1941

nized, stage after stage, in close connection with the gradual elaboration of systems of inclusions (hierachy of logical classes) and systems of asymmetrical relations (quantitative seriations), the sequence of numbers thus resulting from an operational synthesis of classification and seriation."[1] From his reports, there are age levels during which the different stages emerge, but he allows for variations of ages at which these concepts are attained. However, the selection of protocols from a narrow age range gives the impression that the ages at which the stages appear are as fixed as stage sequences.

Other Studies

Many studies have been carried out to validate Piaget's stage sequence theory. Standardized interview schedules have been used in a large number of these studies. They are considered to be an improvement on Piaget's 'clinical' method of interviewing, in which the responses of subjects determine the nature of subsequent questioning. Only a selected number of studies are reviewed since a comprehensive review of studies based on Piaget's researches can be found in Flavell's accounts.[2]

Validation Studies

In an investigation of Canadian children's thinking,

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1 Jean Piaget, The child's conception of number. p. viii.

2 John H. Flavell, The developmental psychology of Jean Piaget. Princeton: D. Van Nostrand, 1963.

Dodwell[1] used several of Piaget's number tasks. His subjects were five to eight year old children. The results, particularly in the conservation tasks, confirmed Piaget's three stages. However, the stages in the seriation and ordination tasks did not always correspond with that attained on the conservation task. This finding led to a further exploration of the interrelationship of Piaget's number tasks.[2] The tasks lent themselves to an ordering in the nature of a "quasi-scale." Dodwell concludes that "whilst Piaget is on the whole correct in his description of the child's understanding of number, the pattern of development is neither as neat, nor as rigid, as he would have us believe."[3] Pursuing the consistency of abilities still further, Dodwell[4] conducted another study. He found that there was a low correlation between the number and classification tasks and he offers an explanation that, whereas children receive instruction in the area of number, they receive little specific instruction on the hierachy of classes.

Elkind[5] studied 80 American children in the four to seven years

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[1] P. C. Dodwell, Children's understanding of number and related concepts. Canad. J. Psychol., 1960, 14, Pp. 191-205.

[2] P. C. Dodwell, Children's understanding of number concepts: characteristics of an individual and of a group test. Canad. J. Psychol., 1961, 15, Pp. 29-36.

[3] P. C. Dodwell, Canad J. Psychol., 1961, 15, p. 35.

[4] P. C. Dodwell, Relations between the understanding of the logic of classes and of cardinal number in children. Canad. J. Psychol., 1962, 16, Pp. 152-160.

[5] D. Elkind, The development of quantitative thinking: a systematic replication of Piaget's studies. J. genet. Psychol., 1961, 98, Pp. 37-46.

age range. He found that age is important in understanding quantity, and that gross one-to-one correspondence was easier than dealing with conservation of continuous (liquid) quantity. He, thus, concludes that the nature of the task is important in determining the particular stage in which the child falls; and that his overall results agree with Piaget's stages.

A non-verbal study of Piaget's number experiments was carried out by Wohlwill.[1] His subjects were four to seven year old children in kindergartens and primary schools in Geneva. The responses of these subjects could be classified into three main categories: a preconceptual, an intermediary, and a final stage which represented number concept in the abstract. These stages correspond with Piaget's categories.

Estes[2] carried out one of the first validation studies with a group of 52 American children in the four to six years age range. She states that no stages were found in the development of number concept, and that, if children could count, they also possessed the types of abilities measured by a selection of Piaget's number tasks. Dodwell[3] has commented on the results of this study, and suggests a possible misinterpretation of the aim of Piaget's research.

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[1] J. F. Wohlwill, A study of the development of the number concept by scalogram analysis. J. genet. Psychol., 1960, 97, Pp. 345-377.

[2] Betsy W. Estes, Some mathematical and logical concepts in children. J. genet. Psychol., 1956, 88, Pp. 219-222.

[3] P. C. Dodwell, Children's understanding of number and related concepts. Canad. J. Psychol., 1960, 14, p. 203.

From Britain, there are reports of confirming studies, some of which have been conducted with mentally handicapped persons. Mannix[1] studied the number ability of educationally subnormal children. In spite of individual differences, he found that Piaget was generally correct in his description of the types of responses children give. Woodward[2] used tasks based on Piaget's researches to study 94 mentally subnormal preadolescents and adults. She reports that responses on three of the four tasks used could be classified according to Piaget's stages. The responses of the subjects were similar to those reported for children aged four to seven years. Hood[3] studied a mixed group of normal (aged four to eight years), educationally subnormal (aged 10 to 15 years) and mentally retarded (aged 41 years) subjects. Piaget's notions were, in the main, confirmed when actual age was considered for the normal group. Increased mental capacity of the handicapped group corresponded with better performance on the number tasks.

Lovell and Ogilvie[4] studied children seven to eleven years old. Their findings generally support Piaget's stages, and they note that conservation on one task does not necessarily involve the same degree

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[1] J. B. Mannix, The number concepts of a group of E. S. N. children. Brit. J. educ. Psychol., 1960, 30, Pp. 180-181.

[2] Mary Woodward, Concepts of number of the mentally subnormal studied by Piaget's method. J. child Psychol. Psychiat., 1961, 2, Pp. 249-259.

[3] Blair Hood, An experimental study of Piaget's theory of the development of number in children. Brit. J. Psychol., 1962, 53, Pp. 273-286.

[4] K. Lovell & E. Ogilvie, A study of conservation of substance in the junior school child. Brit. J. educ. Psychol., 1960, 30, Pp. 109-118.

of understanding of other related problems. Such understanding, they comment, may be highly specific at first, and transfer to other situations increases in depth and complexity with increased experiences and maturation.

Relationship with Other Measures

Some investigators have tried to relate Piaget's tasks to other measures of mental ability. Mannix[1] scaled and related the responses of the educationally subnormal subjects on the Piaget tasks to mental and chronological age. He found a substantial correlation in each case.

Dodwell[2,3] found, among other things, that the performance on the Piaget number tasks correlated with IQ and arithmetic achievement tests. He also found that there was a positive correlation between IQ and the ability to classify, especially with an increase in age.

Almy and her associates,[4] in a cross-sectional and a longitudinal study, report that ability to conserve correlates with other measures. There was a somewhat consistent correspondence between ability to conserve and the logical abilities measured by the Arthur Stencil Design Test. Also, the Ammons Full Range Picture Vocabulary Test, a measure

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[1] J. B. Mannix, The number concepts of a group of E. S. N. children. Brit. J. educ. Psychol., 1960, 30, Pp. 180-181.

[2] P. C. Dodwell, Children's understanding of number and related concepts. Canad. J. Psychol., 1960, 14, Pp. 191-205.

[3] P. C. Dodwell, Relations between the understanding of the logic of classes and of cardinal number in children. Canad. J. Psychol., 1962, 16, Pp. 152-160.

[4] Millie Almy, E. Chittenden & P. Miller, Young children's thinking: studies of some aspects of Piaget's theory. New York: Teachers College Press, Teachers College, Columbia University, 1966.

of language development, was positively correlated with ability to conserve, but it was found to be more predictive of conservation for the middle class then for the lower class children.

In a study of quantitative thinking, Elkind[1] found that there were correlations between Piaget's tasks and the WISC, which were "positive, generally low, and sometimes significant." The greatest correlations were with subtests involving picture arrangement, arithmetic and coding.

The Roles of Environment and Experience

The final group of studies to be reviewed deal with how certain aspects of the child's environment and experience affect the development of thinking outlined by Piaget.

Some cross-cultural studies have shown that in spite of the varying cultural experiences, children's thinking tend to develop along the lines discussed by Piaget. Hyde[2] studied a multi-racial group of children in Aden. The subjects were 48 European, 48 Arab, 24 Indian and 24 Somali children. The age range was from six to eight years. He presented several tasks with local materials such as shells and beads, and obtained results similar to Piaget's. It was found that tasks involving seriation and class inclusion were difficult for all, although European children performed better than the other groups.

The results of a study carried out in the Tiv region of Nigeria

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[1] D. Elkind, The development of quantitative thinking: a systematic replication of Piaget's studies. J. genet. Psychol., 1961, 98, p. 45.

[2] D. M. Hyde, An investigation of Piaget's theories of the development of the concept of number. Unpublished Ph. D. thesis, Univer. of London, 1959.

by Price-Williams[1] also confirmed the notions of Piaget. His subjects, Tiv children ages five and one half to eight years, were presented with tasks involving a continuous (water) and a discontinuous (nuts) quantity. He found that his subjects made the shift from intuitive to concrete operations, at about age seven years.

Greenfield[2] used a selection of Piaget's tests with three groups of Senegalese children. She found that school experience was very significant in attaining the ability to conserve. However, the Senegalese sample showed a time lag when their performance was compared with that of American children. She also found that there were qualitative differences in the approaches of schooled and unschooled children to the problems on conservation.

Goodnow and Bethon[3] found that unschooled Chinese boys could perform the conservation tasks just as well as American children, and that intelligence scores did not correspond with the performance of their Hong Kong subjects. However, these children were markedly inferior in the performance of tasks which involved more exacting analytic and relational procedures.

Noro[4] also studied the development of number concepts in 118

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1 D. R. Price-Williams, A study concerning concepts of conservation of quantities among primitive children. Acta Psychologica, 1961, 18, Pp. 297-305.

2 Patricia M. Greenfield, On culture and conservation. In Jerome S. Bruner et al. Studies in cognitive growth. New York: John Wiley & Sons, Inc., 1966, Pp. 225-256..

3 J. J. Goodnow & Gloria Bethon, Piaget's tasks: the effects of schooling and intelligence. Child Develpm., 1966, 37, Pp. 573-582.

4 Sho Noro, Development of the child's conception of number. Jap. J. educ. Psychol., 1961, Pp. 230-239. (Child Develpm. Abstr., 38, 115).

Japanese children, aged four to six years. The results obtained were similar to the stages outlined by Piaget.

More recently, Almy and her associates[1] examined the differences in conservation abilities between middle and lower class children. Both in the cross-sectional and the longitudinal studies, middle class children conserved at an earlier period than their lower class counterparts.

Some differences, which have been found in cross-cultural studies, can be attributed to differences in cultural experiences. The exact nature of these experiences have been of interest to researchers. They have tried to study, in controlled situations, the factors that are considered relevant to the development of, or acceleration to, an advanced stage in children's thinking. Some of these studies are reviewed to highlight the role of experience in the development of thinking along the lines described by Piaget.

After selecting her subjects with a pre-test of Piaget's tasks, Churchill[2,3] tried to give practice to a group of five year old children in play sessions, designed to improve their classificatory, seriating and ordering abilities. The post-test indicated that the children made a considerable gain. Harker[4] also carried out a training study to

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1 Millie Almy, E. Chittenden & P. Miller, Young children's thinking: some aspects of Piaget's theory. New York: Teachers College Press, Teachers College, Columbia Univer., 1966.

2 Eileen M. Churchill, The number concepts of the young child: part 1. Researches and Studies. (Leeds Univer. Instit. of Educ.), 1958, 17, Pp. 34-59.

3 Eileen M. Churchill, The number concepts of the young child: part 2. Researches and Studies. (Leeds Univer. Instit. of Educ.), 1958, 18, Pp. 28-46.

4 Wilda H. Harker, Children's number concepts: ordination and cardination. Unpublished M. A. thesis, Queens Univer., Kingston, Ontario, 1960.

raise the level of children's understanding of number. The training had positive effects on the attainment of the concepts studied, even though the overall gains were small. It was found that the ability to understand number was closely related to chronological age. However, Flavell[1] comments that the training designs of these two studies were too "global" to judge the nature of experience that influenced any particular numerical ability.

A group of studies carried out by Smedslund[2,3] was designed to accelerate the attainment of conservation using two procedures--external reinforcement, and a method involving addition and subtraction of the amount of plasticine used. He found that his subjects, aged five to seven years, did not respond in the expected direction. Thus, he concludes that external reinforcement was an insufficient condition for the attainment of conservation, but that conditions creating cognitive conflicts, such as presenting competing methods of organizing data, tend to be more effective.[4]

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[1] John H. Flavell, The developmental Psychology of Jean Piaget. Princeton, N. J., D. Van Nostrand, 1963. p. 371.

[2] J. Smedslund, The acquisition of conservation of substance and weight in children. III. Extinction of conservation of weight acquired "normally" and by means of empirical controls on a balance. Scand. J. Psychol., 1961, 2, Pp. 85-87.

[3] J. Smedslund, The acquisition of transitivity of weight in five-to-seven year old children. J. genet. Psychol., 1963, 102, Pp. 245-255.

[4] J. Smedslund, The acquisition of conservation of substance and weight in children. VI. Practice on continuous vs. discontinuous material situations without external reinforcement. Scand. J. Psychol., 1961, 2, Pp. 203-210.

Wohlwill and Lowe[1] used four experimental conditions to induce conservation. They found results that were unexpected in that the control group and the one trained on an addition and subtraction method showed greater gains than those whose training procedures were based on reinforcement and counting. Wallach and Sprott[2] trained children between the ages of six and seven years. It was found that the experimental group reacted to and explained conservation problems much better than the control group.

Summary

Despite much variation in methodology, and in the cultural settings of the studies discussed, there is considerable consistency of findings supporting certain features of Piaget's theories. The sequences, more than the timing of the stages described by Piaget, have received almost unanimous confirmation. Correlations of various Piaget's tasks with other existing measures of mental abilities are reported to be positive but often low. Explanations offered, as Almy and associates[3] comment, refer to the fact that Piaget's theory is based on a different concept of intelligence from those underlying the usual tests of mental abilities.

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1 J. F. Wohlwill & R. C. Lowe, Experimental analysis of the conservation of number. Child Develpm., 1962, 33, Pp. 153-169.

2 Lise Wallach & R. L. Sprott, Inducing number conservation in children. Child Develpm., 1964, 35, Pp. 1057-1071.

3 Millie Almy, E. Chittenden & P. Miller, Young children's thinking: studies of some aspects of Piaget's theory. New York: Teachers College Press, Teachers College, Columbia Univer. , 1966. Pp. 38-39.

The role of experience has not yet been adequately assessed. Piaget[1] himself only indicates that experience is important in the development of thinking, but offers no further clarifications. Approaches that induce cognitive conflicts, and that offer direct specific training on the concepts seem to be fruitful, although more information is needed. Comparative and training studies may yet throw some light on the kind of stimulation that aids transition from one level of thought to another. Such information would be useful in planning the education of young children. The content of the curriculum, the timing of concepts taught to the children, and the method of presenting the information are some of the areas that could be affected.

The Present Study

Piaget has asserted that conservation of number and the logical abilities of seriation, ordination and classification develop simultaneously in the child. The development of number is regarded as an aspect of the development of logical thinking. The important factor, for Piaget, is the change in mental structures; so that, at about the age of seven years, a child approaches problems of conservation, serial ordering, and classification in a similar manner. His evidence had not been based on a single administration of tasks involving all of these concepts, but on comparisons of separate investigations regarding the development of each concept. The present study, among

[1] Jean Piaget, Development and learning. In Richard E. Ripple & Verne N. Rockcastle (Eds.), Piaget rediscovered: a report of the conference on cognitive studies and curriculum development. Ithaca, N. Y.: School of Educ., Cornell Univer., March, 1964. Pp. 7-20.

other things, investigated the validity of Piaget's contention regarding the concurrent development of these abilities.

Also, the study investigated the relationship of children's ability to understand number to other factors which might shed light on certain educational problems in Nigeria. Past research had shown that certain cognitive abilities develop slowly in non-western cultures. Since Nigerian children are at different stages of exposure to modernizing influences at home and in school, another aim of the study was to examine the development of conservation and other abilities in different groups of Nigerian children.

Children brought up under more modern conditions were compared with those reared in the more traditional homes. Although the study was conducted in an urban environment, there are pockets of very traditional areas in the sprawling, native city of Ibadan. The performances of girls and boys, who are brought up somewhat differently, were also compared.

This study, then, attempted to provide information not only on the validity of Piaget's methods for Nigerian school children, but also on the relationship of number concepts to other factors, such as intelligence, the nature of the subjects' experiences at home and in school, and sex. A brief description outlining the differences in the types of experiences provided in different homes and schools of these Nigerian children, is given in the following chapter.

Questions for Investigation

1. Do conservation of number and the logical operations of classification, seriation and ordination occur simultaneously in children?

2. Is mental ability, as measured by the Goodenough-Harris Drawing

Test correlated to understanding of number?

3. Is ability to understand number related to the type of home from which the children come, as measured by the educational level and occupational status of the mother?

4. Do differences exist between boys' and girls' performances on tasks involving number?

II--METHODS AND PROCEDURES

An interview schedule was constructed, based on Piaget's tasks, to investigate the questions stated in the previous chapter. Certain considerations influenced the choice of tasks and other materials used in the study. The interview was administered individually to children of about six to about eight years of age. The selection of tasks and other measures, their administration and the methods of categorizing the data are described in this chapter. However, before these are described, a short outline of the Nigerian school system is given for background information and for reference in a later discussion of the relevance of Piaget's theories to the Nigerian situation.

The Nigerian Educational System

The Nigerian school system was established by the British administrators and it is, thus, modelled on the British pattern. Each of the five regions of Nigeria has modified the system to suit its needs but, on the whole, the pattern remains the same. Whenever these modifications are described, examples will be taken largely from the system in the Western Region of Nigeria, where this study was conducted.

Primary Education

The main purposes of primary education in Nigeria today are to raise the literacy level in the country and to prepare pupils for entrance to secondary schools. The courses vary in length from six to eight years. In the Western Region, the children are admitted at about the age of six years and are offered a six year course, culminating in the award of a primary school leaving certificate. A single teacher is responsible for instruction in subjects such as arithmetic, English, rural science, music or singing, history, geography and art in her class. The syllabuses, which most primary schools use, are supplied by the Ministries of Education.

Secondary Education

There are different types of secondary schools. The secondary grammar schools, to which most primary school children aspire, provide five to seven year courses with a strong academic bias. These lead to the West African School Certificate and the Higher School Certificate. The secondary commercial and modern schools provide courses with vocational and practical subjects.

Teacher Training

There are a variety of teacher training courses leading to the Teachers Elementary Certificate (Grade 111), Teachers Higher Elementary Certificate (Grade 11), and the Grade 1 certificates with other equivalents. In the Western Region, students who have spent two years in secondary modern schools, are qualified to undertake a course lasting for two years in order to become Grade 111 teachers. If such teachers extend their courses for an additional two year period, they can obtain Grade 11 certificates. Teachers trained to the Grades 11 and 111 levels are qualified to teach mainly in the primary schools.

Suitably qualified teachers with adequate experience may return to universities or advanced teacher training institutions for special courses. They are awarded certificates which are equivalent to Grade

One certificates. There are also graduate teachers with college degrees, some of whom possess additional professional qualifications. The Grade One teachers, usually, are not expected to teach in primary schools, although some of them head these schools.

Higher Education

There are universities and other institutions of higher learning which offer courses in varied fields. Suitably qualified students from secondary grammar schools or with comparable backgrounds are admitted although many Nigerian students still attend colleges and universities overseas. The graduates enter government services or teach in secondary schools.

Ownership of Schools

Schools are owned by the different regional governments and "voluntary agencies" such as missionary groups, local organizations and individual proprietors. Governments make grants to the voluntary agency schools and, thus, have some measure of control on the content of the curriculum, especially, since they provide syllabuses and help to organize the external examinations. A big difference between government and voluntary agency schools is in the amount of fees charged. For instance, since the private elementary schools have good teachers, modern equipment and other facilities, high fees are levied. Such fees limit enrolment to those children whose parents are reasonably educated and earn high incomes.

As will be seen later, many of the children who come from "modern" homes attend these private schools, and those from the "traditional" group attend the free schools. The seven schools selected, had many observable differences in the facilities, physical space, educational level of the teachers and teaching equipment.

Construction of the Interview Schedule

Piaget's clinical method of interviewing, described in The child's conception of the world, [1] has not been adopted by other investigators. For Piaget, the clinical method of interviewing is one in which the investigators' subsequent questions depend on the responses of the child. The investigator is free to follow any interesting leads and to vary the form of questioning if it is felt that the child does not understand. In short, the child determines the nature of the questions he is being asked since the interest is in the child's approach to the problems that are posed. This type of interview depends, to a large extent, on the skill of the interrogator and comparisons of children's responses, particularly in a small study as this one, are difficult.

Other investigators who have undertaken studies based on Piaget's researches have adopted three types of interview methods successfully. Some have used nonverbal methods, [2,3] some have

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[1] Jean Piaget, The child's conception of the world. New York: Harcourt, Brace, 1929. Pp. 1-32.

[2] J. F. Wohlwill, A study of the development of number concepts by scalogram analysis. J. genet. Psychol., 1960, 97, 345-377.

[3] M. D. S. Braine, The ontogeny of certain logical operations: Piaget's formulation examined by nonverbal methods. Psychol. Monogr., 1959, 73, No. 5 (Whole No. 475).

given either standardized, individual interviews,[1] or group tests.[2,3] A standardized individual interview was selected for this study to allow for comparability from one child's interview to another. Moreover, the children's reactions during the interview were recorded.

Piaget has stressed that a single response does not accurately indicate the level of the child's thinking and must be interpreted with caution. His clinical method probes further and allows the child sufficient opportunities to express what he really understands. The standardized interview method loses such flexibility so some researchers have included procedures which ensure that the child understands the task or the question posed.

In this study, two such procedures were adopted. Orientation sessions were included to give the children practice with important words and ideas used in each of the three parts of the interview. These sections consisted of conservation, seriation and classification tasks. Moreover, important test questions were rephrased or repeated.

The final tasks were selected after two pilot studies, the first with 15 American children in a day care center, and the second with 18 Nigerian children ages five to eight years in Ibadan. In selecting the tasks, there was consideration of the types of problems

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1 P. C. Dodwell, Children's understanding of number and related concepts. Canad. J. Psychol., 1960, 14, 191-205.

2 W. H. King, The development of scientific concepts in children. Brit. J. educ. Psychol., 1961, 31, Pp. 1-20.

3 Jean M. Deutsche, The development of children's concepts of causal relations. Minneapolis: Univ. of Minnesota Press, 1937.

that would serve equally well at the different age levels and for different groups of children. Thus, each section contained tasks presenting "simpler situations," according to Piaget, and some more complex experiments.

The interview schedule was translated independently by two Yoruba lecturers of the University of Ibadan and then, another coordinated the translations. The final Yoruba edition was commented on by a headmistress of an elementary school and the assistant in this study, who had worked as an interpreter previously. The interview schedule is reproduced in Appendix A, and only a brief description of tasks and their sources are given below.

Conservation

The tests for conservation were drawn from Piaget's [1] major work on the development of number concepts. In an initial orientation session, the subjects were requested to compare two rows of blocks that were obviously unequal in number. They were encouraged to make the numbers in the two rows equal. By taking or adding one or two blocks to alternate rows, the interviewer tried to get the subjects familiar with the use of "same" and "more." Also, the subjects were introduced to the non-suggestive question "what about now?" that was used in later parts of the interview.

Task A: The blocks in the interviewer's row were bunched and the child was questioned about the numerical equivalence of the two rows

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[1] Jean Piaget, The child's conception of number. London, Routledge & Kegan Paul Ltd. 1952.

of blocks. An alternative form of the question was asked if there was no response. Finally, the child was asked "why do you think so?"

Task B: This test was set up in the same manner as the preceding one but the questions were asked after the blocks in the child's row were spread out.

Task C: There was an irregular pattern of eight blocks and the subjects were asked to take an equivalent number of blocks as in the model. Then, they were requested to describe their procedure.

Task D: After counting a set of 10 cups, the children were encouraged to exchange each cup for a penny. Seeds were used to represent pennies. They were asked before and after the exchange for the cardinal value of the set of cups. The final question was "how do you know?"

Seriation and Ordination

The orientation section was designed to give the children practice in arranging objects in order of magnitude. The subjects were given five "houses" and asked to arrange them according to size, and assistance was given when children needed it. A description of seriation by size differences can be found in Piaget's [1] accounts.

Task A: Each subject was presented with seven "houses," which he was requested to arrange according to their sizes.

Task B: The same interview techniques employed in A were used. The subjects were required to seriate two sets of objects, dolls and bean bags, such that the tallest doll was placed in a corresponding

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[1] Jean Piaget & Bärbel Inhelder, Le développement des quantités chez l'enfant. Neuchâtel: Delachaux et Niestlé, 1941. p. 222.

position with the biggest bean bag. A simple story, based on a sight familiar to children, was built around the task. The dolls were described as traders and they were carrying their merchandise, or bean bags, to be sold in a market.

Task C: Having arranged the traders and their wares, the subjects were asked a series of questions based on the arrangement. The questions were designed to investigate the subjects' understanding of the numerical order they assigned the objects when they counted previously. The crucial question was asked when the density of the row of bean bags was increased, so that there was no longer an easily perceptible one-to-one correspondence between the rows. The subjects were asked to identify the trader who was to carry the third bag of beans. This task was also based on Piaget's [1] descriptions.

Classification

Again, there was an orientation section that was designed to introduce the children to the activity of grouping. Besides, attention was drawn to the material with which the objects were made since some of the later questions referred to this. The first task consisted of sorting a collection of animals and then explaining the criterion for grouping. The second task, B, tested their understanding of part-whole relationships. Piaget's [2] experiments using brown and white wooden beads formed the basis of this inclusive relations task.

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[1] Jean Piaget, The child's conception of number. London: Routledge & Kegan Paul Ltd., 1952. Ch. V.

[2] Jean Piaget, The child's conception of number. London: Routledge & Kegan Paul Ltd., 1952. Ch. VII.

List of Tasks

A list of tasks described is included and will be referred to in later discussions.

Conservation

Task A tested the ability to conserve after one of two numerically equivalent rows of blocks had been bunched.

Task B was a test of the ability to conserve after one of two numerically equivalent rows of blocks had been spread out.

Task C involved the ability to conserve the number contained in an irregular arrangement of blocks.

Task D tested the ability to conserve after counting and exchange.

Seriation and Ordination

Task A was a test of the ability to arrange a set of objects in an order of magnitude.

Task B involved the ability to arrange and match two rows of objects according to size.

Task C tested the understanding of numerical positions assigned to the objects arranged in B.

Classification

Task A involved the sorting of objects.

Task B was a test of part-whole relationship.

Order of Presentation

The tasks were presented in the same order to all subjects. The interview started with the conservation problems A and B, followed by C and D. The seriation tasks were next presented and the classification problems ended the interview. This arrangement was maintained so that a non-verbal section, seriation and ordination, separated the two verbal parts of the test on conservation and classification.

Supplementary Materials

The Goodenough-Harris Drawing Test was administered to all the children to obtain an assessment of their intellectual maturity. The Draw-a-Man Test was selected because it has been used in many different cultures and is regarded as relatively "culture free." Also, being a non-verbal test, it is conveniently used with a group of children who may not be able to read. It provided the only assessment of mental maturity since no intelligence tests are administered to Nigerian school children.

A personal data sheet (see Appendix C) was used to collect broad and general information about the language, play materials, and type of home from which each subject came.

Administration of the Interview and Other Materials

All interviews were conducted in Yoruba by an assistant trained by the investigator. The investigator was present at all interviews and recorded the responses on record sheets (see Appendix B). The translation into English was mostly done simultaneously with the recording but, in some cases, where the language was involved, the recording was taken in a phonetic shorthand and the translation discussed shortly after the interview. The average length of the interview as 20 minutes.

As much as possible, the interviews were rotated among schools so that children from different schools were interviewed in one week. Interviews were conducted in an empty room within the school premises or in the libraries, where such facilities existed. A list of pupils to be interviewed was given to the heads of the schools before the date of the interview so that the children, according to one head-mistress, "will be encouraged to come to school on that day."

Personal data sheets were filled out before the final selection of the sample. The investigator, teachers and parents and the children themselves assisted in filling those forms.

The Goodenough-Harris Drawing Test was administered to all the children who had been interviewed in each school. They took the test either in an empty classroom or the school library in an average group of about 19 children. However, in two of the schools for the modern group of children, only eight and six children respectively took the test.

Subjects

Selection of Schools

The subjects were selected from schools in the Ibadan area. Schools were classified according to whether they were private and served the more modern sectors of the community, Type C; whether they served mixed populations of modern and traditional groups, Type B; and whether the pupils were mostly from the traditional areas of the city, Type A.

The private schools, whose pupils were mostly from modern homes, are fee-paying, have good teachers and many of the facilities of a modern elementary school. English is the language of instruction in all the classes since these schools tend to be somewhat international in composition both at the pupil and staff levels. As such, there was some difficulty in obtaining the required number of children who spoke Yoruba fluently as their mother tongue. For this reason, samples were taken from three schools instead of two as originally planned.

Two Type B schools were randomly selected from a list of all the elementary schools in this category. English and Yoruba are the languages of instruction in the lower grades but with English replacing Yoruba altogether in the higher grades. Two difficulties arose in the course of selecting subjects from these schools. There were children who spoke Yoruba fluently but whose mother tongue was not Yoruba. In order to avoid complications, such children were excluded from the sample. The other problem was that some of the children in one of the Type B schools, were boarders. As much as possible, an equal number of boarders from traditional and modern groups were included.

The third group of schools, which served the traditional homes, used Yoruba and English as the media of instruction but in the lower grades, Yoruba was almost exclusively used. A comprehensive list of the schools was obtained from the Institute of Education. The names of all these schools were written on slips of paper, mixed in a bag, and two schools were randomly picked out.

Selection of Subjects

Background information was provided by the personal data sheets already mentioned. Personal data sheets were filled out for all Yoruba children in the Type C and Type B schools. However, every nth child was selected in the three lowest classes of the Type A schools and background data were collected about them. The final selection of subjects was randomly done except in two schools with modern children. In these schools, the number of children who qualified on the basis of the language requirement and whose parents allowed them to participate, was small.

The subjects were 110 boys and girls from the first three classes of the elementary schools. The age range was from about six years to about eight years. It was difficult to obtain the exact ages of the children since many of the births were not recorded but were calculated in terms of local or family historical events. However, the teachers assured the investigator that in accepting the children for school enrollment, there was an attempt to select children to start class one at about age six, even though there were few exceptions. Therefore, children who were about six years of age were expected to be in class one, those who were about seven years old in class two, and the eight year old children in class three. Thus, in this study, the ages were regarded as rough estimates. However, it was possible to obtain exact ages for the children attending Type C schools. A distribution of subjects, their ages and schools are shown in Table 1. The ages of 13 children did not correspond with their expected classes. One six year old child was in class two; five children in the seven year old group were in class one, while two others were in class three. Among the eight year old children, three were in class two and two others in class four.

There were 55 children from "modern" homes with an average Draw-a-Man intelligence score of 100.25 and a standard deviation of 18.27. The term "modern" was used to describe homes in which the mother had received, at least, twelve years of formal schooling.[1] They had ample play materials both in school and at home. At home, they are reported to possess such play materials as dolls, balls, mechanical and educational toys. They tended to live in relatively uncrowded homes with a median number of seven adults including house help. About 91 percent of them were working in hospitals, schools, government offices and other institutions at the time of the study. Only about three percent of these mothers were engaged in their own private businesses. Usually monogamy was practiced in the modern families.

There were also 55 children from "traditional" homes, or homes in which the children's mothers had not more than two years of formal schooling. The average Draw-a-Man intelligence score for this group was 83.08 with a standard deviation of 14.16. The children were reported to have a fewer variety of play materials, at school and in the homes. Balls, bean bags, mats and old tyres were some of the play materials, and 20 percent are reported to have "nothing" to play with at home. At least 15 adults lived in the children's homes,

[1] Mothers' education was used because, in the early years, the children's training is mostly supervised by mothers and, in most cases, the fathers are usually more educated than the mothers.

Table 1

Home and School Background, Age and IQ of Subjects

	Boys	Girls	Total	Estimated Mean Age in months	D-A-M IQ Mean	D-A-M IQ S.D.
				Children From Traditional Homes		
Type A School[1]						
Class I	6	6	12	72	74.3	7.47
Class II	6	6	12	84	83.2	8.92
Class III	6	6	12	96	81.3	12.57
Type B School						
Class I	5	2	7	72	89.7	15.75
Class II	3	3	6	84	88.3	17.66
Class III	3	3	6	96	90.2	18.52
Total	29	26	55			
				Children From Modern Homes		
Type B School						
Class I	4	4	8	72	89.1	8.60
Class II	4	3	7	84	94.2	17.31
Class III	3	4	7	96	97.3	24.39
Type C School						
Class*	4	5	9	75.3	104.6	13.73
	6	7	13	84.4	110.8	17.94
	6	5	11	94.9	108.1	12.50
Total	27	28	55			

[1] Type A School - public; predominantly for traditional group.
Type B School - mixed; for modern and traditional group.
Type C School - private; predominantly for modern group.

* Age did not always correspond with class.

which sometimes refers to compounds. Polygamous marriages are prevalent and the first wife is usually regarded as the mother of all the children in the compound. About 87 percent of the mothers of these children, most of whom are illiterate, engage in petty trading. However, a modicum of pidgin English is spoken by some parents. Only about two percent were employed in institutions, the others were housewives.

Categorization of Responses

Responses to each of the nine tasks in the interview were classified into four categories, three of which were based on Piaget's preoperational, transitional and operational stages. A fourth category of "insufficient evidence" was used for those whose records showed unclear, scanty information. Each task was scored separately. Criteria for scoring are outlined in Appendix D.

To determine the reliability of judgments based on criteria, a random selection of twenty protocols were scored independently by the investigator and a graduate student in psychology. The student had had previous experience with the use of scoring criteria based on Piaget's work. The overall inter-scorer reliability was 94.6 percent ranging from 90 percent in the conservation tasks to 100 percent in the ordination task.

III--RESULTS AND CONCLUSIONS

The first steps in the analysis of the data involved classifying the responses of the children on each of the nine subtests into four categories. For the conservation section, the responses were categorized as definitely conserving; partially conserving; definitely not conserving; insufficient evidence. The responses on the other two parts of the test were similarly categorized. Separate contingency tables were next made for the modern and traditional groups of children on each part of the test.

It was evident that there were fewer frequencies in some of the categories. The category of "insufficient evidence" was combined with that for unsuccessful performers, particularly since, in most cases, their responses in other parts of the interview did not represent a higher level of performance. The transitional group also presented a problem. In some sections of the analyses, the transitional group was combined with the unsuccessful or intuitive group. Thus, in contrasting clearly operational with intuitive responses, it was felt that the child who demonstrated a partial and inconsistent understanding of a conservation, a seriation or a classification problem, should be grouped with his unsuccessful counterpart. Piaget thinks that the children in the transitional stage are still intuitive in their approach to problems. In other parts of the analyses, the partially operational responses of the transitional group were considered in relation to their total performance in the tests.

Task Difficulty

It was apparent from these preliminary investigations that some of the tasks were uniformly difficult for both groups of children. Tables 2a and 2b show the performance of modern and traditional groups of children on each task in the conservation section. The relationship between two tasks are examined at a time. Forty-eight children in the modern group were able to perform the task involving conservation after counting and exchange (task D); only 21 and 17 were able to perform tasks A and B respectively. These were problems requiring conservation of the number of blocks in two rows through two rearrangements. In the second table, it can be seen that the traditional subjects manifest the same trend of performance. Forty-five of the traditional children could perform task D whereas only 11 and eight were able to handle tasks A and B respectively.

The contingency tables for the other two parts involving seriation and classification abilities are in Appendix E (Tables 14-16). The trend of performance for the two groups of subjects is also similar. The problem of seriating one row of objects was easier than seriation of two rows of matched objects (task B). The ordination problem was the most difficult. This task tested the ability of the subjects to maintain a numerical order once the objects were seriated. In the classification section, the sorting task (task A), was much easier than the problem on part-whole relationships (task B).

Although the tasks were selected because they were considered suitable for use with different age groups, some of these tasks merely represented simpler situations. In a discussion of simpler procedures which were introduced into his experiments on the equivalence of sets,

Table 2a

Conservation Abilities Revealed by Children Reared in Modern Homes

Performance on task*	Conserving on C	Not conserving on C	Total
Conserving on D	21	27	48
Not conserving on D	3	4	7
Total	24	31	55
	Conserving on A	Not conserving on A	Total
Conserving on D	20	28	48
Not conserving on D	1	6	7
Total	21	34	55
	Conserving on B	Not conserving on B	Total
Conserving on D	14	34	48
Not conserving on D	3	4	7
Total	17	38	55
	Conserving on A	Not conserving on A	Total
Conserving on C	13	17	30
Not conserving on C	8	17	25
Total	21	34	55
	Conserving on B	Not conserving on B	Total
Conserving on C	10	19	29
Not conserving on C	7	19	26
Total	17	38	55
	Conserving on B	Not conserving on B	Total
Conserving on A	12	9	21
Not conserving on A	5	29	34
Total	17	38	55

* See list of tasks on page 37.

Table 2b

Conservation Abilities Revealed by Children Reared in Traditional Homes

Performance on task *	Conserving on C	Not conserving on C	Total
Conserving on D	27	18	45
Not conserving on D	1	9	10
Total	28	27	55
	Conserving on A	Not conserving on A	Total
Conserving on D	10	35	45
Not conserving on D	1	9	10
Total	11	44	55
	Conserving on B	Not conserving on B	Total
Conserving on D	7	38	45
Not conserving on D	1	9	10
Total	8	47	55
	Conserving on A	Not conserving on A	Total
Conserving on C	8	20	28
Not conserving on C	3	24	27
Total	11	44	55
	Conserving on B	Not conserving on B	Total
Conserving on C	6	22	28
Not conserving on C	2	25	27
Total	8	47	55
	Conserving on B	Not conserving on B	Total
Conserving on A	5	6	11
Not conserving on A	3	41	44
Total	8	47	55

* See list of tasks on page 37.

Piaget argues that children do not necessarily show greater understanding of the less complex experimental tasks. One procedure, the "one for one exchange, does not in itself result in the notion of necessary equvalence of exchanged sets. Before this result can be achieved, one for one exchange, like intuitive correspondence, must become operational, i.e., it must be grasped as a reversible system of displacements and relations."[1] Also, "if the child has not yet reached a certain level of understanding which characterizes the beginning of the third stage, counting aloud has no effect on the mechanism of numerical thought."[2] Similar conclusions are made about simpler procedures on inclusive relations experiments. On the basis of these conclusions, the uneven difficulty levels found in the group of tasks used in this study, are unexpected.

The graphic representation of percent success of all subjects on each task is shown in Figure 1. While 84.5 percent could perform the conservation task D, only 4.5 percent of all subjects successfully handled the inclusive relations task (Part III - task B).

Patterns of Performance

Each child's responses could be categorized according to his pattern of performance on the three parts of the interview since contingency tables (2a, 2b and 14-16 in Appendix E) showed that such an analysis could be fruitful.

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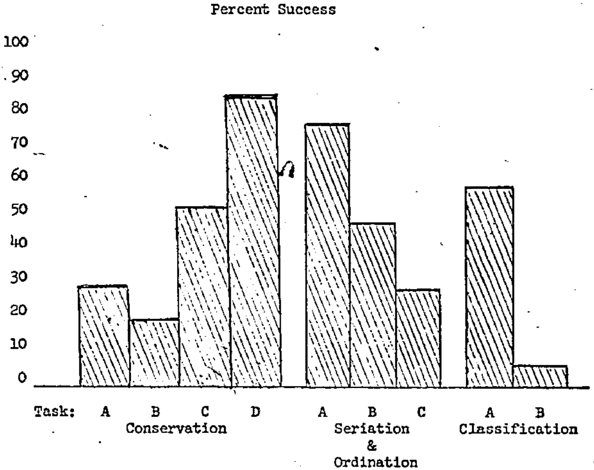
[1] Jean Piaget, The child's conception of number. London: Routledge & Kegan Paul, 1952. p. 61.

[2] Jean Piaget, The child's conception of number. London: Routledge & Kegan Paul, 1952. p. 63.

Figure 1

Difficulty Level of Each Number Task



<u>Conservation</u>

In part one of the interview schedule, there was little difference in the performance of tasks A and B. These tested the subjects' ability to conserve numerical equivalence of two rows of blocks through a bunching and spreading out arrangement. Thus, tasks A and B have been regarded as two aspects of one conservation situation in the analysis of the data.

Four performance patterns are, therefore, possible: no conservation; conservation after provoked correspondence (D only); conservation on

C and D, and on the task of numerical equivalence of two rows of blocks (AB, C and D).

Seriation and Ordination

Each child's performance could be classified in one of four patterns in this section. The first pattern was that of unsuccessful performance on any of the tasks. Seriation of one row of objects by size was the second pattern (A only), followed by the seriation of two rows of objects in addition to the one row seriation (A and B). The final pattern comprised successful performance of A and B, and attaching numerical order to the objects already seriated (A, B and C).

Classification

In the classification section, there were only three patterns of performance. These represented inability to classify on any of the tasks; ability to sort (A only); ability to perform the inclusive relations task in addition to correct sorting (A and B).

There were children whose performances did not fit neatly into any of these patterns. On the basis of task difficulty and median age performance, two criteria were adopted for regrouping these children. Firstly, it was argued that if a child could successfully perform the most difficult task in a section, for example, the AB task in the conservation section, that child could also perform the easier tasks, C and D. Also, as a second measure for reclassifying, the child's performance was compared with the median performance of children of the same age in his group. There were 14 such cases in the conservation section, six in the seriation section, and four in the classification section. There was complete agreement among the judges in all but one of the cases that were considered for reclassification.

Major Results

Conservation, Seriation and Classification Abilities

The first question that was raised in this study concerned the validity of Piaget's hypothesis that conservation and other abilities such as seriation and classification develop concurrently. For Piaget, conservation is a necessary condition for all "mathematical thinking." Therefore, if the child does not conserve, he is unlikely to attain other abilities that make a true understanding of number possible. Since number is the union of asymmetrical relations and classes, Piaget argues that the development of number is actually another aspect of the development of logical thinking. Thus, the ability to seriate, conserve and classify are manifestations of the new thinking which evolves in the child. This novel way of solving problems emerges at about age seven and, thus, makes possible the handling of tasks involving numbers and relationship between numbers.

Since inspection of contingency tables (Appendix E, Tables 17-20) showed that the performance trend of the two groups of children was similar, the modern and traditional groups were combined for this analysis. Tables 3, 4, and 5 show the performance of all children.

Conservation and Seriation

As indicated in Table 3, Piaget's contention that conservation and seriation abilities develop concurrently is only partially upheld. Of the 11 children who could not perform any of the conservation tasks, seven of them were also unable to cope with any of the seriation tasks.

Of the 40 who could perform all conservation tasks, only 14 could successfully handle all the seriation tasks. These numbers indicate that children at a particular level of performance in conservation tasks do not attain the same level in the seriation tasks.

Table 3

Relationship of Conservation and Seriation and Ordination Abilities

	Seriation and Ordination				
Performance on Task*	None	A only	A & B	A, B & C	Total
Conservation					
None	7	2	0	2	11
D only	6	8	10	3	27
C & D	4	9	9	10	32
AB, C & D	2	10	14	14	40
Total	19	29	33	29	110

* See list of tasks on page 37.

There is also some indication that once a certain minimum understanding of conservation is acquired, the seriation problems tend generally to be better understood. Good performance on the conservation tasks is inversely related to poor performance on the seriation tasks. Of the 27 who could perform the easiest conservation task, only six could not perform any seriation task. Out of the 40 children who could successfully handle all the conservation tasks, only two could not perform any of the seriation tasks.

Seriation and Classification

The relationship between seriation and classification is less clear. Of the total number of 91 children who could perform at least one task in the seriation and ordination section, 67 of these could perform at least one of the classification tasks.[1] But only five of these children could perform the inclusive relations task in classification section. Undoubtedly, the ability to seriate does not develop side by side with the ability to understand class inclusion.

Table 4

Relationship of Seriation and Ordination and Classification Abilities

Performance on task*	Seriation and Ordination				
	None	A only	A & B	A, B & C	Total
Classification					
None	13	15	5	10	43
A only	6	12	26	18	62
A & B	0	2	2	1	5
Total	19	29	33	19	110

* See list of tasks on page 37.

[1] The total frequencies in all categories other than "None" have been combined for the seriation and classification sections.

<u>Conservation and Classification</u>:

Table 5 examines the relationship between conservation and classification abilities. Here too, ability to conserve is related generally to ability to handle some classification problems.

Table 5

Relationship of Conservation and

Classification Abilities

Performance on task*	Classification None	A only	A & B	Total
Conservation				
None	9	2	0	11
D only	9	17	1	27
C & D	10	20	2	32
AB, C & D	15	23	2	40
Total	43	62	5	110

* See list of tasks on page 37.

<u>Summary</u>:

The results shown in these tables suggest that the new orientation in thinking which manifests itself in the attainment of conservation, also affects the ability to form series and classes. But, the relationship is not as neat as Piaget hypothesizes.

<u>Number Concept and Intelligence</u>

The next question was concerned with the extent to which children who were able to understand the number tasks were intellectually mature.

The Goodenough-Harris Drawing Test was used to assess the intellectual maturity of the subjects.

A preliminary inspection of the data showed no linear relationship between the two measures. The performance of the children was then scaled on the basis of patterns already described. The range of the scale was from 0, 0, 0 representing no success in any task to a perfect performance of 3, 3, 2. Some of the categories which had larger frequencies formed the basis of the five groups that were developed. For instance, there were ten children, who could perform all of the conservation tasks, all tasks in the seriation section, and the sorting task of the classification section (3, 3, 1). These ten children formed the nucleus of Group E. When credit was given for the tasks on which subjects were partially successful, and the difficulty level of each task was considered, it was possible to obtain a Group E that was fairly homogeneous in performance level. All the groups were formed in the manner described out of a total of six large clusters with frequencies ranging from nine to 12. Table 6 shows the number of children in each of the five groups; the typical total performance of each group of children on the number tests and, mental age on the Goodenough-Harris Drawing Test.

According to the results in Table 6, intelligence, as measured by the Draw-a-Man Test does not correspond highly with performance on the number tests. There are, however, some interesting relationships of a general nature. A minimum mental age is required for successful performance on any of the tasks, possibly, to understand instructions. Thereafter, the relationship between the degree of intellectual maturity and performance on number tasks is not precise. But, those that attained the highest level of performance also have the highest mental age.

Table 6

Relationship Between Intellectual Maturity and Performance on the Number Tests

Description	N	Performance on tasks*	Mental Age in Drawing Test M	S.D.
Group A	21	0,0,0;1,1,0	4.94	5.003
Group B	22	2,1,1;1,2,1	6.41	6.54
Group C	22	2,2,1;2,3,1	6.87	6.98
Group D	20	3,1,0;3,2,1	6.59	6.75
Group E	20	3,3,1;3,3,2	7.63	7.79
Total	105[1]			

* 0,0,0 represents no success on any conservation, seriation and classification tasks.

1,1,0 represents success on one conservation, one seriation and no classification task....

3,3,2 represents success on three conservation, three seriation and two classification tasks.

Performance of Modern and Traditional Groups

A question was raised concerning the differences in the development of number concept between the children from modern and traditional homes. The tables that are included in this section compare the percentage of children from those two groups that fall into the different patterns of performance on each part of the test.

[1] Intelligence scores could not be obtained for all subjects.

Conservation

The children from modern homes show unequivocal evidence of superior performance on the conservation tasks at all age levels (Table 7). However, the difference in the level of performance tends to decrease with age. For example, only eight out of 17, about half of the six year old children from modern homes performed no task or the easiest conservation task, D, whereas more than three fourths, 15 out of 19 of those from traditional homes could also perform, at most, the easiest conservation task. But, by age eight, 15 out of 18 children from modern homes and 14 out of 18 from traditional homes could perform, at least, both tasks C and D.

Seriation and Ordination

Table 8 shows that the modern group of children also performed better than the traditional group in the seriation tasks. The most striking differences occurred in the six year old group. Of the traditional group of children, 57.9 percent could not handle any of the seriation tasks whereas only 11.8 percent of their modern counterparts were unable to perform any of the tasks successfully.

Classification

The differences on the classification tasks were not as apparent as those on the other two sections of the interview schedule. (Table 9). The percent of children who could handle the inclusive relations task in the two groups was not only very small but about the same. Moreover, there was very little difference in the performances of the eight year old group. The trend of performance was, therefore, slightly different in this group of tasks. The traditional children were handicapped at

Table 7

Conservation Abilities Revealed by Children

Reared in Modern and Traditional Homes

	Age							
	About 6 years		About 7 years		About 8 years		Total	
Task*	N	%	N	%	N	%	N	%
Modern Group								
None	1	5.9	0	0.0	1	5.5	2	3.6
D only	7	41.2	4	20.0	2	11.1	13	23.6
C & D	6	35.3	4	20.0	4	22.2	14	25.5
AB, C & D	3	17.6	12	60.0	11	61.1	26	47.3
Total	17	100.0	20	100.0	18	99.9	55	100.0
Traditional Group								
None	8	42.1	1	5.5	0	0.0	9	16.4
D only	7	36.8	3	16.7	4	22.2	14	25.4
C & D	2	10.5	9	50.0	7	38.9	18	32.7
AB, C & D	2	10.5	5	37.8	7	38.9	14	25.5
Total	19	99.9	18	100.0	18	100.0	55	100.0

*Task D: Conservation after counting and provoked correspondence.

C: Conservation of the number of an irregular arrangement of blocks.

A & B: Conservation of the numerical equality of two rows of blocks through two rearrangements.

Table 8

Seriation and Ordination Abilities Revealed by Children Reared in Modern and Traditional Homes

	Age							
	About 6 years		About 7 years		About 8 years		Total	
Task*	N	%	N	%	N	%	N	%
Modern Group								
None	2	11.8	2	10.0	0	0.0	4	7.3
A only	6	35.3	7	35.0	1	5.6	14	25.5
A & B	6	35.3	7	35.0	7	38.9	20	36.4
A, B & C	3	17.6	4	20.0	10	55.5	17	30.9
Total	17	100.0	20	100.0	18	100.0	55	100.1
Traditional Group								
None	11	57.9	4	22.2	0	0.0	15	27.3
A only	6	31.6	7	38.9	2	11.1	15	27.3
A & B	0	0.0	4	22.2	9	50.0	13	23.6
A, B & C	2	10.5	3	16.7	7	38.9	12	21.8
Total	19	100.0	18	100.0	18	100.0	55	100.0

*Task A: One row seriation.

B: Matched seriation.

C: Ordination of objects after matched seriation in B.

Table 9

Classification Abilities Revealed by Children

Reared in Modern and Traditional Homes

	Age							
	About 6 years		About 7 years		About 8 years		Total	
Task*	N	%	N	%	N	%	N	%
Modern Group								
None	4	23.5	9	45.0	5	27.8	18	32.7
A only	12	70.6	11	55.0	11	61.1	34	61.8
A & B	1	5.9	0	0.0	2	11.1	3	5.5
Total	17	100.0	20	100.0	18	100.0	55	100.0
Traditional Group								
None	14	73.7	7	38.9	4	22.2	25	45.5
A only	5	26.3	11	61.1	12	66.6	28	50.9
A & B	0	0.0	0	0.0	2	11.1	2	3.6
Total	19	100.0	18	100.0	18	99.9	55	100.0

*Task A: Sorting and grouping of a collection of animals.

B: Classification involving part-whole relationships.

age six years but manifested about the same level of performance at eight years of age.

Summary

The children from modern homes manifested an earlier performance of number tasks particularly on the seriation problems, but the traditional children tended to make up the disparity in performance at about age eight. The traditional group of children showed least lag in the classification section.

Sex Differences

Question four was raised to examine sex differences in the development of number concept. It was assumed that differences in the upbringing of boys and girls in the culture might have some effect on the development of numerical thinking, particularly as the girls, more often than the boys, assist the parents in petty trading.

Conservation

The boys tended to be superior at ages six and seven years but the girls performed better than the boys at about age eight years on these conservation tasks (Table 10).

The most striking differences occurred at age seven years when a majority of boys (94.7%) could perform at least two of the conservation tasks and only 63.1 percent of the girls at this age could.[1]

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[1] Percentages for categories C & D, and AB, C & D have been combined.

Table 10

Sex Differences in the Performance of

Number Tasks--Conservation

	Age							
	About 6 years		About 7 years		About 8 years		Total	
Task*	N	%	N	%	N	%	N	%
Girls								
None	5	29.4	1	5.3	1	5.6	7	13.0
D only	5	29.4	6	31.6	3	16.7	14	25.9
C & D	6	35.3	5	26.3	3	16.7	14	25.9
AB, C & D	1	5.9	7	36.8	11	61.1	19	35.2
Total	17	100.0	19	100.0	18	100.1	54	100.0
Boys								
None	4	21.0	0	0.0	0	0.0	4	7.1
D only	9	47.4	1	5.3	3	16.7	13	23.2
C & D	3	15.8	8	42.1	8	44.4	19	33.9
AB, C & D	3	15.8	10	52.6	7	38.9	20	35.7
Total	19	100.0	19	100.0	18	100.0	56	99.9

*Task D: Conservation after counting and provoked correspondence.

C: Conservation of the number of an irregular arrangement of blocks.

A & B: Conservation of the numerical equality of two rows of blocks through two rearrangements.

Seriation and Ordination

A trend of performance similar to that observed in the conservation section is indicated in Table 11. The boys started with an advantage and the girls performed just as well as the boys at age eight.

Classification

A comparison of the performances of boys and girls on the classification tasks is shown in Table 12. In this section of the interview, the boys did not maintain the high level of performance described in the two previous parts. The girls are shown to be slightly superior in all tasks.

Summary

Interesting differences are observed in the performances of boys and girls. These differences cannot be interpreted as significant since the sample is small and the differences are slight. At age eight years, in this sample, the girls who started with a disadvantage, perform just as well as the boys except in the classification section where they maintain a superior performance at all age levels.

Other Results

Age and the Development of Number Concepts

A further analysis was made of the relationship between chronological age and the attainment of the abilities of conservation, seriation and ordination, and classification. Piaget indicates that age seven is the crucial age at which the children in his Swiss sample attain these concepts. Table 13 shows unequivocally that these concepts develop with increased age, thus, the findings lend weight to the maturational view of development.

Table 11

Sex Differences in the Performance of

Number Tasks--Seriation & Ordination

	Age							
	About 6 years		About 7 years		About 8 years		Total	
Task*	N	%	N	%	N	%	N	%
Girls								
None	7	41.2	5	26.3	0	0.0	12	22.2
A only	6	35.3	6	31.6	2	11.1	14	25.9
A & B	2	11.8	5	26.3	7	38.8	14	25.9
A, B & C	2	11.8	3	15.8	9	50.0	14	25.9
Total	17	100.1	19	100.0	18	100.0	54	99.9
Boys								
None	6	31.6	1	5.3	0	0.0	7	12.5
A only	6	31.6	8	42.1	1	5.6	15	26.8
A & B	4	21.0	6	31.6	8	44.4	18	32.1
A, B & C	3	15.8	4	21.0	9	50.0	16	28.6
Total	19	100.0	19	100.0	18	100.0	56	100.0

*Task A: One row seriation.

B: Two rows matched seriation.

C: Ordering of objects after the matched seriation in B.

Table 12

Sex Differences in the Performance of Number

Tasks--Classification

	Age							
	About 6 years		About 7 years		About 8 years		Total	
Task*	N	%	N	%	N	%	N	%
Girls								
None	7	41.2	7	36.8	3	16.7	17	31.5
A only	9	52.9	12	63.2	12	66.6	33	61.1
A & B	1	5.9	0	0.0	3	16.7	4	7.4
Total	17	100.0	19	100.0	18	100.0	54	100.0
Boys								
None	11	57.9	9	47.4	6	33.3	26	46.4
A only	8	42.1	10	52.6	11	61.1	29	51.8
A & B	0	0.0	0	0.0	1	5.6	1	1.8
Total	19	100.0	19	100.0	18	100.0	56	100.0

*Task A: Sorting and grouping of a collection of animals.

B: Classification involving part-whole relationships.

Table 13

Age and Performance on Number Tasks

	Age							
	About 6 years		About 7 years		About 8 years		Total	
Task	N	%	N	%	N	%	N	%
Conservation								
None	9	25.0	1	2.6	1	2.8	11	10.0
D only	14	38.9	7	18.4	6	16.7	27	24.5
C & D	8	22.2	13	34.2	11	30.6	32	29.1
AB, C & D	5	13.9	17	44.7	18	50.0	40	36.4
Total	36	100.0	38	99.9	36	100.1	110	100.0
Seriation & Ordination								
None	13	36.1	6	15.9	0	0.0	19	17.3
A only	12	33.3	14	36.8	3	8.4	29	26.4
A & B	6	16.7	11	28.9	16	44.4	33	30.0
A, B & C	5	13.9	7	18.4	17	47.2	29	26.4
Total	36	100.0	38	100.0	36	100.0	100	100.1
Classification								
None	18	50.0	16	42.1	9	25.0	43	39.1
A only	17	47.2	22	57.9	23	63.9	62	56.4
A & B	1	2.8	0	0.0	4	11.1	5	4.5
Total	36	100.0	38	100.0	36	100.0	110	100.0

In one of his publications, Piaget[1] assigns age levels to tasks. According to Piaget, when 75 percent of the sample can successfully complete a task, it can be assumed that children of that age should normally be able to perform that task. When that criterion is applied to this study, it is evident that although chronological age is a significant factor in the development of number concepts, the Nigerian subjects meet that criterion only in a few of the tasks. About 75 percent of the six year old children, 97 percent of the seven and eight year old children could perform the provoked correspondence conservation task. More than 75 percent of the subjects at ages seven and eight years could perform the conservation task involving taking the same number of blocks as in a given pattern. About the same proportion of subjects in the seven and eight year old groups could also perform the one row seriation task. When the two row seriation and the sorting task in the classification section are considered, only eight year old subjects reach the criterion level.

Most of the analyses in this study were based on patterns of performance, and when the overall pattern is considered, at no age level, do subjects reach the 75 percent criterion level.

Summary

The results presented in this chapter indicate that Piaget's methods have been successfully used in a different cultural setting.

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[1] Jean Piaget, The development of mental imagery. In Richard E. Ripple & Verne N. Rockcastle (Eds.), Piaget rediscovered: a report of the conference on cognitive studies and curriculum development. Ithaca: School of Educ., Cornell Univer., March, 1964. p. 31.

Chronological age and the nature of the home from which the subjects come have been found to influence the development of number concepts. Slight sex differences have been found to exist in the sample. Intelligence, as measured by the Goodenough-Harris Drawing Test, has been found to have minimal relationship with the development of number concepts, measured by tasks of conservation, seriation, ordination and classification. Although these abilities appear in some measure at about the same time, the relationship is not as perfect and precise as Piaget's theory contends.

IV--EXPLANATIONS AND STRATEGIES OF THE CHILDREN

This chapter describes differences in the approaches of groups of children with special attention to those factors that misled them. Also, an attempt is made to examine the main descriptive differences in the modern and traditional groups of children.

Intuitive and Operational Responses

Piaget postulates that there is a difference in the approach of the intuitive child, who is unable to conserve, seriate and classify, and a child who thinks at an operational level. The intuitive child is global in his approach, depends largely on perceptual attributes of the arrangement and centers only on one aspect of the problem at a time, thus, neglecting other informative cues. The operational child, who can conserve, seriate and classify, is not only less dependent on perceptual properties of an array, but goes beyond the "givens" of the situation, analyzes and synthesizes different relationships of a problem.

On the basis of this analysis by Piaget, the responses are being described as they progress from the global, perceptually based strategy to the internalized, synthesizing way of handling problems. The discussion that follows is based on such descriptions.

Explanations

The justifications given by the subjects in the conservation and classification sections support Piaget's general descriptions of the differences in the approach of the intuitive and operational child. Many of the responses, both operational and intuitive, were perceptually based.

Comparison of the Poorest and Best Performers

To illustrate the differences in the approach of the intuitive and operational groups of children, a comparison of Groups A and E, described in the preceding chapter, in the section examining the relationship of intelligence and number concepts, is undertaken. Group A showed the least advanced and Group E the most advanced performance. There are 21 children in each group.

Conservation

Task A required that the subjects determine the numerical equivalence of two sets of blocks after one row of blocks had been bunched.

Three levels of responses were considered. At a very intuitive level, were some children who made no attempt to focus on aspects of the problem that the adult intended. Their comments tended to be irrelevant to the solution of the problem. They, for instance, justified numerical equality or inequality of the two rows of blocks because "they are both many." These children also described the color of objects when a question was specifically directed towards the number of objects. On the whole, responses were global and absolutely dominated by perceptual factors. Sixteen children used such explanations, 15 of which are in Group A, and only one in Group E.

At a more advanced level, responses were still perceptual but somewhat more specific about aspects of the arrangement or action that attention was focused on. For instance, the children asserted that two previously equivalent sets of blocks which had been rearranged, were no longer equal "because one is longer," or still equal "because you only pushed these together." When the children could describe two features of the arrangement, such as "one is long and the other (set of blocks) is round," a higher level of thinking was not necessarily achieved because of inability to coodinate the relationships observed. Eleven children used the types of explanations described in this paragraph and they were evenly distributed between Groups A and E.

Children, using a third strategy, could relate two or more aspects of the problem. Some of these children related a past and a present state, and asserted that the two sets of blocks were "same," because they were equal when you arranged them before." One set of responses compared appearance and reality, and still another went beyond the situation; the children realized that some features of the objects, for example, number, could not be altered by rearrangements. They, therefore, insisted that "they are 11 each." They had, according to Piaget, internalized and coordinated their observations. Fifteen children used explanations in this category, and all of them are in Group E.

In Task C, the children were required to take an equivalent number of blocks as those contained in a given pattern. They were then asked to describe their procedure.

The children in Group E took the correct number of blocks, and their descriptions showed reliance on counting and numbers. Eighteen of the 21 children described methods using numerical reasoning, such as, "I took eight," "I put two here, three and three to match the numbers in your rows." The other three children in this group copied the pattern with a typical explanation, such as, "I arranged them like yours."

Most of the poor performers took an incorrect number of blocks, and their descriptions of procedure and actual behavior provided clues about what misled them. Only three children directly or by implication referred to the use of counting and number to solve the problem. All the other children tried to copy the pattern. Many of them arranged blocks in patterns completely different from the model. There were semi-circular patterns, a circle with one block in the middle and single rows of blocks. Some of the children scattered the blocks around without any definite pattern. Their descriptions showed that there was a reinterpretation of the instruction that the interviewer had given. "I took all the other ones," "I added these ones to yours," "I took them out of the box" were some of the descriptions.

Seriation

The children were requested to arrange houses, dolls and bean bags according to their sizes.

The main difference between the two groups could be seen in the methods employed during the comparisons of objects. Ten of the Group E children carried out the comparisons mentally. Another ten children compared two or three objects at a time. However, they compared A and B and then related them to the next pair C and D. Sometimes, A and B were compared, next, B and C and so on.

In the group of poor performers, only three of the 21 children carried out the comparisons mentally. Ten of them combined the two-at-a-time comparisons with other methods. They tended to compare A and B, and later E and F without considering how the latter pair related to A and B. One of the children carefully compared two small bean bags, placed them before the larger dolls and indicated that she needed more of the small bags of beans to continue her placements. Eight of the children did not bother to compare the objects in any observable manner and placed them in a random order. Of these eight children, only two showed signs of not understanding the orientation section.

Classification

Task A: This was a sorting task in which the children were given a collection of animals and asked to group them on the basis of "likeness." The main difference between the two groups was that the Group E children could select and maintain one criterion in the task. The other children misinterpreted the instructions or else, they changed very rapidly from one criterion to another during the sorting.

Fifteen of the 21 children in Group E gave reasons indicating that the groups were constructed on the basis of shared characteristics. Responses such as "there are ducks here, crocodiles, birds, and horses," "they are four different animals" were given.

On the other hand, 13 out of the 21 children in Group A gave explanations that showed they were not using any common attribute of the objects in grouping. The most frequent response was "so that they (the animals) may remain separate." One of the children put all the animals singly with the explanation that they were all "meaty."

Another interesting difference was that none of the children in Group E sorted on the basis of color, whereas eight of the children from Group A did.

Task B: On the inclusive relations task, where the children were asked to compare the numbers in a group B with the numbers in its subgroups A and A', there were slight differences. The children from the best performing group could indicate the aspects of the problem that misled them. The main source of error lay in the fact that they were comparing A and A' instead of either B and A or B and A', as was requested. The most intuitive group asserted that there were the same number of white as plastic chickens because "you had asked me to touch them before," "they are different," and, two of the children actually insisted that there were more red chickens although the question did not refer to the red chickens at all.

Summary

In the comparison of intuitive and operational responses Piaget's descriptions have been upheld. The younger children were the most intuitive in their explanations. Even the operational children regressed to intuitive explanations in difficult tasks, such as that involving the comparison of a whole and its part.

V--DISCUSSIONS AND IMPLICATIONS

Discussions in this chapter are based on the validity of Piaget's methods for a Nigerian sample. The study deviated from the classical researches of Piaget in that a standardized, individual interview schedule was used instead of his flexible, clinical method of inquiry. Also, in this study, the analyses of data have been based on patterns of performance on a series of tasks rather then on the depth of understanding shown in one of Piaget's experiments. It has been assumed, for instance, that a child who successfully completed conservation tasks AB, C and D was necessarily a "better" conserver than one who performed only tasks C and D.

The next sections examine the influences of experience and maturational factors in the development of operational thinking. The pedagogical values of some aspects of Piaget's theory for the Nigerian schools are also considered.

The Roles of Maturation and Experience

The influence of experience on children's thinking is discussed at two levels. Since this study was conducted in a different cultural setting, some of the results are discussed in relation to findings in other cultures. Moreover, since the children from traditional and modern homes were compared, the differences that were found between these groups are partly related to experiential factors.

The Development of Conservation and Related Abilities

According to Piaget's theory, certain distinct abilities emerge at a certain stage of the child's development. Ability to conserve, seriate and classify are said to develop simultaneously. The results of this study, show that Piaget's contention is upheld in a general sense but that attainment of a particular level of conservation does not presuppose a corresponding degree of ability to seriate. The least developed of the abilities studied was classification, especially when a class inclusion problem was posed.

The results have shown that all the abilities develop with chronological age. Besides, the stages and sequences of the development of number concepts have been upheld in a culture that is different from that where Piaget conducted his experiments. Thus, it can be said that some of the abilities are influenced maturationally irrespective of the different cultural demands.

However, conservation and the logical abilities of seriation and classification develop at different rates within each group of children in this study. It seems, then, that maturation allows for the cognitive capacity essential for the attainment of these concepts to develop, but the actual level of understanding is controlled by the stimulation provided by the children's experiences. Although there is no direct comparison, it can be noted that the Nigerian children, ages seven and eight, attain the 75 percent criterion level set by Piaget,[1] in a few of the tasks used. Nor is their performance comparable to that in

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[1] Jean Piaget, The child's conception of number. London: Routledge & Kegan Paul Ltd., 1952.

Almy's[1] study.

On the whole, the seriation tasks were slightly more difficult than the conservation tasks, and the class inclusion problem was not understood by most of the children. Dodwell's[2] finding, that there was a low correlation in the performance of problems involving cardinal numbers and logical classes, is relevant. He explained this finding on the basis that whereas children receive instruction in numerical problems, little specific instruction is given on the hierarchy of classes. Miller[3] also, found that most children in kindergarten and second grade, in a suburban middle class school, failed a pretest consisting of class inclusion problems. Her training methods, including among other things, specific tuition on hierarchy of classes, helped some children to attain the class inclusion concept.

In conclusion, it can be said that conservation, seriation and classification may develop concurrently and to the same degree if the requisite experiences are provided by the environment.

Performance of Modern and Traditional Groups of Children

The performance of children from modern homes was superior to that of their counterparts from traditional homes, even though they were at the same maturational level of development. This disparity

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[1] Millie Almy, E. Chittenden & P. Miller, Young children's thinking: some aspects of Piaget's theory. New York: Teachers College Press, Teachers College, Columbia University, 1966. Ch. 3.

[2] P. C. Dodwell, Relations between the understanding of the logic of classes and of cardinal number in children. Canad. J. Psychol., 1962, 16, Pp. 152-160.

[3] Paula E. Miller, The effects of age and training on children's ability to understand certain basic concepts. Unpublished Ph.D. dissertation: Teachers College, Columbia University, 1966.

in performance cannot be wholly explained on the basis of superior intellectual maturity of the modern group of children, especially, since intelligence was only minimally related to performance on the number tasks. Experiential factors at home and in school must be partly responsible for those differences. As mentioned in the second chapter, the children from modern homes attended more modern elementary schools, had good teachers and ample toys to play with. Since the traditional children in the mixed schools seemed to perform better than many of the others in the same group, it is likely that school experiences influence the development of these concepts. Also, there was little difference between the two groups in the performance of conservation task D. This task involved counting and exchange, activities in which the two groups of children had direct experience. On the other hand, the class inclusion task, which is the least directly taught in schools, was poorly performed by both groups.

Sources of Error

Piaget outlines the limitations of the unsuccessful or pre-operational child as his tendency to "centre" on one aspect of the problem at a time. He also depends on perceptual cues. The findings, in this study, support Piaget's descriptions of pre-operational and operational strategies.

Specific Cultural Influences

In this study, intuitive children also 'misinterpreted' the problems. For instance, an instruction which required that the child take "just as many blocks" as contained in a given pattern was reinterpreted in various ways. Sometimes, the children responded as if they were asked to take all the other blocks from the box or to build another pattern on the model. Also, when white and plastic chickens were compared, a few children responded that there were "more red" chickens. The problem could be one of lack of understanding, but this seems not to have been the case since most of the children understood the orientation section. A more likely interpretation is that these children, most of whom were from the traditional homes, and all of whom were six year old children, had little experience in attending to adults in the type of adult-child relationship posed either in the classroom or the test situation.

Another observation was that some children from both types of homes, but much more from traditional homes, made a common error in the orientation task. When they were asked to identify the followers in a group of seven, of which the seventh man was acknowledged leader, these children indicated the sixth, fifth and fourth men, or, the three smallest men. There could have been an ambiguity in the questioning but several other children responded appropriately.

Also, in the sorting task, some children explained that they had made various groupings "so that they (the animals) may be separate." These children may have been influenced by an observation that the animals concerned lived in different natural settings.

Finally, it must be pointed out that the strange one-to-one adult-child relationship may have caused difficulty for some subjects. The children from modern homes were, on the whole, more demonstrative in their curiosity, appeared more confident and were definitely more willing to talk spontaneously with the interviewers. Also, only children from the modern homes directly accosted the adult with her actions, e.g., they would explain "you merely bunched mine," "you did not take any away" as opposed to the passive expression "mine was bunched." Adult-child relationships are defined by traditional culture, and children, particularly girls, are expected to be extremely respectful to adults. That the girls at ages six and seven years did not perform as well as the boys, but performed equally well at age eight years, may be one of the outcomes of upbringing that trains them to be quiet in the presence of adults.

Apart from the usual limitations outlined by Piaget and which were confirmed in this study, cultural experiences may have influenced the responses of the children in the test situation.

Intelligence and Number Tasks

In this study, intelligence, as measured by the Goodenough-Harris Drawing Test, was very slightly related to the development of number concepts, studied through tasks based on Piaget's descriptions. This finding was unexpected because, according to Harris[1], "the drawing test evaluates primarily the ability to form concepts", and Piaget's tasks are also tests of concept formation. The drawing test is also purported to be culture free. However, Harris[2] suggests that

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1 Dale B. Harris, Children's drawings as measures of intellectual maturity. New York: Harcourt, Brace & World, Inc., 1963, p.7.

2 Dale B. Harris, Children's drawings as measures of intellectual maturity. p. 133.

if cultural influences are suspected, the test may more profitably be used to compare children within the culture rather than across cultures. In this study, only intracultural comparisons were made.

There are some suggestions about the very slight relationship of the intelligence scores to the performance on the number tasks. First, a narrow age range, six to eight years, was studied. Therefore, the concepts measured by the Drawing Test may not have been tapped in a group of children, who are merely beginning to value pictorial representations. Moreover, Harris[1] states that the value of the Drawing Test as "an index of intelligence is perhaps not quite so firm" as its objectivity and reliability. Finally, there were some cultural influences in children's drawings, particularly those children from traditional homes, for which no credit was given. One such feature was the drawing of both full face and profile in one representation of the human face. A scoring device adapted to suit the needs of the Nigerian culture may have produced a different result.

Implications for Education and Research

This study has demonstrated that Piaget's theories can be fruitfully employed in examining the development of Nigerian children's thinking. The next sections suggest ways that Piaget's theory can be further used in research and the education of young children.

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[1] Dale B. Harris, Children's drawings as measures of intellectual maturity. p. 36.

Recommendations for Education

There is no doubt that children make a transition from an intuitive to an operational mode of thinking about problems. The pace of transition is slower in the Nigerian sample than in other samples studied in western countries. As Almy and associates[1] report, the ability to conserve is related to reading readiness and other aspects of school achievement. Therefore, it might be desirable to help children to make the shift from intuitive to more mature forms of thinking at an earlier age, particularly, as there is an urgency in training personnel to meet the country's manpower needs.

A modification in instructional methods can help the Nigerian children to make the transition more efficiently. A report of a commission in Western Nigeria, gives one of the causes for the "lamentably" low standard of education in the primary schools as the teacher's lack of professional "skill (the professional 'know-how') to awaken a child's interest in what is being taught and to kindle in his pupils a love of learning."[2]

According to Piaget's theory, the action of the individual is crucial to the development of operational thinking. Therefore, the teachers should make provisions for individual experimentation and direct manipulation of materials. Unfortunately, teaching is still

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[1] Millie Almy, E. Chittenden & P. Miller, Young children's thinking: studies of some aspects of Piaget's theory. New York: Teachers College Press, Teachers College, Columbia Univer., 1966.

[2] Extract from the report of the commission appointed to review the educational system of Western Nigeria, December 1960 to January 1961, Teaching as a profession. In L. G. Cowan, J. O'connel & D. G. Scanlon (Eds.), Education and nation building in Africa. New York: Frederick A. Praeger, Publishers, 1965. Pp. 384-385.

formal in most primary schools, and the practice is reinforced by beliefs in the culture, which require that children "should be seen, not heard." The extreme reserve of children during the interviews, especially those from traditional homes, may have been one of the outcomes of such beliefs. It must be mentioned that children from the modern homes tend to have greater freedom of expression at home and in their schools.

Piaget's theory contends that thought is not yet free from its concrete content even in the stage of concrete operations. Children still need concrete objects to buttress their judgments. Thus, an ample amount of different objects, especially those that could be procured inexpensively in the localities, should be made available in the classrooms. The children could use such materials to practice grouping and serial ordering, sometimes, with instructions from the teacher.

Children need to manipulate objects but they also need to express themselves verbally. As indicated in an earlier chapter, the verbal explanations of the children's behavior showed up not only limitations in their thinking, but also, the actual sources of error. Interviews along the lines suggested by Piaget, should help the teacher to realize that children are at different stages of conceptual development. This increased understanding of individual differences is bound to affect her teaching.

So far, the method of instruction has been considered, but Piaget's notion of stage sequencing, which was also validated in this study, has relevance for what children ought to be taught. Many discussions on the improvement of curricula, have considered what concepts children should be taught in the different classes and how best these concepts can be arranged to match the conceptual level of the pupils. Hunt[1] attaches great importance to the effectiveness of teaching that is properly timed, that is, when the child is ready to move from one level of organizing information to another. But, as he points out, such timing is pedagogically difficult. Karplus[2] has adopted what might prove to be an important approach in the teaching of physical concepts. The method emphasizes pupil activity and a hierarchical organization of concepts. In other words, there seems to be an implicit belief that children can be taught physical concepts, previously considered too difficult for them, if these are presented in an ordered series.

In the large Nigerian classes, it will be difficult for the teacher to present material precisely when each child is ready to make the shift, even if she did know when it would occur. However, teaching could take place in small, flexible groups, organized by the teacher, on the basis of careful assessments of abilities and rates of development within her class. Also, such teaching could not only be anchored at a very concrete level, but could be arranged to repeat important concepts. Specific instructions within the different disciplines on some of the more basic concepts, e.g., grouping, ordering, and such like, could be encouraged.

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[1] J. McV. Hunt, Intelligence and experience. New York: Ronald Press, 1961.

[2] Robert Karplus, The science curriculum improvement study. In Richard E. Ripple and Verne N. Rockcastle (Eds.), Piaget rediscovered: a report of the conference on cognitive studies and curriculum development. Ithaca: School of Educ., Cornell Univer., March, 1964. Pp. 113-118.

It will be recalled that an external examination is given at the end of the primary school course. Much of the teaching in the upper classes of the primary schools is directed toward passing this examination. There are no other objective measures of the children's ability and achievement. Therefore, the teacher, who arms herself with some of Piaget's tasks, has at her disposal, useful tools for assessing the progress of the pupils. Besides, she might be convinced of the need for improving the child's approach to problems rather than the current practice of teaching specific details for the examination.

So much has been said about the role of the teacher that it is necessary to consider some aspects of the training of teachers. First of all, the academic background of many of the teachers is inadequate. It may, thus, be difficult for them to read Piaget's accounts, select and use relevant tasks. Therefore, they need some measure of training and help with the theory and practical demonstrations of the interview methods. Part of this training necessarily involves a way of looking at children. They are not "little wise men"; they are different from adults not only in size but in their approach to problems; they are not vessels into which knowledge can be poured but are actively engaged in interpreting their world.

In conclusion, Piaget's notions can be used as the basis for improving instructional methods, assessing children's abilities and for providing teachers with the much needed philosophy of teaching.

Implications for Research

This study has provided some information about research in Nigerian children's thinking, but many questions are raised.

The children in Nigeria show a lag in the development of more mature forms of thinking, as measured with Piaget's instruments. What does such a lag entail? Does it mean that the children who attain the abilities studied at a slower pace, cannot be trained to "catch up" with the faster ones, or to attain the level of functioning expected for their maturational stage? Do these children compensate in the personal, social and emotional aspects of development for the slowness in the cognitive areas?

Piaget's contention that conservation and other logical abilities develop concurrently has only been partially upheld. It was suggested that maturation allows for the capacity, and experiences influence the level of development of each ability. If such is the case, adequate training should smoothen out the uneveness in level of understanding of the different abilities.

Finally, there was an observation that children from the traditional homes performed more poorly than children from modern homes. The main difference between the groups is in the amount of modernizing influences to which they are exposed. Further research could analyze the aspects of these modernizing influences that aid the development of thinking. On the other hand, information could be collected on the specific cultural beliefs and practices that inhibit the development of thinking. In this regard, the observation that the traditional children attending the mixed schools, performed better than other traditional children, is relevant. More information could be provided. Schools could be carefully graded according to their teaching procedures, educational facilities they provide, teaching philosophy, and the performance of children within each category examined.

VI--SUMMARY

The aims of this study were to extend Piaget's research and to examine the relevance of Piaget's theories to aspects of Nigerian education.

Piaget's theory of cognitive development, and particularly, number concept were discussed. It was noted that Piaget's main aim is to uncover characteristics of mental structures in different stages of development. There are three such stages, namely, the sensori-motor stage, the stage of concrete operations, in which age seven is an important milestone and, the period of formal operations during which thought is most mobile and systematic.

It was pointed out that Piaget regards number concept as another aspect of logical thinking. Thus, the stages found in investigations of logical thinking are also to be found in the development of number concept. Moreover, the logical abilities of seriation and classification are essential for a true understanding of number. These are said to develop side by side. In dealing with the problems testing the understanding of these concepts, children manifest two strategies. The intuitive approach entails a centering on one aspect of the problem and a reliance on perceptual features. The operational child, on the other hand, considers relationship between objects.

The present study employed a standardized, individual interview schedule based on Piaget's tasks to investigate a series of questions in a group of Nigerian children.

Subjects were 110 Nigerian children from traditional and modern homes, which were selected on the basis of the educational level of the mothers. The children were six to eight years old, from the first three classes of seven elementary schools. The schools were classified on the basis of whether their pupils came from the more modern or the more traditional sectors of the Ibadan community. Three categories were used. Only children who spoke Yoruba as their mother tongue were included in the sample. Initial screening was done on the basis of the information collected by means of personal data sheets.

The Goodenough-Harris Drawing Test was used as a measure of the intellectual maturity of the subjects. This test and the number tasks were administered to the subjects in their schools.

Four questions were raised in the study. The first question related to Piaget's contention that conservation, seriation and classification developed concurrently. Another question examined the relationship of the development of number concepts to intelligence, as measured by the Draw-a-Man Test. The performances of children from modern and traditional homes were compared in an attempt to examine the effect of experience on the development of number concepts. Also, sex differences were examined.

There were nine subtests, four on conservation, three on seriation and ordination, and two on classification problems. Data were analyzed on the basis of patterns of performance.

In the main, Piaget's theories were upheld in the Nigerian sample. Analyses showed that the simultaneous development of conservation, seriation and classification was only partially upheld. There was slight relationship between intelligence and the performance on the number tasks. The children from modern homes performed better than those from traditional homes. Slight sex differences were noted with the boys showing an advantage at ages six and seven and the girls performing just as well as the boys at eight years of age.

The results of the study were discussed in relation to the effect of experience as highlighted by performance in a different cultural setting, and also, in relation to the different backgrounds of the children from modern and traditional homes. Children's explanations were also examined. It was noted that Piaget's methods could be fruitfully employed in Nigeria. Implications of the findings for research were discussed, and recommendations were made about improvement of instructional and assessment methods in the Nigerian schools. Piaget's notions could even be used as a basis for a philosophy of teaching.

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Appendix A

Interview Schedule

PART I--CONSERVATION

1. Orientation (put out 11 blocks)

A. Here are some blocks (igi)...I am going to put them on the table ...like this (place blocks in a row in front of child). That is your row of blocks. Here are some more blocks...(take 8 blocks from the box on the table), I am going to put them on the table too. This is my row of blocks. ARE THERE JUST AS MANY BLOCKS IN MY ROW AS IN YOUR ROW? (push box toward child). You take some more blocks and make my row have just as many blocks as your row.

B. (remove one block from child's row)

Now I am going to put one of these blocks in the box.

WHAT ABOUT NOW?

(HAVE YOU GOT JUST AS MANY BLOCKS AS I HAVE?)

(IS THERE ANY ROW THAT HAS MORE BLOCKS?)

C. (return the one block)

WHAT ABOUT NOW?

(ARE THERE JUST AS MANY BLOCKS IN THE TWO ROWS?)

(IS THERE ANY ROW THAT HAS MORE BLOCKS?)

D. (remove two blocks from interviewer's row)

WHAT ABOUT NOW?

(HAVE YOU GOT JUST AS MANY BLOCKS AS I HAVE?)

(ARE THERE MORE BLOCKS IN ANY OF THE ROWS?)

E. (return the two blocks)

WHAT ABOUT NOW?

2. <u>Tests</u>

A. (bunch the blocks in interviewer's row i.e. blue blocks)

Now I am going to do this to my blocks. WHAT ABOUT NOW?

(HAVE YOU GOT JUST AS MANY BLOCKS AS I HAVE?)

IS THERE ANY ROW THAT HAS MORE? If child says "not same"

ask WHICH IS MORE?

WHY DO YOU THINK SO?

Match both rows of blocks again.

B. (spread out blocks in child's row i.e. red blocks)

WHAT ABOUT NOW? (HAVE YOU GOT JUST AS MANY BLOCKS AS I HAVE?) IS THERE ANY ROW THAT HAS MORE? If child says "not same," ask WHICH IS MORE?

WHY DO YOU THINK SO?

C. (put away all blocks except 8)

Now I am going to leave these blocks on the table ...like this...arrange them quickly

```
 X X
x x x
 x x x
```

I WANT YOU TO TAKE JUST AS MANY BLOCKS AS I HAVE ON THE TABLE. HAVE YOU GOT JUST AS MANY BLOCKS AS I HAVE?

TELL ME HOW YOU DID IT?

D. (put out 10 paper cups)

Count how many cups I have on the table. HOW MANY?

I am going to give you some money and I want you to buy the cups from me. When you buy with one penny, I will give you one cup.

(After exchange, pile up cups and pennies)

CAN YOU TELL WITHOUT COUNTING HOW MANY CUPS YOU HAVE BOUGHT?

HOW DO YOU KNOW?

PART II--SERIATION AND ORDINATION

1. Orientation

A. (put out 5 blocks randomly)

I made houses from these blocks. HAVE YOU SEEN BLOCKS LIKE THESE BEFORE? DO YOU SOMETIMES PLAY WITH THEM?

Let us take these two (#2 and #4), they look alike but one is a little bigger than the other.

CAN YOU TELL ME WHICH ONE IS BIGGER? (encourage the child to slide the blocks together) ...After child has decided which one is bigger, place the smaller one to the left of Interviewer and the larger to the right.

B. (present block #3)

Where shall we put this one...IS IT THE BIGGEST ONE AND GOES HERE, OR THE SMALLEST ONE AND GOES HERE OR DOES IT GO HERE IN THE MIDDLE?

C. (similarly present blocks #1 and #5)

WHERE SHALL WE PUT THEM?

Now we have arranged them from the smallest to the biggest... Baba has the biggest house, Mama has the one that is next to it and the little baby has the smallest one.

2. Tests

A. (simple one row seriation--houses)

Place seven houses on the table.

NOW I WANT YOU TO ARRANGE THE HOUSES IN ONE LINE, like we did just now, FROM THE SMALLEST TO THE BIGGEST ONE.

B. (matched seriation--traders and bags of beans)

Place 7 dolls on the table, in a scrambled manner ...I WANT YOU TO ARRANGE THESE PEOPLE FROM THE BIGGEST TO THE SMALLEST ONE. You may put the biggest one here and the smallest one over there ...The men are going to carry these bags of beans (put out 7 bags of beans) to the market. The biggest man carries the biggest bag ...NOW ARRANGE THE BAGS OF BEANS SO THAT THE BIGGEST MAN CARRIES THE BIGGEST BAG AND THE SMALLEST MAN CARRIES THE SMALLEST BAG. (If the child does not arrange them correctly, the "I" arranges them in order of magnitude IMPERCEPTIBLY).

C. (ordination)

Let us count and make sure that there are still 7 men and 7 bags of beans. (Encourage the child to count.) The 3 smallest men are not going to the market today because they are not strong enough (or well enough). SHOW ME THOSE THAT WILL GO. (FO OWO KAN--TOUCH THEM)

SHOW ME THE FIFTH MAN.

If they are all, all of them now, (indicating with a hand gesture) going to the market, I know that the biggest man likes to walk in front ...SHOW ME THOSE THAT WILL FOLLOW

THE SEVENTH MAN. HOW MANY OF THEM? (encourage child to touch them) Push the bags together so that B#3 is before M#4 but B#7 is still in front of M#7 ...Then lift B#3 forward slightly and ask ...SHOW ME WHOSE BAG OF BEANS I HAVE LIFTED (Gbe--taken). (WHICH MAN WILL CARRY THIS BAG OF BEANS?)

PART III--CLASSIFICATION

1. Orientation (put out 3 circular, 3 triangular and 3 rectangular blocks. 2 of each are painted red while the third block in each set is white.)

   A. Here are some blocks different in shape and color, some are red, some are white; some are like tall buildings, some are round as the moon, and some are like small houses. I WANT YOU TO PUT ALL THOSE THAT ARE ALIKE TOGETHER.

   Encourage the child to handle and sort the blocks.

   B. (remove the rectangular blocks)

   Look at the blocks I now have on the table. ARE THERE MORE WHITE BLOCKS, MORE RED BLOCKS OR ARE THEY JUST THE SAME NUMBER? Count them if you want to. If necessary, encourage the child to separate white and red blocks.

2. Tests

   A. (put out 3 birds, 3 crocodiles, 3 ducks, 3 horses; one of each is painted in the following colors: yellow, pink, white.)

   Here are many animals that you know--horses, ducks, birds, crocodiles. I WANT YOU TO PUT ALL THOSE THAT ARE ALIKE

TOGETHER. After the child has arranged them, ask, ARE ALL THOSE THAT ARE ALIKE IN THE SAME PLACE? If answer is "no," repeat PUT ALL THOSE THAT ARE ALIKE TOGETHER. WHY HAVE YOU PUT THEM IN THESE (whatever the number of groups child made) GROUPS?

B. (put out on the table 5 red and 5 white, hard plastic chickens)

Here are some red and white chickens. Do you know what they are made of? Touch them and see. (encourage child to handle as many of the chickens as possible.) If child does not suggest a name for the material with which the chickens are made, tell him, "they are all made of okuta, (hard material like stone)" SHOW ME ALL THE RED CHICKENS. HOW MANY?

SHOW ME ALL THE WHITE CHICKENS. HOW MANY?

SHOW ME ALL THE PLASTIC (substitute appropriate name) CHICKENS. ARE THERE MORE WHITE CHICKENS, MORE RED CHICKENS OR ARE THEY JUST THE SAME NUMBER?

WHY DO YOU THINK SO?

ARE THERE MORE WHITE CHICKENS, MORE PLASTIC CHICKENS OR ARE THEY JUST THE SAME NUMBER?

WHY DO YOU THINK SO?

Appendix B

Recording Interview

Code No.________________________ Date________________________

Name of child____

Sex__________________________ Age__________________________

School____

Class__________________________

Interviewer________________________ Recorder________________________

Taped interview?________________________

Length of interview________________________

Time of day________________________

Child's fluency in Yoruba: fluent______________ Other______________

Child's attitude & other comments:

PART I--CONSERVATION

Orientation

Child understood throughout ____________

Prompting needed before child understood ____________

Doubtful child ever understood ____________

Other ____________

Tests

A. (bunched blocks)

What about now? ____________

Same ________ I more ________ S "more" ________

Why do you think so? ____________

Other ____________

B. (blocks spread out)

What about now? ____________

Same ________ I more ________ S "more" ________

Why do you think so? ____________

Other ____________

C.

Number taken ________ Correct pattern ________

Method child used ____________

Affirmation ____________

Tell me how you did it? ____________

Other ____________

D. (cups and seeds)

How many ________ After exchange, number given ________

How do you know? ____________

PART II--SERIATION AND ORDINATION

Orientation

Child understood throughout ____________________

Prompting needed before child understood ____________________

Doubtful child ever understood ____________________

Other ____________________

Have you seen these before ____________________

Do you sometimes play with them? ____________________

Tests

A. Biggest correct ____________ Smallest correct ____________

Nos. 2 & 3 correct__________ Method__________ Other__________

Nos. 4 & 6 correct__________ Method__________ Other__________

No. 5 correct__________ Method__________ Other__________

B. (dolls and traders)

No. of dolls correct__________ Method__________ Other__________

No. of bags correct__________ Method__________ Other__________

C. Show me those that will go ____________________

No. correct ____________________ Other__________

5th man ______________ Other____________________

Follower's correct ______________ Other______________

How many ______________.

Bag taken away, correct ______________ Other______________

PART III--CLASSIFICATION

Orientation

Understood throughout training ____________

Prompting needed before child understood ____________

Doubtful child ever understood ____________

Other ____________

Tests

A. (sorting--animals)

Type ______ Shape ______ Color ______ No. of groups ______

Other ____________

Affirmation ____________ Other ____________

Why ____________

B. (inclusive relations)

All the red ones, correct ______ Other ______

All white ones, correct ______ Other ______

All plastic, correct ______ Other ______

More white ______ More red ______ Same ______

Other ____________

Why ____________

More white ______ more plastics ______ Same ______

Why ____________

Other ____________

Appendix C

Personal Data Sheet

Name of child ....

Sex ....

Age .... Date of birth ....

School ....

Mother's occupation ....

Where does mother work? ....

What is last class mother passed in school? ....

What language does child speak in school? ....

What language does child speak at home? ....

How does child usually spend his time after school? ....

....

Where does child live? ....

What types of play materials does child use (a) at home ....

.... (b) in school ....

....

How many brothers .... Sisters ....

does child have? ....

Are any brothers and sisters older than child attending school? ......

.... How many? ....

About how many people live in the same house with the child? ....

....

Appendix D

Instructions for Categorizing Interview Data

PART I--CONSERVATION

There is an orientation section, which might be useful if the recording on the tests is unclear. Initially, the four tests in part one are scored separately but the final category will be determined by the child's pattern of performance in the section. Numerals 2, 1, 0 and an * are used to denote the categories described below.

Orientation

Understood throughout	2
Prompting needed before child understood	1
Doubtful that child ever understood	0
Insufficient evidence	*

Tests A & B (score separately)

In A and B, does the child maintain the notion that a rearrangement of blocks does not alter the original number and equivalence of the two sets of blocks? Can he adequately explain why this is so?

Definitely conserving 2

Child whose record indicates a "same" response is put in this group except his explanation falls into the "g" and "h" categories, in which case, he is classified with the partial conservers.

Categorize explanations as follows:[1]

a. use of counting and number e.g., "because there are 11 here and 11 there."

b. reference to previous correspondence, e.g., "because they were equal before you (bunched them."
(spread them out."

c. reference to observed action or present arrangement, e.g., "because you didn't take any away," "you only bunched yours."

d. reference to reversed situation, e.g., "if you arrange these in a straight line, they will be the same."

---

[1] It is permissible to look for explanation under another section if scorer feels that reason given does not fall into any of the categories listed.

e. reflecting appearance vs. reality, e.g., "it looks longer but they are really the same."

f. reference to two dimesnions of the problem, e.g., "this is merely bunched and the other is in a straight line."

Partially conserving 1

Child who initially indicates that there are "more" or that the two sets of blocks are "not the same" on the first question but shifts to "same" when asked to identify which is more.

Also, child who gives "same" response to "what about now" question, does not shift on the second question but whose explanation does not show that he really understand that this is so.

Categorize explanations as follows:

g. expressing conviction, e.g., "I know that they are equal" or simply "they are equal," without indicating why they are equal.

h. expressing inability to explain, "I don't know," "no reason."

For other explanations, look under categories for conservers and nonconservers.

Definitely not conserving 0

Child's response indicates that he thinks the two sets of blocks have become different in number, "they are not the same," "I have more," and orientation section record shows that he understood. In response to the "why" question, child's explanation relates to the appearance of things generally.

Categorize explanations as follows:

a. use of counting and number, e.g., "because there are 13 here and 11 there."

b. reference to observed action or present arrangement, e.g., "two were taken out of mine," "you took some of yours," "you put mine together."

f. reference to two dimensions of the problem, e.g., "this is round and the other is in a straight line." Note: "mine is longer and red," does not belong here. The score, in that case, would be a combination of "i" and "j."

g. merely expressing conviction, e.g., "I know that this is more," "I have more."

h. expressing inability to explain, e.g., "I don't know," "no reason," "nothing."

i. focus on only one aspect of the problem, e.g., "these are red," "they are many."

Insufficient evidence *

Children who make no response at all or whose records contain little and unclear information that cannot be categorized. If child's response to the "what about now" question can be categorized, then he does not belong here. If such a child does not respond to the second part, then his explanation subscript is omitted.

Test C

Here, the observer's record (written against "method child used") is only used if the child's explanation is not clear. Disregard description on correctness of pattern. Look for the ability to make a set corresponding in number to the given model - an arrangement of eight blocks.

Definitely conserving 2

a. Child picks 8 blocks and on the second chance he is given, maintains that he has an equivalent number. In his description of procedure, he shows evidence of counting or copying the pattern, e.g., "I took two, three, three to match the numbers in your rows," "I arranged them like yours."

b. Child who takes 7 or 9 and in the second chance he is given, corrects his error and is able to describe procedure as indicated in the previous paragraph.

Partially conserving 1

a. Child who takes 7, 8, 9 and maintains both on first and second chance that he has the correct number but is unable to describe adequately how he did it, e.g., "I got them from the box like you did."

b. Child who takes much more or less than the number required initially but on the second chance, he discovers his error and takes 8 irrespective of description given. Include here, those who take 8 and give a response such as that there is "no reason."

Definitely not conserving 0

a. child who cannot either on the first or the second trials take the correct number of blocks.

b. Also, child whose descriptions seem irrelevant.

Insufficient evidence *

No response could be elicited from the child and information on protocol is too little to place child in any of the other categories. If the child failed to respond to the desctiption alone and his other response can be categorized in any of the other sections, then he does not belong here.

Test D

Does the child's ability to count have any influence on his ability to conserve? After a "provoked" one-to-one correspondence, does the child maintain an equivalence of the numbers or does he depend on the appearance of the objects for his answers?

Definitely conserving 2

a. Can count up to 10 and give same number arrived at originally after the exchange has been made.
   Also, the explanation indicates that the numbers have not changed, "they are still 10," "I counted them before," "when you gave me one cup, I gave you one penny."

b. Children who count 9 or 11, if there appears to be a mistake in counting may be included here if the number given in the counting section is retained after the exchange.
   The explanation is as indicated in "a."

Partially conserving 1

a. Children who count but "forget" the number arrived at originally and assert that there are "just as many," after exchange.

b. Child who says 9, 10, 11 before and after exchange without being able to explain why. Include here those who respond correctly but give a "nothing" or "no reason" explanation, or merely assert equality of numbers.

Definitely not conserving 0

a. Children who cannot count to 10, who assign numbers to cups inappropriately or name numbers but in an incorrect order. Children who give any number two less or two more than 10.

b. Children who give different numbers for the questions before and after the exchange.

c. Children whose explanations seem irrelevant and they did not respond correctly on the counting section.

Insufficient evidence *

Records incomplete. Child refuses to respond or uses gesture language.

PART II--SERIATION AND ORDINATION

Does the child understand how to coordinate a series of relationships when several objects are compared? For instance, does he realize that the block #3 is bigger than #2 but smaller than #4? Can he keep to the numerical order of the objects so arranged?

Orientation

Understood throughout	2
Prompting needed before child understood	1
Doubtful that child ever understood	0
Insufficient evidence	*

Tests A and B (separate score for each test)

Definitely seriating 2

Child makes no misplacements irrespective of method used. *

Partially seriating 1

Child makes two misplacements, i.e., if two adjacent objects are interchanged (records may indicate 6 or 5 correct) irrespective of method used.

In B, child who makes correct placements either on the traders' row or on the row of bean bags but makes mistakes in arranging the second row, is placed in this category, irrespective of method used. That is, if the score is seven correct in one of the rows and any other score on the second row. Also, six or five correct in both rows, irrespective of method.

Definitely not seriating 0

More than two misplacements irrespective of method used.

Insufficient evidence *

Child does not perform the task and the records are definitely unclear.

Test C

Simply check the four responses as a, b, c, d separately. Where the question has two parts as in "c," both parts have to be correct, e.g., there must be a check sign for "followers correct" and the child has to give the correct number, "six."

Definitely ordinating 2

a. All responses correct.

b. Last response correct and two other responses.

Partially ordinating

Last response and one other correct. Last question incorrect but a, b, c correct.

Definitely not ordinating 0

Last response and at least one other incorrect.

Insufficient evidence *

Incomplete records. No response from child at all.

PART III--CLASSIFICATION

Here, the interest is in whether the child can form logical groups and understand inclusive relations such as a set of white chickens being part of a larger set of plastic chickens.

Orientation

Understood throughout	2
Prompting needed before child understood	1
Doubtful that child ever understood	0
Insufficient evidence	*

Test A

Definitely able to sort 2

a. Child uses a single, observable criterion to group objects, e.g., color, type, shape. If child sorts on the basis of color, there should be three groups; if type, there should be four groups. That is whatever the criterion, the sorting must be consistent with only that criterion.

b. Also, for explanation, child shows an understanding that members of each group share a similar property, e.g., "these are all the same color," or else, child explains how the groups differ. "There are ducks here, horses, birds and crocodiles" is an example. Partially correct explanations, e.g., "they are the same" or "there are three in each group" to be included here.

Partially able to sort 1

a. Child able to sort completely using one observable criterion but when asked for affirmation, he shifts to another criterion, e.g., type--four groups.

b. Child who is able to sort but cannot adequately verbalize the basis for sorting, e.g., "you asked me to do it."

c. Sorting not quite clear but reason is explicit, e.g., "they are different animals in each group."

d. Child unable to sort on the first attempt but sorts properly on the second chance, irrespective of explanation given.

Definitely unable to sort 0

Child responds but makes no observably logical groups at all and does not give what seems like a logical reason for action, or gives no reason at all.

Insufficient evidence *

No response and the records unclear.

<u>Test B</u>

First check the identification responses to find out whether the child understands and can identify each of the groups--red, white, plastic--used in later questions.

Definitely understands inclusive relations 2

a. Groups correctly identified <u>and</u>

b. Child states that groups of white and red chickens are equivalent because he counted them or "they are five each." <u>And</u>

c. Child understands that there are more plastic than white chickens with an adequate explanation such as, "they are all plastic but only five are white."

Partially understands inclusive relations 1

a. Groups correctly identified <u>and</u>

b. Child gives "same" response for the question on red and white chickens and can explain his judgment. Also, such a child vacillates between "same" and "more" response on the inclusive relations question, irrespective of explanation given.

c. child who correctly answers the other questions, asserts "more" for the inclusive relation question but cannot adequately explain his judgment.

d. child who gives "same" answer to the last two questions but whose explanations indicate an awareness that the red and white are equal, but the plastics are more than either subgroup, whatever the cue the child uses, e.g., that there are "more" because the chickens all have the "same sound."

Definitely does not understand inclusive relations 0

a. child's identification responses correct and

b. child gives "same" response to the last two questions without adequate explanations. Child who responds correctly when asked about the comparison of red and white chickens but is completely unable to understand either in reply to the inclusion question or in explanation that the plastic chickens are more than the white.

c. child asserts "more" white or red and also does not correctly respond to the question on inclusion.

Insufficient evidence *

Child who makes no response at all or whose record is unclear so that he cannot be justifiably included in any of the other categories. Child whose record on the orientation indicates that he did not understand and such a child could not identify the groups of chickens.

Appendix E

Table 14

Seriation and Ordination Abilities Revealed

by Children Reared in Modern Homes

Performance on Task	Seriating on B	Not Seriating on B	Total
Seriating on A	37	14	51
Not Seriating on A	0	4	4
Total	37	18	55
	Ordinating on C	Not Ordinating on C	Total
Seriating on A	17	34	51
Not Seriating on A	0	4	4
Total	17	38	55
	Ordinating on C	Not Ordinating on C	Total
Seriating on B	17	20	37
Not Seriating on B	0	18	18
Total	17	38	55

Table 15

Seriation and Ordination Abilities Revealed

by Children Reared in Traditional Homes

Performance on Task	Seriating on B	Not Seriating on B	Total
Seriating on A	19	16	35
Not Seriating on A	2	18	20
Total	21	34	55
	Ordinating on C	Not Ordinating on C	Total
Seriating on A	9	26	35
Not Seriating on A	3	17	20
Total	12	43	55
	Ordinating on C	Not Ordinating on C	Total
Seriating on B	8	13	21
Not Seriating on B	4	30	34
Total	12	43	55

Table 16

Classification Abilities Revealed by Children

Reared in Modern and Traditional Homes

Performance on Task	Classifying on A	Not Classifying on A	Total
	Modern Group		
Classifying on B	2	1	3
Not Classifying on B	34	18	52
Total	36	19	55
	Traditional Group		
Classifying on B	2	0	2
Not Classifying on B	28	25	53
Total	30	25	55

Table 17

Relation of Conservation and Seriation Tasks--Modern Group

Performance on Task	Seriating on A	Not Seriating on A	Total
Conserving on D	44	4	48
Not Conserving on D	7	0	7
Total	51	4	55
	Seriating on B	Not Seriating on B	Total
Conserving on D	33	15	48
Not Conserving on D	4	3	7
Total	37	18	55
	Ordinating on C	Not Ordinating on C	Total
Conserving on D	16	32	48
Not Conserving on D	1	6	7
Total	17	38	55
	Seriating on A	Not Seriating on A	Total
Conserving on C	30	0	30
Not Conserving on C	21	4	25
Total	51	4	55
	Seriating on B	Not Seriating on B	Total
Conserving on C	21	9	30
Not Conserving on C	16	9	25
Total	37	18	55

Table 17 cont.

Performance on Task	Ordinating on C	Not Ordinating on C	Total
Conserving on C	12	18	30
Not Conserving on C	5	20	25
Total	17	38	55
	Seriating on A	Not Seriating on A	Total
Conserving on AB	25	1	26
Not Conserving on AB	26	3	29
Total	51	4	55
	Seriating on B	Not Seriating on B	Total
Conserving on AB	20	6	26
Not Conserving on AB	17	12	29
Total	37	18	55
	Ordinating on C	Not Ordinating on C	Total
Conserving on AB	9	17	26
Not Conserving on AB	8	21	29
Total	17	38	55

Table 18

Relation of Conservation and Seriation Tasks--Traditional Group

Performance on Task	Seriating on A	Not Seriating on A	Total
Conserving on D	32	13	45
Not Conserving on D	3	7	10
Total	35	20	55
	Seriating on B	Not Seriating on B	Total
Conserving on D	19	26	45
Not Conserving on D	2	8	10
Total	21	34	55
	Ordinating on C	Not Ordinating on C	Total
Conserving on D	10	35	45
Not Conserving on D	2	8	10
Total	12	43	55
	Seriating on A	Not Seriating on A	Total
Conserving on C	21	7	28
Not Conserving on C	14	13	27
Total	35	20	55
	Seriating on B	Not Seriating on B	Total
Conserving on C	15	13	28
Not Conserving on C	6	21	27
Total	21	34	55

Table 18 cont.

Performance on Task	Ordinating on C	Not Ordinating on C	Total
Conserving on C	9	19	28
Not Conserving on C	3	24	27
Total	12	43	55
	Seriating on A	Not Seriating on A	Total
Conserving on AB	12	2	14
Not Conserving on AB	23	18	41
Total	35	20	55
	Seriating on B	Not Seriating on B	Total
Conserving on AB	7	7	14
Not Conserving on AB	14	27	44
Total	21	34	55
	Ordinating on C	Not Ordinating on C	Total
Conserving on AB	5	9	14
Not Conserving on AB	7	34	41
Total	12	43	55

Table 19

Relation of Seriation and Classification Tasks--Modern Group

Performance on Tasks	Classifying on A	Not Classifying on A	Total
Seriating on A	35	16	51
Not Seriating on A	1	3	4
Total	36	19	55
	Classifying on B	Not Classifying on B	Total
Seriating on A	3	48	51
Not Seriating on A	0	4	4
Total	3	52	55
	Classifying on A	Not Classifying on A	Total
Seriating on B	27	10	37
Not Seriating on B	9	9	18
Total	36	19	55
	Classifying on B	Not Classifying on B	Total
Seriating on B	2	35	37
Not Seriating on B	1	17	18
Total	3	52	55
	Classifying on A	Not Classifying on A	Total
Ordinating on C	11	6	17
Not Ordinating on C	25	13	38
Total	36	19	55
	Classifying on B	Not Classifying on B	Total
Ordinating on C	1	16	17
Not Ordinating on C	2	36	38
Total	3	52	55

Table 20

Relation of Conservation and Classification Tasks--Traditional Group

Performance on Tasks	Classifying on A	Not Classifying on A	Total
Conserving on D	28	17	45
Not Conserving on D	2	8	10
Total	30	25	55
	Classifying on B	Not Classifying on B	Total
Conserving on D	2	43	45
Not Conserving on D	0	10	10
Total	2	53	55
	Classifying on A	Not Classifying on A	Total
Conserving on C	18	10	28
Not Conserving on C	12	15	27
Total	30	25	55
	Classifying on B	Not Classifying on B	Total
Conserving on C	1	27	28
Not Conserving on C	1	26	27
Total	2	53	55
	Classifying on A	Not Classifying on A	Total
Conserving on AB	9	5	14
Not Conserving on AB	21	20	41
Total	30	25	55
	Classifying on B	Not Classifying on B	Total
Conserving on AB	0	14	14
Not Conserving on AB	2	39	41
Total	2	53	55

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