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THE COGNITIVE DEVELOPMENT OF KENYA AFRICAN CHILDREN AS SHOWN BY THEIR PERFORMANCE ON SELECTED PIAGETIAN TASKS OF CONSERVATION

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By
Ruth Wayua Mwangangi, B.S., M.S. in Ed.

* * * * *

The Ohio State University
1974

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CHAPTER I
INTRODUCTION TO THE PROBLEM

In recent years, openness in education has become a key concept in the education of young people. Such phrases as "open education", "integrated day", "Leicestershire model", and "activity-centered learning" are used to describe an educational approach which aims at providing more freedom and less authoritarianism in the classroom. Advocates of "open education" stress an environment of manipulative materials, choice for students, and flexibility in the use of time, space and materials. Once again the child has become the focus of attention in education. The essential concept behind open education is that children are unique individuals whose learning needs can be met only in a free, active atmosphere where each child can pursue his particular interests and learning needs as they arise.

Many of the ideas of open education are put into practice in the so-called "open classroom" where the child is honored as an active agent in his own learning. Emphasis is on the interaction between the learner and his environment, and teachers are free to plan with the children as they see fit. In the open classroom, children are provided with choices and options of what to do. There is a willingness to make
curriculum relevant to the children's needs. Ideas from some of the British Infant Schools with their reliance on Piagetian principles and insistence on concrete operations are being used in the open classroom (Frazier, 1972). The role of the teacher has become one of facilitating the processes and conditions through which the learner may discover the solution on his own.

The philosophy of open education has support from many sources, including the works of such people as Rousseau, Froebel, Montessori, Dewey, and Piaget. In his book *Emile*, Rousseau emphasizes the importance of learning from experience. Speaking of *Emile*, Rousseau states, "Whatever he knows, he should know not because you have told him, but because he has grasped it himself. Do not teach him science: let him discover it." (Rousseau, in Boyd’s translation of *Emile*, 1969 p. 73).

Dewey’s pragmatic approach to experience emphasizes the learner's self-involvement in the process of reconstruction of meanings from his experience. According to Dewey, children learn best by involving themselves in real situations and by doing real things. For him, experience is truly an experience only when objectives and conditions are subordinated to what goes on in the mind of the individual who is having the experience. (Dewey, 1917)

From Froebel, open education has gained the idea that play is the learning vehicle for the young child. Montessori,
with her wealth of medical and clinical knowledge, alerted educators to the importance of materials and surroundings for structuring the learning of young children.

However, in the opinion of this investigator, the writings and research findings of Piaget, the Swiss psychologist, have made the greatest impact on open education today. Hunt has described Piaget as the Giant of Developmental Psychology (Hunt, in Elkind and Flavell, 1969).

Piaget is essentially a genetic epistemologist. For more than forty years, Piaget has studied the nature of knowledge and the cognitive development of children and adolescents. His efforts have been centered upon the task of uncovering and explaining some of the basic phenomena of the origin and nature of knowledge, as well as the intellectual, physiological, and development of children and adolescents. His theory has helped educators become aware of ways in which a child views his world. It has helped teachers use more discovery types of teaching and to become aware that children need a rich environment in which they can manipulate objects and ideas. Piaget's theory implies that the individual need not only interact with objects but also with other individuals around him so that he has opportunity to test his knowledge, to question it, and to change his mental structure if necessary. In his "clinical method", Piaget has set an example of how teachers can use questions to find out how children think.
The developmental psychology of Jean Piaget has not only made a great impact on education, but has offered cross-cultural cognitive psychologists an alternative way of studying the cognitive development of children. According to Piaget, cognitive development consists of a progressive structurization whereby actions and intellectual operations become organized into coherent systems. Piaget has posited that a succession of more complex and adaptive skills are built up from the initial sensory-motor flexes of the newborn, through the impact of environmental stimulation on the maturing nervous system and through the infant's active exploration and experimentation. A series of stages through which different children progress at different rates can be recognized in the child's actions, perception, speech, and thinking. Piaget distinguishes four stages of development: sensorimotor stage, pre-operational stage, concrete-operations, formal operations.

Sensorimotor Development. (0-2 yrs.)

Piaget considers this stage to be very important in the development of the child, "for it is during this time that the child constructs all the cognitive substructures that will serve as a point of departure for his later perceptive and intellectual development..." (Piaget and Inhelder, 1969 p. 3). During the early part of this period, objects have no permanence to the child. For instance, if the infant were playing with an object and it slipped from his hands and
dropped out of sight, the infant would not look after it but might attend to something else. To the infant, it is as though something that is out of sight has no existence.

Toward the end of the first year, however, the infant begins to seek after objects that have disappeared and thus gives evidence that he now attaches permanence to things that are no longer present to his senses. He also shows evidence of trying to solve his problems mentally before he acts. The child begins to anticipate the results of his actions. For instance, he pushes a toy off the tray of his chair and then looks at the floor where it has fallen.

The Pre-Operational Stage (2-7 yrs.)

In Piaget's view, this period is marked by the emergence of what he calls symbolic function or true systems of representation such as language. The acquisition of language increases rapidly in the third year and symbolic play appears. A child engages in symbolic play, for example, when he calls a stone a turtle. Thinking at this stage is limited to the particular state of the situation considered. The child centers upon one feature of an object or a situation at a time. He is unable to relate one problem to another in the same situation. He sees the world only from his own point of view.

The Concrete-Operational Stage (7-11 or 12 yrs.)

At this stage actions become interiorized thought operations which, when fully coordinated, are structured in the
form of reversible systems of logical operations. These are the operations of classification, ordering, the construction of the idea of number, spatial and temporal operations and the operations of logic of classes and relations. Even though the child can reason about concrete things, he has difficulty in reasoning about verbal propositions.

**Formal Operations. (11 or 12 onwards)**

The child at this stage can deal with many variables simultaneously. He becomes capable of reasoning correctly about propositions that he considers pure hypotheses. He is able to "draw conclusions from truths which are merely possible, which constitutes the beginning of hypothetico-deductive or formal thought." (Piaget and Inhelder, 1969 p. 132)

While these stages do not follow a rigid chronological timetable, the sequence in which they appear is assumed to be virtually universal. Piaget and his followers are not interested in the score on a test, but attempt to describe the basic structures and processes which mediate the transition from one stage of development to another. This knowledge of the child's intellectual development has led cross-cultural psychologists to seek to determine whether the properties of thought described by Piaget and his followers are basic to any knowledge, that is, are universal, or whether they are influenced by cultural factors.
The age range of 6 to 11 years encompasses the establishment of what Piaget calls "operational" intelligence. The main feature of this stage is the construction of invariants of quantity, weight, volume, length, area, et cetera, of objects despite alteration of their perceptual aspects. It is during this time that the stable concepts of space, time, relations, classes, and combinations become available to the child, and it is primarily the operational use of these concepts that constitute the bases of general knowledge and intelligence (Furth, 1970). One of the child's most surprising achievements during this period is the mastery of the so-called "conservation problems".

The concept of conservation is important in Piaget's theory of development. It marks the beginning of logical thinking and the transition from a pre-operational to an operational level of thought. In Piaget's view, a child's thinking is largely dependent on perception from 4 to 7 years of age. At this stage thinking tends to be determined by the child's "centering" on one aspect of the situation and ignoring other aspects. But from the age of 7 or 8 years, the child is able to break away from his dependence on perception. He becomes increasingly able to apply logical thought to practical problems and concrete situations. The important aspect of the achievement of conservation seems to be the ability to attend to the invariant features of the problem without being misled by conflicting and irrelevant
perceptual cues. For instance, if one of two equal balls of clay is flattened into a pancake shape, the child who has achieved conservation will know that there is the same amount of clay in the pancake as there is in the ball, whereas, a child who is a nonconserver will probably attend to the different shape and say there is more clay in one shape than in the other.

The concept of conservation has been taken as "one of the main criteria for the achievement of Piaget's stage of concrete operations" (De Lemos, 1969). Perhaps because of this, considerable research attention has been directed to conservation problems. Many replication studies of Piaget's and Inhelder's findings have been carried out on children of West European origin; however, relatively few studies have also been reported on children from other cultural backgrounds.

In most cases, a chronological retardation in the development of conservation has been reported among children of non-western cultures (Price-Williams, 1962; Greenfield, 1966; Mohseni, 1966; Za'rour, 1971; and Bovet, 1968, 1971). However, a few authors have found no difference in performance between children from some non-western cultures and children from western cultures. Price-Williams (1961) found no difference in performance between the Tiv of Central Nigeria and European children. By the age of 7-6 to 8-6, all subjects had acquired the conservation of continuous quantity (earth), discontinuous quantity (nuts) and number. Price-
Williams worked with materials that were familiar to the subjects.

In a study by Goodnow (1962), Europeans in Hong Kong, "average" Americans, and Chinese of low socio-economic status and almost no schooling, were almost indistinguishable for conservation of amount, weight and volume, Mohseni (1966) found that school children in Teheran developed conservation of quantity, weight and volume at approximately the same time as Europeans.

Similarly, Okonji (1970) showed that when children were tested on familiar materials, no differences were found between a western and a non-western sample in classificatory attitude. Deregowski and Serpell (1971), too, found that Zambian children did not differ significantly from Scots on re-sorting of toys.

Cross-cultural research has not been restricted to verifying Piaget's stages. Research has also been done on factors affecting operational development. According to Piaget, four factors are interacting in enabling the child to acquire progressively more complex structures of thought. These factors are: maturation, experience, educational and cultural transmission, and equilibration.

**Maturation**

Piaget claims that maturation takes part in every transformation that takes place during a child's development. However, this does not explain everything about the child's
cognitive development "because the average ages at which these stages appear (the average chronological ages) vary a great deal from one society to another." (Piaget, in Ripple and Rockcastle, 1964, p. 10). Apart from this, there is very little known about the maturation of the nervous system beyond the first 2 years of life.

Experience

Piaget distinguishes two types of experiences. One is what he calls physical experience which consists of acting upon objects and drawing some knowledge about the objects by abstraction from the objects. The other he calls logical-mathematical experience where the knowledge is not drawn from the objects, but it is drawn by the actions effected upon the objects. This type of experience is necessary before there can be operations. However, once the operations have been attained, this experience is no longer needed.

Educational and Cultural Transmission

This is the result from exchanges, discussions, agreements and oppositions in social intercourse between children or between children and adults. This factor is insufficient in explaining intellectual development because the child can receive valuable information via language or via education only if he is in a state where he can understand this information. To receive the information, he must have a structure which enables him to assimilate this information.
**Equilibration**

Piaget considers this factor to be a fundamental one in development. The reason for this is that in the act of knowing, the subject is active, and when faced with an external disturbance, he will react in order to equalize the "balance" between external stimulation and his capacity to internalize it. Consequently the individual will tend towards equilibrium. The process of equilibration takes the form of a succession of levels of equilibrium. That is, it is not possible to reach the second level until equilibrium has been reached at the first level and so on. Piaget considers this self-regulation process to be a fundamental factor in the acquisition of logical-mathematical knowledge. However, equilibration by itself, cannot function without the other three factors already mentioned.

It is evident then, that the constant interaction of these four factors makes it difficult to examine each one of them independently. In any research concerned with the various influences on operational development, more than one of Piaget's four factors could be involved at any one time. Thus, in the past, cross-cultural research has concentrated on assessing only two kinds of influence on cognitive development: education and cultural transmission, as well as experience.

On the basis of studies by Goodnow (1962), Kelly (1970), and Heron (1971), it is generally believed that there is no
direct relationship between the development of concrete-operations and western-type schooling. However, in a study of Wolof children in Senegal, Greenfield (1966) found that schooling was one of the principal cultural influences on operational development. Greenfield's subjects were rural unschooled children, rural school children, and urban school children. She found that only 50 percent of the unschooled children attained conservation by the age of 9. The rural school children tended to do better than the urban school children. These results Greenfield attributed to the disrupting influences of recent urbanization. However, Greenfield does not clarify what these disrupting influences are.

More important than schooling seems to be the contact with western cognitive values and stimulation which schooling brings with it. European contact, however, is difficult to define precisely. It seems to be associated with the urban/rural differences (Greenfield, 1966) and with social class (Lloyd, 1971). In her study of Yoruba subjects from traditional (Oje) and educated (Elite) homes, Lloyd found an overall Elite superiority in test performance of children between 3 and 5 years of age.

All authors report significant differences in the rate of operational development in favor of the high European contact groups, even when schooling, urbanization, language, and social class are held constant. The difference appears
to be due to the length of contact and to the extent to which traditional values and activities have been retained.

Another factor influencing operational thinking is that of perception. The field of perception offers the most reliable data on cross-cultural differences in illusion susceptibility, pictorial depth perception, diagonality, and color-form preferences. The differences obtained between the performance groups of different cultural settings are substantial. Unfortunately, there have been very few research studies on perception conducted with children as subjects. Two such studies by Munroe and Munroe (cited in Olson, 1970) examined the effects of two East African cultures on the development of children's ability to construct the diagonal. To this end 143 children of the Logoli and Kipsigis tribes in Kenya were tested. The authors found that the general life experiences of the children in the physical world appeared to have an important effect on this development. The Logoli children who had done a large amount of exploring and finding their way around in geographical space performed better than children with less experience of this type. The Munroes also noticed a large sex difference in Logoli children's ability to copy the diagonal. There was a marked superiority in performance of boys over girls. This could be attributed to the fact that boys spend their time looking after cattle and exploring the land while girls are
expected to stay at home to assist adults in the care of siblings.

Okonji (1969) found similar results in a study of urban and rural young adults in Nigeria. The aim of his study was to investigate the consequences of differences in techniques of child-rearing usually observed among parents in rural and urban environments on the development of cognitive styles among their children. His subjects were 208 adults and adolescents of both sexes, including 46 male and 30 female undergraduate students at Nsukka and 99 adult males and females and 33 school boys and girls from Ibusa.

Okonji compared the university students with students in a New York university. The results indicated that on the whole, Nigeria University students from urban settings performed as well as university students in New York. The University of Nigeria rural males were not significantly more field-independent than the New York females.

The results of most studies reviewed here seem to show that, among factors influencing cognitive development, cultural ones may be more important than had previously been hypothesized. However, very little is known about the cultural factors that may so significantly influence cognitive development.
Significance of the Study

A large number of descriptive studies have recently clarified the cross-cultural validity of Piaget's theory. However, a great deal of further quasi-experimental research is needed to link qualitative and quantitative aspects of operational development to specific cultural factors. Nevertheless, it should be kept in mind that different cultures provide their members with different experiences because of the widely varying conceptual systems they possess. Also, different cultures, as reflected in their language, draw conceptual and linguistic distinctions in radically different ways. It is not surprising, therefore, that the rate and course of intellectual growth should show considerable cross-cultural variation when measured against the yardstick of the Piagetian stages, which imply mastery of concepts central to western culture. But it is difficult at the same time to see how non-western cultures, and especially African cultures can achieve the high standard of living to which they aspire without assimilating large portions of the western conceptual system.

In Sub-Saharan Africa, where until recently, very little basic research into psychological problems and especially problems related to cognitive development has been done, there is a great need for research data describing in detail the cognitive capability of elementary school children so
that curriculum innovations may be more rationally based. There is also a need to find out how other cultures view their world and how this affects their cognitive development. It should be possible to apply this knowledge to the educational needs and problems of developing countries.

It is hoped that this study will point out some of the cultural factors that may affect cognitive development of children in Kenya. People in the developing countries where knowledge and utilization of natural resources have remained almost static over the past several centuries, now recognize that they must move into the era of science and technology in order to improve their standard of living. Hopes of achieving higher standards of living seem to depend directly upon the ability of the country to train the personnel it needs at all levels of administration, commerce, and industry. This cannot be done without education. Throughout the world, the explosion of scientific knowledge and the demand for qualified manpower is causing educators and teachers to reexamine the content of syllabi and teaching methods. In developing countries where mass education even for elementary-school-age children has not yet been introduced, the problems of teaching are even more acute. Hopefully, then, implications from this study will be of use to those concerned with the education of young children in Kenya.
Statement of the Problem

According to Piaget, the stages of development and their order of succession should be invariant, since these are determined by biological structures and functions that are independent of the environment. However, the rate of development would be determined by the child's interaction with his environment so that social and cultural factors may influence the age at which stages are achieved.

The purpose of this study is to determine what empirical links may be present between cognitive development and environmental factors in the child's development. The aim of this study is not merely to find out at what age Kenyan children attain conservation or how they compare with children of western cultures, but also to find out what differential effects (if any) conditions in the child's home and school background may have on his performance. This researcher attempts to find out something about how the culture in which the child lives affects his way of looking at the world. The study is conducted in Kenya where the subjects are African children of primary-school age.

Hypotheses

In view of the evidence found in the research literature, the following hypotheses are tested by this study:

H_{01}. There is no significant difference at the .05
level between the performance of Kenyan rural school children and city school children on conservation tasks using clay.

\( H_02 \). There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on conservation tasks using water.

\( H_03 \). There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on conservation of number.

\( H_04 \). There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on conservation of area.

\( H_05 \). There is no significant difference at the .05 level between the performance of Kenyan boys and the performance of Kenyan girls on conservation tasks.

\( H_06 \). There is no significant difference at the .05 level between the performance of older Kenyan children and younger Kenyan children on conservation tasks.

\( H_07 \). Of the following independent variables, there is no one variable or combination of variables which is a predictor of children's performance on conservation
tasks:
1. Father earning wages
2. Mother earning wages
3. Type of house
4. Chores done before and after school
5. Number of siblings
6. News media in the home

In relation to these hypotheses, the investigator will attempt to answer the following questions:

1. Do rural school boys perform as well on conservation tasks as do city school boys or city school girls?

2. Do rural school girls perform as well on conservation tasks as do city school girls or city school boys?

3. When categorized by chronological age (6-7½ years, 7½-8½ years, 8½-9½ years, 9½-10½ years), is there any difference in performance on conservation tasks between children of adjacent age levels; for example, do 6-7½ year-old children perform as well as 7½-8½ year-old children?

4. Do the children from the more expensive city schools perform better on conservation tasks than children from the low cost city schools?

5. Do Kenya African children attain conservation at ages comparable to those of children from western cultures?

6. Does the number of years that Kenya African children have spent in school affect their performance on conservation tasks?

Overview of Design

The techniques of investigation in this study derive from Piaget's work. The design used is basically that of
comparative survey. However, an analysis of variance is used to determine the statistical significance in the variability of the data collected. The subjects in the study are all African children randomly selected from 10 rural schools in Machakos district and 10 city schools in Nairobi.

**Definition of Terms**

In order for the reader and the writer to share a similar frame of reference, the following terms are defined as they are used in this investigation:

- **Non-Conserver**—This term is used to refer to the child who is unable to see the invariance of substance, number, and area after one or two transformations.

- **Transitional Conserver**—This term is used to refer to the child who is able to see the invariance of substance, number, and area after transformations, but who is unable to justify his answers.

- **Conserver**—This refers to the child who sees invariance of substance, number, and area after transformations and can justify his answers.

- **Rural Schools**—These are situated at least 20 miles from Machakos, the principal town in the district of Machakos. These schools are characterized by poor facilities (buildings, desks, writing and reading materials, et cetera) and sometimes by poor teaching methods (mostly rote memorization).
City Schools--The Nairobi schools comprise three types of schools which reflect the socio-economic status of the parents of the school children. These types of schools are:

(a) Low-Cost Schools. These are schools attended by the children of the low socio-economic status parents. The children in the low-cost schools pay smaller school fees than children attending the other types of schools in the city.

(b) Middle-Cost Schools. These are the former Asian schools that are now integrated. It is believed that the facilities and teachers in these schools are better than those in low-cost schools. Also the children in these schools pay three times as much school fees as children in the low-cost schools.

(c) High-Cost Schools. These schools are the former European schools. It is generally agreed that they are the best schools in the city in terms of facilities, materials and teachers. The children in these schools pay 10 times the amount of school fees that children in the low-cost schools pay.

All schools selected are either fully or partially maintained by the Nairobi City Council.
Assumptions and Limitations

The following assumptions are made in this investigation:

1. That the investigator is adequately prepared to interview children using Piagetian tasks.
2. That the subjects in this study were of normal intellectual capabilities.
3. That the data collected are analyzed by appropriate statistical procedures.
4. That schools and children were representative of the school populations from which they were selected.

Limitations

This study was limited by the following:

(a) Language.

The child's mother tongue was used except in situations where the examiner did not know the child's language. In these cases interpreters were used in interviewing the children.

(b) Time Limit.

Because of the limited time for data collection, the researcher might not have been able to gather all the relevant information concerning the child's background.

(c) High-Cost Schools.

The small number of children from the High-Cost Schools (in this case only 8) makes it difficult to make generalizations from the data.
(d) Selection of Rural Area.

Because of differences in tribal languages, the investigator selected her own tribal area for the study. This might be a limiting factor since rural life might differ in other parts of Kenya.

Summary

In this chapter, the theoretical basis for the study was cited with the brief literature review of cross-cultural research done in the area of conservation. The problem to be studied was identified and the rationale for it was presented. Also presented were the hypotheses to be tested, the definition of terms used in the study, and the assumptions and limitations of the study.

The next chapter, chapter two, deals with a detailed review of literature related to Piagetian tasks of conservation. Literature related to child development and environmental and social factors influencing child development will be cited.
In Chapter I, a brief review of literature related to cross-cultural research in the area of conservation was presented. This chapter deals with a detailed review of literature related to Piaget's tasks of conservation and cross-cultural research. The chapter is divided into three sections:

1. Validation Studies of Piaget's Concept of Conservation
2. Environmental and Social Factors Influencing the Child's Intellectual Development
3. Cross-cultural Studies in Conservation

As a preface to the review of literature, it seems pertinent to outline some key concepts related to Piaget's notion of conservation. These concepts are: operation, thought processes underlying conservation, and the three stages in the development of the concept of conservation.

**Operation**

Piaget maintained that the idea of operation is central to knowledge. To Piaget, "knowledge is not a copy of reality" (Piaget, 1964, p. 8). An individual comes to know an object not by just looking at it and making a mental
"picture" of it, but by acting on, modifying, and transforming the object. Only by doing all this does the person come to understand how the object is constructed. An operation then is an internalized action which modifies the object of knowledge. Piaget further explained, "for operations to exist, these actions must become reversible and capable of being coordinated into integral structures." (Piaget, 1967, p. 82).

Thus, a child confronted with a conservation task must mentally transform the data he sees and organize the data in the solution of the problem at hand. For instance, when asked if a liquid in two differently shaped glasses is equal, an individual must either mentally reverse the action of pouring the liquid from one glass to the other or attend to the compensatory aspects of the two shapes; that is, he must see that the height of the column of liquid in the tall thin glass compensates for the width in the short glass.

Thought Processes Underlying Conservation

The child at the concrete operational stage utilizes certain thought processes in deducing conservation. These processes are reversibility, identity, and compensation. The criteria used by Piaget and his collaborators in deciding whether the child is a conserver are that: (1) the child sees the invariance of substance, volume, weight, et cetera, after transformation and (2) the child
justifies his answer by using the notion of reversibility, compensation and identity. Compensation refers to the fact that in a transformation, quantity does not change. For example, if a ball of plasticine is rolled out into a sausage shape, it becomes longer but thinner. Identity refers to the fact that another ball of plasticine that had not been rolled out can be rolled out into a similar sausage as the already altered piece.

Piaget considered reversibility to be a key concept in conservation. By the term reversibility, he meant that a transformed object can be returned to its original state. That is, the action of transforming an object can be reversed. A child uses this concept when he says that the sausage in the experiment can be rolled back into a ball.

Lovell and Ogilvie (1960) questioned the significance of reversibility as a necessary and sufficient condition for conservation performance. In their study of conservation of substance, they found 27 of the 322 children they interviewed to be aware of the concept of reversibility and yet these subjects still failed to conserve.

Three Stages in the Development of the Concept of Conservation

In the attainment of the concept of conservation, Piaget stipulated a three-stage development of understanding: no conservation, "on and off" sort of conservation, and a logically certain conservation stage. This writer
has named these stages non-conservational, transitional, and conservational.

In the first stage, the child shows no evidence of conservation. He centers his attention upon certain perceptual cues and ignores others. For example, he tends to think the water in the tall thin glass is more than that in the wide shorter glass. He attends to the height of one glass and ignores the width of the other one. This child then will not conserve until he is able to coordinate both the height and the width of the containers in arriving at his judgment.

In the transitional stage, the child tentatively shows conservation for some transformations but denies it for others. According to Piaget, this second stage is not necessarily found in all children (Otaala, 1973).

In the third stage, the child asserts conservation in the case of all transformation for the type of quantity concept in question. Piaget stated that "there always comes a time (between 6 1/2 years and 7 years 8 months) when the child's attitude changes: he no longer needs to reflect, he decides, he even looks surprised that the question is asked, he is certain of the conservation....If we ask him his reasons, he replies that nothing has been removed or added." (Piaget, 1966, p. 140).

It must be noted, however, that the ability to conserve depends on test materials used. Beard (1957, quoted by
Lovell and Ogilvie, 1960) found that among 60 children aged 6 and 7 years, some of the children who were non-conservers when comparing balls of plasticine, could conserve when water was poured from one vessel to a number of smaller vessels. It seems then that some children who are able to conserve continuous quantity in one situation will not necessarily conserve continuous quantity in a different situation using different materials.

In summary then, for a child to be considered a conserver, it is imperative that he either mentally reverses the transformational action (operation) by using the thought processes of identity or reversibility or he attends to the compensatory aspects of the objects upon which he is tested. Also the child goes through three stages (non-conservational, transitional, and conservational) in the development of his understanding of conservation.

Validation Studies of Piaget's Concept of Conservation

Many validation studies of Piaget's conservation tasks have been carried out in Canada, Britain and the United States and an increasing number of them are being carried out in non-western countries. In general, these studies have addressed themselves to four main questions:

1. Are the stages of development as described by Piaget in Swiss children identifiable in other populations?
2. Are the relationships among abilities within any given stage similar to those set forth in the theory?

3. What are the relationships between the attainment of thought as described by Piaget and intellectual development as measured in other more traditional ways such as intelligence tests?

4. What is the role of experience in either facilitating or inhibiting progress from one level of thought to another?

Studies reviewed here will be those dealing with quantity and number in relation to the four questions outlined above.

Validation of Stages

In general, replication studies have supported Piaget's findings concerning the sequence of stages in the attainment of conservation. A stage of non-conservation is followed by the transitional stage which in turn is followed by a conserving stage in which the child's concept of quantity and number are stable and he is no longer deceived by perceptual appearances.

One study to validate Piaget's findings in regard to conservation of substance was done by Lovell and Ogilvie (1960). Seven to ten-year-old British children were individually tested in an effort to trace the development of the concept of invariance of substance and to establish the arguments used by children to justify their answers. The results of the study confirmed the three stages in the
development of the concept of conservation of substance. However, it was at times difficult to classify correctly children who were in the transition stage.

Elkind (1961) administered tests of conservation of number, of continuous quantity, and of discontinuous quantity to four to seven-year-old American children. He found that conservation of continuous quantity was more difficult than that of discontinuous quantity, but all three types of conservation were age-dependent.

In another study aimed at establishing the influence of the kind of question concerning conservation (for instance, Is it the same? Is it different?) and of the type of conservation task (prediction, judgment, or explanation) on the maturity of children's responses to a number of conservation problems, Pratoomraj (1966) found that the attainment of conservation increased with age. Pratoomraj's subjects were 128 children age four through seven years.

Dodwell (1960, 1961) gave a battery of Piaget number tasks to samples of kindergarten, first-grade, and second-grade Canadian children. Their ages ranged from five to ten years. Dodwell's tasks included three conservation tasks. In one, the child compared the number of two sets of beads for which he had already established the equivalence, after they were placed in beakers of varying shapes. In another, eggs and egg cups were used, and in
the third, poker chips were used. Dodwell was able to identify the three stages found by Piaget in the development of number conservation. However, he concluded that "the pattern of development of number concepts does not follow the sequence described by Piaget with great regularity" (Dodwell, 1961, p. 36). The reason for this conclusion was that the number tasks were of unequal difficulty and therefore a child could give a concrete-operational response to one problem and give a pre-operational response to another.

**Acceleration of Stages**

Piaget's age ranges for the appearance of particular stages are only approximations rather than statistical averages or developmental norms. Therefore, "bright" children may achieve aspects of certain stages faster than their "average" counterparts. The question then arises as to what extent the notion of conservation can be speeded up by means of specially developed learning techniques.

Attempts to induce conservation through structured tasks have met with ambiguous results. Some studies have shown the ineffectiveness of training, others have favored training as a way of inducing conservation.

Piaget maintains that specific training or teaching plays a very minor or no role in the acquisition of conservation. He indicates that learning "cannot be obtained by external reinforcement. The logical structure is
reached only through internal equilibration by self-regulation" (Piaget, 1964, p. 16). Therefore, learning of logical structure can take place only if it is based on the learning of simpler structures.

The majority of learning studies deal with acquisitional processes in two related areas: number and quantity. One of the studies in the area of number development was reported by Wohlwill and Lowe (1962). Their subjects were 72 kindergarten children with a mean chronological age of 5 years, 10 months. After a non-verbal and a verbal pretest on Piaget's conservation of number, the children were divided into four groups with three of the groups undergoing different training procedures. The fourth group was used as control. One group repeatedly counted sets of elements before and after their spatial rearrangement. A second group was given a similar reinforced practice coupled with addition and subtraction of elements in a set. The third group was given the opportunity to see that a given set of elements could be made to form either a very short or a very long row without altering cardinal value.

The results of the posttest showed that all the children showed a significant pre-to-posttest improvement on the nonverbal measure of conservation. There were no significant differences in amount of improvement among training subgroups or between them and the control group.
These results seem to support Piaget's contention that logical structure develops as a function of an internal process, equilibration, which is heavily dependent on activity and experience.

Smedslund conducted a number of experiments to compare the relative merits of "reinforcement-based" learning and equilibration models in providing an adequate explanation of cognitive growth. His first experiment was similar to that done by Wohlwill and Lowe and his results were equally unproductive (Smedslund, 1961b). In later experiments, however, Smedslund (1971e, 1961f), by introducing cognitive conflict in the experiments, found that 5 to 7 year-old children who went through the cognitive conflict procedures did better on the posttest than their counterparts who received no training. The tests involved the conservation of substance and weight.

Many training studies have been done since 1961. One of these studies was done by Goldschmid in Canada. His subjects were 110 English-speaking middle-class children in kindergarten in the Montreal Protestant school district. The subjects were randomly assigned to six experimental groups. The experimental subjects were trained on two tasks, half of them on discontinuous quantity, two-dimensional space, and substance. The other half on continuous quantity, number, and weight. Each half was in turn
divided into three groups which were trained on reversibility, compensation, and a combination of reversibility and compensation, respectively.

The results of the study indicated that the experimental groups did significantly better \( p < 0.001 \) than the control group and also that reversibility training was more effective than the compensation and combination training and that training on the first set of tasks (discontinuous quantity, two-dimensional space, and substance) was more successful than training on the second set (continuous quantity, number, and weight). These results seem to provide evidence that the acquisition of conservation can be accelerated.

Other more recent studies seem to be shifting away from the study of the process involved in conservation per se, to consideration of related perceptual and language factors. Bruner (1964) reported an experiment in which 5, 6, and 7 year-old children were asked to make a matrix of nine glasses varying in three degrees of diameter and three degrees of height. When one of the glasses was transposed from one side of the matrix to another, the younger children had difficulty rebuilding the matrix. They appeared to be dominated by the picture of the original matrix. Although use of language bore no relation to success in copying the original matrix, Bruner suggested that improvement in language might help the child in solving a problem like
this. Bruner further proposed that language might serve as a kind of prop to help the child overcome the pull of visual perceptions.

After doing the classic conservation tests involving liquid in beakers of various sizes, Frank (1964) introduced a screen. The child could see equivalence of water in two beakers of equal size but when the water was poured into a third beaker, the child couldn't see the level of water in the third beaker because of the screen. The number of correct responses increased when the children were asked about the equivalence of water. However, when the screen was removed, all the four-year-olds reverted to non-conservation responses, but 70 percent of the five-year-old children stuck with their conservation responses. This was remarkable considering that only 20 percent of the children conserved on the pre-test.

It seems clear that current experimentation on the acceleration of the transition from non-conservation to conservation is not conclusive. More research is needed in order to establish the durability of conservation achieved through training. The question still remains: Is there a transfer of this type of conservation to other tasks involving conservation? It should also be kept in mind that different researchers use different criteria for assessing the presence or absence of conservation. For instance, Bruner and his associates consider a child to be conserving
if he gives a correct response to the first question.

Bruner does not go on and ask the child to explain his judgment, whereas, Smedlund will not deem anyone a conserver unless he or she can give an adequate explanation for his/her answer. Inhelder, Bovet, Sinclair, and Smock (1966) raise the objection that "the operational structure (as defined by Piaget) underlying the conservation concepts appear to us to be a complex, coordinated system that cannot be evaluated by rather summary investigation of answers to pre-selected questions with no exploration of the child's justification of those answers."

**Relationships Among Abilities Within Stages**

There are various recurrent patterns in intellectual development. Piaget has called one of these patterns "horizontal decalage." The term refers "to a repetition which takes place within a single period in development." (Flavell, 1963, p. 22). The best known example of this is the succession of difficulty in the conservation of quantity, weight, and volume. In other words, a child may attain the concept of conservation but ordinarily this is related to the conservation of mass before it is applied to weight and volume.

In the original study, Piaget used two clay balls of identical size, shape and weight. The children tested were 5 to 12 years old. Piaget asked the children to judge the amount, weight, and volume of the two balls of clay after
one had been made into a "sausage" shape. He found that the discovery of conservation followed a regular order that was related to age. The conservation of mass was discovered at ages 7 to 8 years; the conservation of weight was discovered at ages 9 to 10 years; and the conservation of volume was discovered at ages 11 and 12 years.

Several researchers have replicated Piaget's study of horizontal decalage. Elkind (1961) tested 175 children from kindergarten through sixth grade on their abilities in conserving mass, weight, and volume. The order of difficulty obtained in Elkind's study was the same as that observed by Piaget. However, the age of attainment of conservation for each quantity was higher in Elkind's sample than in Piaget's. Piaget had found that 75 percent of the children he was working with attained conservation of mass at ages 7 to 8 years, conservation of weight at 9 to 10 years, and conservation of volume at 11 to 12 years (Piaget, 1951). The results of Elkind's study show that only 25 percent of 11 year-olds had attained conservation of volume.

Tuddenham (1970) reported a high positive correlation (.65) between the clay and water pouring conservation. He further added that "our data strongly suggest that the attainment of concrete operations on one problem is no guarantee that the child will achieve a comparable level when another problem is posed." Other researchers, such as
Dodwell (1962) and Lovell and Ogilvie (1961), have published data showing noncorrespondence of cognitive stage across different content areas.

Verification of horizontal decalage also has been reported in cross-cultural research on conservation. Otaala (1973) reported that the parallel development of conservation, seriation, and classification was only partially supported in Iteso children of Uganda. Mohseni (1966, reported in Dasen, 1972) verified Piaget's sequence of difficulty in the attainment of the conservation of quantity, weight and volume by Iranian children. Kiminyo (1973) also found the same sequence of difficulty with Kamba children of Kenya.

Goodnow, (1962) working with American and Chinese subjects, found the conservation of weight to be easier than that of volume in all of her subsamples. De Lemos on the other hand found conservation of weight easier than conservation of quantity in Australian Aborigines. She, however, confirmed the later development of conservation of volume. Dasen (1970) was unable to confirm De Lemos' findings about conservation of weight before quantity.

There seems to be little consistence in the data reported about the relationships among operational abilities. Differences in the nature of tasks provided and differences in age groups studied may account for the discrepant results. Perhaps the abilities are related as Piaget suggests, but
educational and other experiences may have helped to facilitate the development of one and not the other.

Environmental and Social Factors
Influencing Intellectual Development

Piaget claims that there are four factors that are fundamental to cognitive development. These factors are: (1) maturation, (2) physical environment, (3) social transmission, and (4) equilibration or self-regulation. Although little is known as to the extent to which these factors affect intellectual development, it is generally accepted that a physical environment rich in manipulative objects has a favorable effect on intellectual development. Social interaction between a child and his peers or other adults tends to create disequilibrium in the child so that he is forced to accommodate and assimilate and thus qualitatively change his mental structures.

Individual differences in cognitive development have come to be considered to be the result of the interaction of ones genetic makeup and his physical and social environment. These differences could be attributed to several interacting factors, such as lack of intellectual stimulation, poor health, malnutrition, poor schooling, et cetera. However, it is practically impossible to disentangle the precise effect of any one factor. (Vernon, 1969, p. 33) The effects of some of these factors on intellectual
development are discussed under the sub-headings: physical environment, social environment, socio-economic status, and child-rearing practices.

**Physical Environment**

The fact that even prior to school entrance age, the level of performance on intelligence tests of children from disadvantaged backgrounds is markedly lower than that of their counterparts from more advantaged environments, has served to focus the search for sources of this discrepancy on the period of early childhood. Piaget's theory implies that young children require a rich variety of sensory stimulation and kinaesthetic experience if they are to establish the schemata underlying perception of a world of objects and, further, that later conceptual development rests on this prior perceptual stage.

Cross-cultural studies in the area of perception have reported ethnic group differences in perceptual phenomena. Segall, Campbell and Herskovits (1963) maintained that the crucial factor in the Muller-Lyer illusion is whether or not children are reared in a man-made (carpentered) environment or in a more curving rural environment. The Muller-Lyer illusion depends upon the subject's interpreting oblique angles as right angles seen in perspective. Children from a carpentered environment learn to interpret obtuse or acute angles as cues to the third dimension and this affects the way urban dwellers perceive the illusion.
Allport and Pettigrew (1957) reported that Zulus are less liable to the Ames Rotating Trapezoid illusion than urbanized Africans or whites. Jahoda (1966), on the other hand, found no difference on the Muller-Lyer illusion between Ghanaian tribes which differ in types of dwelling and furnishing although he confirmed the greater susceptibility of Europeans. Jahoda suggested that access to education is an important factor in helping to familiarize Africans with western-type three-dimensional interpretation.

In another study, Berry (1966) applied perceptual and other tests to three groups of 120 members each of the Temne tribe in Sierra Leone, living in an environment of bush and trees; Eskimos living in carpentered shacks, but depending for survival on fine perceptual discrimination in an environment of snow and ice; and Scottish people who represented a western control group. The subjects ranged in age from 10+ years to 40+ years. Berry found that in a closure test of discriminating small details the Eskimos were best. Scots were in the middle and the Temne were the poorest. Eskimos were found to be more "active, analytic and independent" in their perceptions while the Temne were more "passive, global and dependent". Berry pointed out that the groups differed culturally in social organization and child upbringing with the Eskimos emphasizing individual resourcefulness and the Africans emphasizing conformity.
If early perceptual development is the foundation for later conceptual development, then the physical environment plays an important role in cognitive development. Different people view the world around them in different ways, depending on the perceptual cues they use. Therefore, it is then not surprising that there are differences in cognitive development among people of different cultures and backgrounds. However, as the social environment interacts with the physical environment in perceptual development, it is difficult to say which environment exerts the greater influence on cognitive development.

Social Environment

The social environment in the home and the effects of this environment upon the intellectual performance of the child have provided the basis for a continuing controversy. It has been difficult, seemingly impossible, to pinpoint the variables within the social environment which actually handicap mental development. Nevertheless, Vernon (1965) proposed the following as major environmental handicaps to mental development:

1. Physiological and nutritional factors.

These factors mainly operate during pregnancy and the early years of life. However, disease and malnutrition during his early years may affect the child later as they lower the energy and activity level of the child so that he cannot explore his environment and seek out self-stimulating
experiences.

2. Perceptual deprivation during the preschool years.

Piaget has emphasized the importance of experience in the development of logical thinking. Lack of opportunity to manipulate, examine and question one's surroundings will lead to slow development toward operational thinking. More important than perceptual deprivation is the conceptual deprivation which occurs when parents fail to answer questions, encourage curiosity, and provide books and other types of experiences necessary for the development of logical thinking.

3. Repression of independence and constructive play.

Such repression is achieved either through overprotection by parents or through subjection and conformity to cultural traditions. The repression of independence seems to be linked with deficits in spatial abilities, in three-dimensional perception and in technical skills (Hudson, 1962).

4. Family insecurity and lack of planfulness.

This factor is especially common in families living at subsistence level where immediate gratification of physiological needs takes precedence over long term purposeful planning.

5. Female dominance.

In many cultures, the father "may choose to play" a minor role in child rearing. Witkin, Goodenough and Karp (1962) claim that the lack of masculine models may favor
6. Education in underdeveloped countries.

Schools in these countries are starved for materials. Also, teachers frequently are poorly qualified and typically follow highly formal and mechanical methods which discourage intellectual initiative.

It is obvious that there is a great deal of overlap in the effect of the above factors on intellectual development. In this section, review of literature on conservation as it relates to social environment is presented in two areas: social-economic status and child-rearing practices.

Socio-economic Status

One major area of the research literature that bears a largely circumstantial relation to parental practices and intellectual characteristics of the child is concerned with performance of children from families of different social classes. Hunt (1961) advanced the view that lower-class children have an orientation and a style of response to demands for cognitive functioning which are fundamentally different from and less efficient than those of middle-class children. Also, lower-class children possess fewer language skills and are less well able to use such skills in the course of cognitive work.

In studies focused on the differential responsiveness of three-year-old white middle-class and Puerto Rican working-class children to the cognitive demands of the verbal at the expense of spatial abilities.
Stanford-Binet test, Hertzig and colleagues (1971) concluded "while gross global socio-class differences are not currently in particular evidence, more specific differences particularly in relation to the manner in which new skills are taught, attitudes toward task-mastery, and the achievement of a measure of independence in behavior appear to be of significance for the development of cognitive style." Hess and Shipman's findings support this conclusion. On the basis of data gathered from 163 Black families representing four social status levels ranging from families with mother on public welfare to families with college-educated fathers, Hess and Shipman (1965) attempted to identify the cognitive environment to which lower-status children are exposed. The mother's strategies for orienting the child toward selected cues in the environment, the types of control technique she used, and her patterning of stimuli to organize information were found to be of particular importance for the development of cognitive functioning in the child.

Zimiles (in Hellmuth, 1971) examined the influence of a set of variables on conservation of number performance in three groups of five- and six-year-old children of white middle-class, Negro disadvantaged, and Jewish parochial school background. The results of the study showed that in both age groups, the disadvantaged groups performed less well; the difference between them and their more privileged
age-mates was much greater among the six-year-olds than among the fives.

Although the cited literature indicates the influence of social class on cognitive development, it seems as though the socio-economic level per se is not the key factor, but rather the general conditions of the environment surrounding a child at a particular socio-economic level.

**Child-rearing Practices**

In reviewing literature on class and ethnic influences upon socialization, Hess (in Carmichael, 1970) contended that there is a functional tie between economic activities and child rearing practices of adults either directly or through values that are rewarded on the job or in the home. The high degree of unconditional compliance found among children from subsistence economies is attributed to the fact that child training in these societies is geared toward the development of the behavior useful for adult economy.

A number of studies indicate that the modes of parent-child interaction and child-rearing practices affect cognitive development of children. For example, Bing (1963) studied 60 mothers of fifth grade children of either high or low verbal ability with similar total I.Q. She compared the high with the low verbal groups on an interview questionnaire and a mother-child interaction situation. Bing
concluded that some of the antecedents of high spatial and numerical abilities included opportunity and freedom of exploration and permissiveness for objective exploration. Moreover, over anxious discipline and excessive control were suggested as factors contributing to low verbal ability in children.

The Munroes (1972) tested 18 Kikuyu children of ages 5 to 9 years on compliance. The children were given two tasks by their own mothers and the same two tasks by another child's mother. Overall obedience was found to be very high in this sample with over fifty percent of the children obeying fully on all the tasks. Unlike American subjects, the Kenyan children did not disobey their own mother more than another child's mother. According to the Munroes, this compliance syndrome seemed to be a natural concomitant of the child's participation in the household's economic activities where the children were directed in their activities by an older person more than 50 percent of the time.

Based on data on child rearing practices, it can be concluded that the teaching styles of mothers and other adults induce and shape the learning styles and information-processing strategies of children. A social environment in which behavior is controlled by status rules rather than by attention to the individual characteristics of a specific situation and one in which behavior is not mediated by
verbal cues or by teaching that relates events to one another and the present to the future, will produce:
(1) a child who relates to authority rather than to rationale, (2) a child who, although often compliant, is not reflective in his behavior, and (3) a child for whom consequences of an act are largely considered in terms of immediate punishment or reward rather than future effects and long-range goals.

Cross-Cultural Studies in Conservation

Cross-cultural studies in conservation have attempted to find out how certain aspects of a child's environment and experience affect the development of thinking outlined by Piaget. In general, cross-cultural studies have shown that, in spite of varying cultural experiences, children's thinking tends to develop along the lines suggested by Piaget. Among other things, some researchers have attempted to find out if the Piagetian concept being tested develops at the same time in non-western children as it does in European children. Such researchers as Price-Williams (1961), Goodnow (1962), Opper (1972), Kiminyo (personal communication, 1973), and Mohseni (1966) found that the age of acquisition of Piagetian concepts was the same as that found with European or American children.

Price-Williams (1961) found that all the Tiv children he worked with had acquired the conservation of continuous
quantity (earth), discontinuous quantity (nuts), and number by the age of 7-6 to 8-6. Godnow and Bethon (1966) found little or no difference between 11 year-old Chinese boys with little or no schooling and 11 year-old American boys of "average" intelligence on their performance on conservation of weight, surface, and volume.

Opper (1972) investigated the urban/rural differences of aspects of intellectual development in Thai children. She tested children of ages 6 to 11 years on tasks of class inclusion, seriation and conservation and found that the ages of acquisition of the Thai urban group closely paralleled those of the Swiss children for the concrete tasks. The Thai rural group lagged behind the urban group in performance on these tasks.

Using the traditional Piagetian tasks for the conservation of mass, weight, and volume, Kiminyo (1973) found no rural/urban differences in performance on conservation tasks. The Kenyan children did as well on these tasks as American and European children. Similarly, school children in Teheran (Mohseni, 1966, quoted in Dasen, 1972) showed conservation of quantity, weight and volume at approximately the same time as Europeans although these children were one or two years retarded on intelligence tests.

Several researchers, however, have found a developmental lag in the acquisition of Piagetian concepts among children of non-western societies. Goldschmid and his
associates (1973) administered conservation tasks to 250 children ranging in age from 4 to 8 years in each of the following countries: Australia, Holland, England, New Zealand, Poland, and Uganda. The rate of conservation acquisition varied somewhat across the samples studied with Ugandan children lagging behind all others in the tests. The authors attributed this developmental lag to the fact that Ugandan children were shy and inhibited in the test situation. Such shyness might well have affected the children's performance, particularly in the explanation of conservation.

De Lemos (1969) tested 145 Aboriginal children of 8 to 15 years on conservation of number, quantity, length, weight, and area. De Lemos found a severe reduction in the rate of development of Aboriginal children. A large proportion of her sample failed to reach the concrete operational level even at ages 14 to 15 years. Dasen's (1972) replication of De Lemos' study produced very similar results.

In a study undertaken to determine the extent to which development of number and liquid conservation in Lebanese children paralleled that of children of the same age in other cultures, Zarour (1971) found that Lebanese children were lagging behind American children of a middle-class school. The subjects for this study were 224 Lebanese elementary school children in Beirut. Their ages ranged from 5 to 9 years.

Although Greenfield (1966) found that "Bush" school children performed almost as well as European children, only about half of the unschooled rural Wolof children attained conservation of quantity at 11 to 13 years. This slow rate of development was attributed to lack of schooling and to beliefs in magical powers on the part of the unschooled children. Heron and Simonsson (1969) also found that Zambian urban school children after the age of 10 lagged behind Aboriginal children in the conservation of weight. Similarly, Okonji (1971) found the same developmental lag among school children in Uganda on their understanding of geometric concepts. Otaala (1973) found that 75 percent of the Iteso primary school children tested did not acquire conservation until the age 9 to 10 years.

In all the studies reviewed above, some or all of the individuals reached the stage of concrete operations, although some did at a later age than middle-class Europeans. However, the fact that some researchers have found no difference in performance between non-western cultures and western cultures raises questions of methodological techniques and materials used as well as experimenter's bias.
Certainly more replication studies are needed to verify the results obtained.

Including the studies on the rate and age of acquisition of concrete operations, cross-cultural researchers have also addressed themselves to different variables that might affect cognitive development. Among these variables are: schooling, urban/rural environments, home background, sex differences, and genetic factors. The effect of these variables on acquisition of the conservation concept is in the following subsections:

Schooling

Several researchers have studied schooling as a variable that might affect the acquisition of conservation concepts. On the basis of studies by Goodnow and Bethon (1966), Kamara (1971), Kiminyo (1973) and Mermelstein and Shulman (1967), there is no direct relationship between the development of concrete operations and western type schooling. Goodnow and Bethon (1966) found that unschooled Chinese children performed as well as American children of the same age on conservation tasks of weight, volume, and surface.

Mermelstein and Shulman (1967) compared the performances of Negro 6- and 9-year-old children from Prince Edward County, Virginia, with little or no schooling on a series of Piagetian conservation tasks with those of Negro children of comparable ages from a community which had regular schooling. No significant differences could be
attributed to the effects of non-schooling on the attainment of conservation.

Similarly, Kamara (1971), in a study of the cognitive development of Themne children of Sierra Leone, stated, "Both the schooled and the unschooled children of this study were found to be conservers at ages which approximated those that were found by Piaget and Inhelder for Swiss children." Kiminyo (1973) also found no significant differences between schooling and non-schooling in total scores on conservation tasks among Kamba children of Kenya.

On the other hand, Greenfield (1966), De Lemos (1969) and Okonji (1971), among others, found non-schooling to have a detrimental effect on the acquisition of the concept of conservation. De Lemos suggested that, "While the development of conservation does not appear to be directly related to schooling, the school situation may help to provide the kinds of experiences that are necessary for its development." (p. 266). In explaining the puzzling performance of the non-schooled Ugandan children on length conservation, Okonji stated, "It is because of the rather non-mensurational nature of the cultural milieu of the subjects in this study that we think schooling experience has more far reaching consequences for these children's acquisition of conservation of length concept than would normally be expected on the basis of orthodox and very maturational Piagetian views." (p. 127).
Thus, research on the effect of schooling on ability to conserve has produced contradictory results. However, these studies are lacking in adequate description of the quality of schooling experience and the non-schooling type of cultural experience that may facilitate or inhibit the development of the various conservation concepts. Newer methods of teaching based on active manipulation of concrete materials may be more effective in helping children to achieve conservation than teaching methods based on verbal instruction and rote learning. Also, the effect of schooling will be minimal if the cultural environment is adequate for the development of a certain concept. On the other hand, if the cultural environment is not adequate or lacks the need for the attainment of a particular concept, then the effect of schooling will be more pronounced.

**Urban/Rural Environment**

The role of urban/rural environment in cognitive development has not been adequately defined. The term "urban" seems to be linked to contact with western cognitive values, with European contact (Dasen, 1972), or with "advantaged" environment (De Lacey, 1971). Rural environment, on the other hand, seems to be associated with a non-technical environment, with a "deprived" environment (De Lacey, 1971), or with low or no contact with western values. Most researchers who have investigated the effect of the urban versus rural environment on acquisition of conservation
report significant differences in the rate of operational development in favor of the "high-contact" groups.

In an assessment of the verbal intelligence and operational thinking in part-Aboriginal children, De Lacey (1971) reported progressively lower levels of verbal intelligence and operational thinking for low-socioeconomic European, town part-Aboriginal and reserve part-Aboriginal children. De Lacey (1970) in an earlier study designed to assess the development of logical thinking of four samples of Australian children, had found a marked relationship between the degree of enrichment in children's environment and classificatory ability. In this study, two of the samples comprised European children identified as belonging to either a high-or-low socioeconomic status. The other two samples comprised full-blood Aboriginal children with one sample living in an isolated rural community and the other sample living in much closer contact with Europeans and their technology. De Lacey concluded that the development of additive and multiple classificatory ability reported by Inhelder and Piaget might occur only where the child's environment provided a favorable opportunity for cognitive growth as in the case of the high-socioeconomic sample.

Opper (1971), in a study mentioned earlier, found the urban group of children to be ahead of the rural group on all Piagetian tasks presented to the children. The span of
this difference in conservational development varied from one to three years depending upon the task.

Lorraine Fitzgerald (1970) tested children from three Ga subcultures on Piagetian tasks of conservation. The three subcultures of the Ga tribe in Ghana were "described" as: traditional rural, traditional old town urban (densely populated), and westernized suburban (urban affluent). The results of the study showed a tendency for suburban children to attain conservation at an earlier age than either old-town urban or rural children. On the conservation of quantity, the rural children surpassed both the suburban and old-town urban children by the age of eleven.

Unlike the studies reviewed above, Kiminyo (1973) found no significant difference in the performance of rural and urban children in Kenya on conservation of quantity, weight and volume.

Greenfield (1966), on the other hand, reported that city-schooled Wolof children performed less well on conservation of quantity than bush-schooled children until the age of 11 to 13 years.

Before any valid generalizations can be made on the effect of rural and urban environment on cognitive development, further research is needed to link specific aspects of the environment to aspects of cognitive development.
Home Background

This variable, as it is studied in connection with Piaget's theory, includes such factors as social class, family size, elite and traditional homes (Lloyd, 1971) and modern and traditional homes (Etuk, 1967). Most studies done with children from western societies have examined the effect of social class on the acquisition of Piagetian concepts of conservation and classification. In general, it has been reported that children from lower socio-economic backgrounds show a slower rate of progress through the stages of cognitive development than do their privileged counterparts in more favorable environments. For instance, Baker (1970), in examining the influence of socioeconomic class on the manifestation of conservation of number, found conservation ability to be manifested significantly more often by middle-class than by lower-class children. However, a within-sex analysis revealed that this socioeconomic class difference held only for female subjects.

In another study, Gaudia (1970) administered a series of standardized conservation tasks to 126 lower-socioeconomic status Indian, Negro and White children in the first three grades of western New York state schools. Significant differences at the .05 level were found between the Negroes and the Indian/White groups on the age of acquisition of conservation. The entire lower-socioeconomic status differed significantly from the norming group. The age of
acquisition seemed to be at least a year retarded in Negroes and the lower-socioeconomic status children.

In the non-western, non-industrialized societies, hardly any studies have examined the relationship between socioeconomic status and ability to conserve. Perhaps the dearth of studies is caused by the difficulty in making a distinction among socioeconomic classes in rather homogeneous groups. However, in the few studies that have attempted to link home background factors to cognitive development, it has been found that children from more modern homes tend to perform better than children from the more traditional or rural homes. Etuk (1967), for example, found that children from modern homes in Nigeria performed better than their traditional counterparts on seriation, classification and conservation. Likewise, Lloyd (1971) reported a higher level of performance in Nigerian children from elite homes compared to children from rural homes.

In a different type of study, Mehryar (1972) compared family size, intelligence and academic performance of secondary school students in Shiraz, Iran. He found that intelligence test scores increased with rise in the educational level of fathers and decreased with an increase in the number of siblings. He concluded that family size affected academic success.

More research is needed to link specific home background factors to cognitive development of children from non-western
Sex

Most studies in conservation either have not considered the problem of sex differences or report a lack of evidence of sex differences in conservation abilities. Dodwell (1961) and Almy and her associates (1966) did not find differences in performance of boys and girls on conservation tasks. Some studies of children from other cultures also have reported no sex differences in performance on conservation. For instance, Kiminyo (1973) found no significant differences between male and female Kenyan children in total scores on conservation tasks. Heron and Simonsson (1969) reported no significant differences in conservation performance between Zambian boys and girls.

In contrast to these studies, in California Tuddenham (1970) reported "superiority of boys over girls on most of the conservation problems." (p. 322). Similarly, Goldschmid (1967) found that boys performed better than girls in the conservation of substance and discontinuous quantity. Goldschmid attributed this difference to the fact that boys in their play activities had more opportunity to manipulate objects and perceive them after different transformations than girls. However, he suggested that further research to discover the bases for such differences should be done.
In the less technical societies, several researchers have reported significant sex differences in performance on conservation problems. In Iran, Zarour (1971) reported better performance of boys than girls on conservation of number. He attributed this difference to the fact that boys are allowed greater freedom of exploration and play than girls. In another study on conservation of weight, Zarour reported again the superiority of boys over girls in conservation performance. Similarly, Bat-Hae and Hosseini, (1971) reported higher scores on conservation tests for Iranian boys than for Iranian girls.

On the basis of these studies, it seems as though some cultures favor the development of conservation in boys more than in girls. Nevertheless, more research is needed to validate the findings of these studies.

Genetic Factors

This researcher has found only two studies attributing genetic factors to the ability to conserve. One of these studies was done by De Lemos in Australia. In her study De Lemos (1969) administered several conservation tasks to part- and full-blood Aboriginal children of ages 8 to 15 years. She found significant differences at the .05 level between the performance of part and full Aboriginal children on conservation tasks. De Lemos suggested that this might be due to "the part Aboriginal children having a higher probability of inheriting a higher intellectual potential."
De Lemos' study has been criticized in terms of her sample selection, analysis of data and experimenter bias.

Dasen (1972) replicated De Lemos' study and found no significant differences between part and full Aboriginal children.

In another study, Tuddenham (1970) reported a poor performance of Negroes compared to Whites on conservation tasks. Tuddenham's sample consisted of 350 children in the first four grades drawn from schools in California. The schools were deliberately selected to cover a wide range of socioeconomic levels.

Research on the influence of genetic factors on conservation has not been conclusive. More carefully designed studies are needed in this area to link genetic factors to the development of operational thinking.

Summary

Literature related to Piaget's tasks of conservation was presented in three sections: (1) Validation Studies of Piaget's Concept of Conservation, (2) Environmental and Social Factors Influencing Cognitive Development, and (3) Cross-cultural Studies in Conservation. In general, validation studies carried out in Canada, Britain and the United States supported Piaget's findings. The stages of development as described by Piaget in Swiss children were
identifiable in other populations. Studies done in non-western societies often reported a developmental lag in children from these societies. A lack of enough studies with children of non-western cultures was pointed out. Some cross-cultural studies have reported environmental (urban/rural), home-background (western/traditional), sex, and genetic differences in performance on conservation tasks. The need for more research to link physical and social-environmental factors to acquisition of conservation was mentioned.

In the next chapter, selection of subjects and experimental procedures will be reported.
CHAPTER III
PROCEDURE

In this chapter the design of the investigation and the methodology used are discussed. The chapter is divided into three sections:

1. Re-statement of hypotheses.
2. Selection and description of subjects.
3. Methods and procedures.

Re-statement of Hypotheses

The following hypotheses were tested by this investigation:

$H_01$. There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on conservation tasks using clay.

$H_02$. There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on conservation tasks using water.

$H_03$. There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on
conservation of number.

\( H_0^4 \). There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on conservation of area.

\( H_0^5 \). There is no significant difference at the .05 level between the performance of Kenyan boys and the performance of Kenyan girls on conservation tasks.

\( H_0^6 \). There is no significant difference at the .05 level between the performance of older Kenyan children and younger children on conservation tasks.

\( H_0^7 \). Of the following independent variables, there is no one variable or combination of variables which is a predictor of children's performance on conservation tasks:

1. Father earning wages
2. Mother earning wages
3. Type of house
4. Chores done before and after school
5. Number of siblings
6. News media in the home

In relation to these hypotheses, the investigator will attempt to answer the following questions:
1. Do rural school boys perform as well on conservation tasks as do city school boys or city school girls?

2. Do rural school girls perform as well on conservation tasks as do city school girls or city school boys?

3. When categorized by chronological age (6-7½ years, 7½-8½ years, 8½-9½ years, 9½-10½ years), is there any difference in performance on conservation tasks between children of adjacent age levels; for example, do 6-7½ year-old children perform as well as 7½-8½ year-old children?

4. Do the children from the more expensive city schools perform better on conservation tasks than children from the low cost city schools?

5. Do Kenya African children attain conservation at ages comparable to those of children from Western cultures?

6. Does the number of years that Kenya African children have spent in school affect their performance on conservation tasks?

Selection of Subjects

The subjects of this study were African children who attend primary schools either in Nairobi, Kenya or in the rural area of Machakos, one of the Kenyan counties. Ten city schools were randomly selected for the study from a list of all schools that are partially or fully supported by the Nairobi City Council. Of these 10 schools, 6 are low-cost schools, 3 are middle-cost schools and 1 is a high-cost school. Eight children of ages 6 to 10½ years, one boy and one girl for each of four age groups, were randomly selected from the list of pupils attending each of these 10 schools. All together 80 children from the city schools participated
in this study.

In the rural area, ten schools were randomly selected from the list of all rural schools in the Northern and Eastern Divisions of Machakos district. The schools selected for the study were at least 20 miles from Machakos, the nearest town. Again 8 children of ages 6 to 10½ years, one boy and one girl for each age group, were randomly selected from each of these rural schools. All together, there were 80 children from the rural schools who participated in this study.

Prior to the beginning of the study, headmasters and headmistresses of the schools selected for the study had been requested to provide the investigator with a list of all children whose ages fell between 6 and 10½ years. The table of random numbers was used to select from each school list one girl and one boy for each of the following age groups:

1. 6 years to 7½ years
2. 7 years, 7 months to 8½ years
3. 8 years, 7 months to 9½ years
4. 9 years, 7 months to 10½ years

**Populations From Which the Children Were Selected**

Although there are variations in the depth of the exposure and the amount of time in which rural children have been exposed to Western values, it is possible to make generalizations about the background of the rural primary school children of Machakos. The rural children selected for this study come from homes where their parents
are peasant farmers. In general, life in the rural area revolves around subsistent farming activities in which both parents and children participate. There are cattle, sheep and goats to be herded, and land to be tilled. In some cases, the men have left home to work in the big cities and towns.

The content of early experiences for rural children grows naturally out of the physical and the social world. As children share in common tasks in the field and homestead (herding cattle, weeding, collecting firewood, fetching water, et cetera), they are taught decency of speech and behavior, respect for elders, and the laws that govern the community. They learn the complex relationship between themselves and their nuclear family, the extended family, the clan, and the tribe. Emphasis is placed on good manners, obedience to adults, hospitality to friends, and cooperation in common tasks. There are few opportunities to ask questions and rarely are questions invited from children. In most cases, children do, without questioning, what they are asked to do by adults. Discipline from parents and other adults is usually authoritarian.

By the time rural children get to school, they have had very limited manipulative experiences in a "carpentered" environment; an environment in which there are a variety of rectangular, square, oblong, and right-angled objects. A more curving environment is familiar to the rural children.
In their early years, children are kept close to their mothers and mother substitutes. They are weaned late—usually after 2 or 3 years. Soon after weaning, children cease to enjoy the almost continual adult company of their early years. From a relatively early age (about the age of 4 or 5), children are assigned such duties as minding the baby, fetching water and firewood, looking after cattle, et cetera.

As the children grow older, they internalize traditional social, religious, and magical beliefs. Their thinking becomes affected by these beliefs. When they finally go to school, they have to make choices between traditional and scientific facts which often contradict one another. For example, a child from the rural area, and sometimes from the city, is more likely to believe that someone suffering from malaria is ill because someone has "looked at him with an evil eye" than to believe that the disease is caused by parasites transmitted into the blood by the bite of Anopheles mosquitoes.

The city school children, on the other hand, live under slightly different conditions. Nairobi is the capital city in Kenya and consequently has been greatly influenced by Western ideals and values. Children living in this environment do not participate in such activities as looking after cattle, fetching firewood, tilling the land et cetera. They do not benefit from living in an extended
family where other significant adults (grandparents, aunts, and uncles) help induct them into tribal laws. In general discipline by parents is not as authoritarian as is the case in the rural area.

Children in the city interact with other children and adults from other tribes. They have more free time to play with other children and they acquire values of other children. Although they learn some of the traditional social, religious, and magical beliefs from their parents, these beliefs do not dominate the children's lives as is the case in the rural area.

Also children in the city live in modern houses usually with both water and electricity in the house so that they do not have to fetch water or firewood. In general, the environment in the city is more "carpentered" rather than curving. Children have opportunities to manipulate rectangular objects, corners et cetera. By the time they go to school, the city children have already acquired Western ideas and some scientific facts.

The Schools

Education at both the primary and the secondary school level is centralized. All primary school children follow the same curriculum and use the same books. A typical primary school syllabus includes such activities as reading, writing, number work, physical education, religious education, geography, history, general science, arts
and crafts, and mother-tongue (language of the home and the tribe). English, the medium of instruction in most schools, is a subject which is greatly emphasized in the daily timetable.

Since all children have to take an examination at the end of their primary school career (Standard VII, when they take the Kenya Preliminary Examination), teaching is generally mechanical with emphasis placed on the facts that children need to learn in order to pass the examination. Due to lack of materials (books, paper, audio visual aids) learning takes the form of rote memorization. Children rarely question the veracity of what the teacher says. In the classroom children are encouraged to ask questions but the type of questions they ask are to clarify what the teacher says. Teachers usually ask simple questions which require a one-word answer. Rarely are children asked divergent questions where they have to hypothesize or evaluate a situation.

In Kenya, children who attend school have to pay school fees. Since it is sometimes difficult for parents to save enough money to pay for the education of their children, some children do not start school until they are about 9 years old. Therefore, it is not uncommon to find nine and six-year-old children in the same class, especially in the rural schools.
Methods and Materials

The following materials were used in this study:
1. Two balls of clay each with a diameter of about 2 inches.
2. Water in two plastic jars each with a capacity of 32 fluid ounces. (One bowl of diameter 6 inches and 3 paper cups were used for the tasks involving conservation of water.)
3. 16 pieces of wood each with a diameter of 3/4 inch and a length of 1/2 inch.
4. Two green rectangular sheets of construction paper each 8 inches by 12 inches.

Procedure

In the rural schools, each child was individually interviewed by the investigator. In the city schools the same procedure was used except in cases where the investigator could not speak the child's mother tongue. In such cases, the interview was conducted through interpreters who were in some cases older children in the sixth or seventh grade or teachers who spoke the child's language.

The child was asked to respond to two questions on each of three conservation tasks (clay, water, and number), and to respond to one question on the fourth conservation task (area). The investigator attempted to put the child at ease by having the child talk about his home experiences,
his interests, and his activities outside of school. At the beginning of the interview, it was ascertained that the child knew for what purposes the materials could be used.

In general, the procedure used in the interview was that used by Piaget and his collaborators. First, the child was asked if the two objects (clay balls, jars of water, pieces of wood arranged in two rows, or pieces of paper) were equal. Next, one of the objects of the pair was deformed in a certain way and the child was asked again if the two objects were equal. Then he was asked to justify his answer. In cases where the child was expected to respond to two questions (clay, water, and number), again one of the objects was distorted in a different way and the child was asked to justify his answer. The child's responses were tape recorded and later the tapes were transcribed.

In the city schools, the investigator first explained to the interpreters the purpose of the interview and then conducted a demonstration interview of a school child who was not included in the study. In cases where the investigator and the child did not speak the same language, the interpreters were asked to translate the investigator's instructions and questions for the child. The same interview procedure (conservation tasks and questions are found in Appendix A) was used with all children who participated in the study.
Scoring

Since each question followed a change in which quantity remained the same, each question answered affirmatively by the child was a correct response and an affirmative response was given a score of 1. Following this response the child was asked to justify his answer. A justification response which referred to the compensatory aspects of the two objects or to the equivalence of the objects before transformation, or the reversibility of the transformation action was considered a correct response and it was given a score of 1. Since three of the tasks involved 2 questions related to change and the accompanied response for justification, a total of 14 points could be scored by the child, that is, 4 points each for the conservation of clay, water, and number, and 2 points for the conservation of area. A non-conservation response, that is, a negative response concerning the equality of the quantity of the two objects after one transformation scored zero. A child was considered to be in a transitional stage if he only answered correctly and justified only one of the two questions. Therefore, a score of zero for any task indicated a non-conserver, and scores of 1, 2, and 3 for the first three tasks, and a score of 1 for the fourth task indicated children at the transitional stage. A child was considered a conserver only if he scored 4 points for each of the tasks requiring 2 transformations, and 2 points for the task
involving conservation of area.

Method of Analysis

To test for the separate and combined effects of environment, sex, and age, a three-way analysis of variance was used. Analysis of variance was used because it was considered to be the most discriminating of tests used in analyzing data. Where the F ratio was significant, the Tukey's test of significance was used to pinpoint the source of the difference. A step-wise multiple regression was used to examine the predictability of the variables in H07 in the performance of children on conservation tasks.

Summary

In this chapter, the design of the investigation and the methodology used were discussed. A brief description of the subjects and their background was given. In the next chapter, the data collected for the study will be analyzed and the results given.
CHAPTER IV
RESULTS

This chapter presents the results of the analyses of data obtained during this investigation. These results are presented in five sections:

(1) Differences in performance between the rural and the city school children on conservation of clay, water, number, and area.

(2) Differences in performance between boys and girls on conservation of clay, water, number, and area.

(3) Differences in performance between older and younger children on conservation of clay, water, number, and area.

(4) Conditions in the home and their relation to the children's performance on the conservation of clay, water, number, and area.

(5) Questions related to the hypotheses.

At the end of each section, a short discussion of the results is presented.

A three-way analysis of variance was done for each of the following conservation tasks: clay, water, number, and area. Where the F ratio was significant, a Tukey's post hoc
test was performed to ascertain the source or sources of differences between groups. For each of the conservation tasks, three major factors were examined. These factors were: A — Environment, B — Sex, C — Age. Where the F ratio for interaction effects was significant, a Dunn's test of significance was run to find the source of differences between groups.

An examination of Table 1, Analysis of Variance Summary Table for Conservation of Clay, reveals that, with respect to environment, an F ratio of 4.928 (df 1, 144) was significant at the .05 level. Also an F ratio of 3.384 (df 3, 144) was significant at the .05 level with respect to age. The F ratio for the second main effect, sex, failed to reach significance at the .05 level.

An examination of Table 2, Analysis of Variance Summary Table for Conservation of Water, shows that an F ratio of 10.243 (df 3, 144) was significant at the .01 level with respect to age. Also, with respect to interaction of age and environment, an F ratio of 2.269 (df 3, 144) approached significance at the .05 level. However, the F ratio for the main effects of environment and sex failed to reach significance at the .05 level.

In conservation of number, Table 3 shows that with respect to age, an F ratio of 11.279 (df 3, 144) was significant at the .01 level. Also, with respect to interaction of age and environment, an F ratio of 3.398 (df 3, 144) was
### Table 1

**Analysis of Variance Summary Table**

**For Conservation of Clay**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Environment)</td>
<td>10.000</td>
<td>1</td>
<td>10.000</td>
<td>4.928 *</td>
</tr>
<tr>
<td>B (Sex)</td>
<td>0.025</td>
<td>1</td>
<td>0.025</td>
<td>0.012</td>
</tr>
<tr>
<td>C (Age)</td>
<td>20.600</td>
<td>3</td>
<td>6.867</td>
<td>3.384 *</td>
</tr>
<tr>
<td>A X B</td>
<td>1.225</td>
<td>1</td>
<td>1.225</td>
<td>0.604</td>
</tr>
<tr>
<td>A X C</td>
<td>7.300</td>
<td>3</td>
<td>2.433</td>
<td>1.199</td>
</tr>
<tr>
<td>B X C</td>
<td>3.875</td>
<td>3</td>
<td>1.292</td>
<td>0.637</td>
</tr>
<tr>
<td>A X B X C</td>
<td>1.875</td>
<td>3</td>
<td>0.625</td>
<td>0.308</td>
</tr>
<tr>
<td>S/ABC (Error)</td>
<td>292.200</td>
<td>144</td>
<td>0.029</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>337.100</td>
<td>159</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at .05 level.

significant at the .05 level. With respect to the main effect of sex, an F ratio of 3.008 (df 1, 144), though not significant, approaches significance at the .05 level. The ratio for the main effect of environment failed to reach significance at the .05 level.

An examination of Table 4, Analysis of Variance Summary Table for Conservation of Area reveals that, with
TABLE 2
ANALYSIS OF VARIANCE SUMMARY TABLE
FOR CONSERVATION OF WATER

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Environment)</td>
<td>0.006</td>
<td>1</td>
<td>0.006</td>
<td>0.006</td>
</tr>
<tr>
<td>B (Sex)</td>
<td>0.006</td>
<td>1</td>
<td>0.006</td>
<td>0.006</td>
</tr>
<tr>
<td>C (Age)</td>
<td>33.269</td>
<td>3</td>
<td>11.089</td>
<td>10.243**</td>
</tr>
<tr>
<td>A X B</td>
<td>0.156</td>
<td>1</td>
<td>0.156</td>
<td>0.144</td>
</tr>
<tr>
<td>A X C</td>
<td>7.369</td>
<td>3</td>
<td>2.456</td>
<td>2.269</td>
</tr>
<tr>
<td>B X C</td>
<td>0.369</td>
<td>3</td>
<td>0.123</td>
<td>0.113</td>
</tr>
<tr>
<td>A X B X C</td>
<td>4.119</td>
<td>3</td>
<td>1.373</td>
<td>1.268</td>
</tr>
<tr>
<td>S/ ABC (Error)</td>
<td>155.900</td>
<td>1</td>
<td>1.083</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>201.194</td>
<td>159</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Significant at .01 level.

respect to age, an F ratio of 5.446 (df 3, 14) was significant at the .01 level.

The F ratio for the main effects of environment and sex failed to reach significance at the .05 level.
## TABLE 3

### ANALYSIS OF VARIANCE SUMMARY TABLE

**FOR CONSERVATION OF NUMBER**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Environment)</td>
<td>2.500</td>
<td>1</td>
<td>2.500</td>
<td>2.486</td>
</tr>
<tr>
<td>B (Sex)</td>
<td>3.025</td>
<td>1</td>
<td>3.025</td>
<td>3.008</td>
</tr>
<tr>
<td>C (Age)</td>
<td>34.025</td>
<td>3</td>
<td>11.342</td>
<td>11.279 **</td>
</tr>
<tr>
<td>A X B</td>
<td>0.900</td>
<td>1</td>
<td>0.900</td>
<td>0.895</td>
</tr>
<tr>
<td>A X C</td>
<td>10.250</td>
<td>3</td>
<td>3.417</td>
<td>3.398 *</td>
</tr>
<tr>
<td>B X C</td>
<td>4.525</td>
<td>3</td>
<td>1.508</td>
<td>1.500</td>
</tr>
<tr>
<td>A X B X C</td>
<td>2.750</td>
<td>3</td>
<td>0.917</td>
<td>0.912</td>
</tr>
<tr>
<td>A/ ABC (Error)</td>
<td>144.800</td>
<td>144</td>
<td>1.006</td>
<td></td>
</tr>
</tbody>
</table>

**Total** 202.775 159

* Significant at .05 level

** Significant at .01 level
### TABLE 4

**ANALYSIS OF VARIANCE SUMMARY TABLE**

**FOR CONSERVATION OF AREA**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Environment)</td>
<td>0.506</td>
<td>1</td>
<td>0.506</td>
<td>1.170</td>
</tr>
<tr>
<td>B (Sex)</td>
<td>0.756</td>
<td>1</td>
<td>0.756</td>
<td>1.748</td>
</tr>
<tr>
<td>C (Age)</td>
<td>7.069</td>
<td>3</td>
<td>2.356</td>
<td>5.446**</td>
</tr>
<tr>
<td>A X B</td>
<td>0.056</td>
<td>1</td>
<td>0.056</td>
<td>0.130</td>
</tr>
<tr>
<td>A X C</td>
<td>1.219</td>
<td>3</td>
<td>0.406</td>
<td>0.939</td>
</tr>
<tr>
<td>B X C</td>
<td>0.169</td>
<td>3</td>
<td>0.056</td>
<td>0.130</td>
</tr>
<tr>
<td>A X B X C</td>
<td>1.669</td>
<td>3</td>
<td>0.556</td>
<td>1.286</td>
</tr>
<tr>
<td>S/ ABC (Error)</td>
<td>62.300</td>
<td>144</td>
<td>0.433</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>73.744</td>
<td>159</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Significant at .01 level.**
Differences in Performance Between Rural and City School Children in Conservation of Clay, Water, Number, and Area

Differences between Rural and City Children on Conservation of Clay

As shown earlier (Table 1), there was a significant difference (at the .05 level) in conservation of clay with respect to environment. An examination of the mean scores for rural and city school children in conservation of clay (Appendix B Table 14), shows the mean score for rural children (3.17) to be higher than the mean score for city children (2.67). It can then be concluded that the rural school children performed significantly better than the city school children in conservation of clay. A look at the number of children who responded correctly to the two questions on conservation of clay, and who were able to justify their answers (Figure 1) shows some more differences between the rural and the city school children. Figure 1 shows the percentages of children who were considered conservers (as defined in this investigation) with respect to clay. An examination of Figure 1 reveals that there were more rural children than city children able to conserve clay at the first and the third age levels, whereas,
Age Levels

- **Rural Children**
  - \( C_1 = 6 \) years to 7 years, 6 months

- **City Children**
  - \( C_2 = 7 \) years, 7 months to 8 years, 6 months

- **All Children**
  - \( C_3 = 8 \) years, 7 months to 9 years, 6 months
  - \( C_4 = 9 \) years, 7 months to 10 years, 6 months

**FIGURE 1**

PERCENT OF CHILDREN AT DIFFERENT AGE LEVELS REVEALING CONSERVATION OF CLAY
there were more city children than rural children at the second and the fourth age levels who were able to conserve clay.

Differences between Rural and City Children in Conservation of Water

With respect to environment (rural and city), Table 2 shows that an F ratio of 0.006 (df 1, 144) failed to reach significance at the .05 level. Therefore, it can be concluded that there was no significant difference in performance between the rural school children and the city school children in conservation of water. However, an examination of the number of children considered conservers (as defined in this investigation) shows a different picture. Figure 2 (Percent of Children at Different Age Levels Revealing Conservation of Water) shows that, except for children at the youngest age level where there were more rural children than city children able to conserve water; the city school children consistently had higher percentages than rural school children with respect to conservation of water.

Differences between Rural and City Children in Conservation of Number

An examination of Table 3 shows that, with respect to environment, an F ratio of 2.486 (df 1, 144) failed to reach significance at the .05 level. It can then be concluded that there was no overall significant difference between the rural school children and the city school
PERCENT OF CHILDREN AT DIFFERENT AGE LEVELS REVEALING CONSERVATION OF WATER
children in conservation of number. However, by looking
at the interaction of the main effects of environment and
age, one finds in Table 3 an F ratio of 3.398 which was
significant at the .05 level. Figure 3 illustrates the
pattern of this interaction of environment and age in
conservation of number.

In Figure 3, the largest gap between the means occurs
for rural and city school children at the youngest age
level (6 years to 7 years, 6 months). A Dunn's test of
significance was performed to compare the differences
between these two means. A critical value of .805 at the
.05 level was necessary for any mean to be significantly
different from another. The difference between the means
was greater than the critical value. It was then concluded
that there was a significant difference at the .05 level in
conservation of number between rural 6 years to 7 years, 6
months children and the city children of 6 years to 7 years,
6 months age level. The rural children at this age level
performed better than their city counterparts in conserva-
tion of number. There was no significant difference in
performance between the rural and city children at the other
three age levels in conservation of number.

In looking at the number of children able to conserve
number (Figure 4), it is evident that the rural children at
the first, second, and third age levels had the same or
higher percentage of conservers than did the city children.
FIGURE 3
INTERACTION OF AGE AND ENVIRONMENT
ON CONSERVATION OF NUMBER
FIGURE 4

PERCENT OF CHILDREN AT DIFFERENT AGE LEVELS REVEALING CONSERVATION OF NUMBER
It is of interest to note that whereas all the city children at the oldest age level conserved number, only ninety percent of the rural children at the same age level were able to do so.

**Differences between Rural and City Children in Conservation of Area**

As shown earlier in Table 4, an F ratio of 1.170 (df 1, 144) failed to reach significance at the .05 level with respect to environment. An examination of Figure 5 (the percentage of children conserving area) shows that at the first and the third age levels the rural children had higher percentages of conservers than did the city children at equivalent age levels. At the second and the fourth age levels, however, the city children had higher percentages of conservers than the rural children at the same age levels.

**Discussion of Results**

Analyses of data on the effects of environment, in this case rural versus city, on children's conservation of clay, water, number, and area, reveal that with respect to conservation of clay, the rural school children performed significantly better than the city school children. The marked superiority of rural children over city children in the conservation of clay implies that rural children have had more experience working or playing with clay than city children. These results support the findings of Greenfield (1966) that the rural Wolof school children showed a performance in
FIGURE 5
PERCENT OF CHILDREN AT DIFFERENT AGE LEVELS REVEALING CONSERVATION OF AREA
conservation of quantity which was superior to that of the city school children. Kiminyo (1973), however, did not find any significant difference in performance between Kenyan rural and urban school children in conservation of quantity. The findings in this investigation, that there was no significant difference in performance between the rural and city school children in conservation of water, number, and area, support Kiminyo's findings.

Differences in Performance Between Boys and Girls in the Conservation of Clay, Water, Number, and Area

Differences between Boys and Girls in Conservation of Clay

The Analysis of Variance Summary Table for conservation of clay (Table 1) shows that with respect to sex an F ratio of 0.012 (df 1, 144) failed to reach significance at the .05 level. It can then be concluded that there was no significant difference between boys and girls in their performance on conservation of clay. It is of interest to note, however, that girls had a slightly higher mean score in conservation of clay than did boys (Appendix B Table 14). This difference between means is not significant.

In examining the number of children at various conservation categories as defined in this investigation, it was found that there were more boys than girls at the
non-conservation stage with respect to conservation of clay (Table 5). These differences between boys and girls are not significant.

**Differences between Boys and Girls in Conservation of Water**

Table 2, Analysis of Variance Summary Table for conservation of water, shows that with respect to sex, an F ratio of 0.006 (df 1, 144) failed to reach significance at the .05 level. It can then be concluded that there was no significant difference in performance on conservation of water between boys and girls. The mean scores for boys and girls in conservation of water (Appendix B Table 14) show that the mean score for boys (3.300) was slightly higher than that for girls (3.287). This is surprising because girls, as they do their house chores, are supposed to have more opportunities to play with water than do boys. However, it must be remembered that these differences between means are not significant; therefore, boys are not necessarily better than girls in conservation of water. Table 5 shows also that there were more boys than girls (54 and 51 respectively) at the conservation stage in conservation of water.

**Differences between Boys and Girls in Conservation of Number**

In conservation of number (Table 3), an F ratio of 3.008 (df 1, 144) approaches significance at the .05 level with respect to sex. In examining the mean scores for boys and girls, a mean score for boys (3.550) was higher than the one for girls (3.275) in conservation of number.
TABLE 5
NUMBER OF CHILDREN AT VARIOUS STAGES OF
CONSERVATION WITH RESPECT TO CLAY (C), WATER (W),
NUMBER (N), AND AREA (A)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Conservation</th>
<th>Transitional</th>
<th>Non-Conservation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>W</td>
<td>N</td>
</tr>
<tr>
<td>Boys</td>
<td>47</td>
<td>54</td>
<td>63</td>
</tr>
<tr>
<td>Girls</td>
<td>46</td>
<td>51</td>
<td>57</td>
</tr>
</tbody>
</table>

(Appendix B Table 14). This difference between means is, however, not significant. Table 5 also shows that, as regards conservation of number, there were more boys than girls (63 and 57 respectively) at the conserving stage. Again these differences are not significant.

Differences between Boys and Girls in Conservation of Area

An examination of Table 4 shows that with respect to sex, an F ratio of 1.748 (df 1, 144) failed to reach significance at the .05 level. It can then be concluded that there was no significant difference at the .05 level between boys and girls in conservation of area. Although this
difference is not significant, Appendix B Table 14 shows that the mean score for boys in conservation of area was higher than that for girls. Also, as with other conservation tasks, in conservation of area, there were more boys than girls (61 and 56 respectively) at the conserving stage (Table 5). This difference, however, is not significant at the .05 level.

Discussion of Results

In general, there was no significant difference in performance at the .05 level between boys and girls in the conservation of all quantities -- clay, water, number, and area (Tables 1, 2, 3, and 4). These results support the findings of Dodwell (1961) and Almy and her associates (1966) who did not find differences in performance of Canadian and American boys and girls on conservation tasks. The results support also the findings by Kiminyo (1973) of no significant differences between male and female Kenyan children in total scores on conservation tasks. It should be pointed out, however, that there were some differences between boys and girls in the number of children at each of the three conservation stages.
Differences in Performance between Older and Younger Children in Conservation of Clay, Water, Number, and Area

Differences between Older and Younger Children in Conservation of Clay

An examination of Table 1 shows that with respect to age an F ratio of $3.384$ (df 3, 14] was significant at the .05 level. A Tukey's post hoc test was performed to find the sources of differences. Table 6 reveals that the oldest children, $C_4$ (9 years, 7 months to 10 years, 6 months), did significantly better at the .05 level than the youngest children, $C_1$ (6 years to 7 years, 6 months), in the conservation of clay. There were no significant differences in performance on conservation of clay between the other age levels.

Differences between Older and Younger Children in Conservation of Water

Table 2 shows that, with respect to age, an F ratio of $10.243$ (df 3, 14] was significant at the .01 level. A Tukey's test of significance (Table 7) reveals that:

(1) There was a significant difference in performance at the .05 level between children at the second age level, $C_2$ (7 years, 7 months to 8 years, 6 months), and children at the first age level, $C_1$ (6 years to 7 years, 6 months), in conservation of water.
TABLE 6
COMPARISON OF MEANS OF THE FOUR AGE GROUPS IN CONSERVATION OF CLAY
(TUKEY'S APOSTERIORI TEST)

<table>
<thead>
<tr>
<th>Group Mean</th>
<th>$C_1$</th>
<th>$C_2$</th>
<th>$C_3$</th>
<th>$C_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.525</td>
<td>2.625</td>
<td>3.175</td>
<td>3.375</td>
</tr>
</tbody>
</table>

| C₁  | ---  | 0.100 | 0.650 | 0.850 * |
| C₂  | ---  | 0.550 | 0.750 |        |
| C₃  | ---  |       | 0.200 |        |
| C₄  | ---  |       |       |        |

HSD = $q_{4}$√$\frac{MS_{error}}{40}$ = 0.830 (Critical)

(2) There was a significant difference in performance at the .05 level between children at the third age level, $C_3$ (8 years, 7 months to 9 years, 6 months), and children at the first age level, $C_1$ (6 years to 7 years, 6 months), in conservation of water.

(3) There was a significant difference in performance at the .05 level between children at the fourth age level, $C_4$ (9 years, 7 months to 10 years, 6
TABLE 7

COMPARISON OF THE MEANS OF THE FOUR AGE GROUPS IN CONSERVATION OF WATER
(TUKEY'S APOSTERIORI TEST)

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>$C_1$</th>
<th>$C_2$</th>
<th>$C_3$</th>
<th>$C_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2.575</td>
<td>3.225</td>
<td>3.675</td>
<td>3.700</td>
</tr>
</tbody>
</table>

\[
\text{HSD} = q_{14} \sqrt{\frac{\text{MS error}_{40}}{4}} = 0.607 \quad \text{(Critical)}
\]

months), and children at the first age level, $C_1$ (6 years to 7 years, 6 months), in conservation of water.

There was no significant difference in performance at the .05 level between the second ($C_1$) and the third ($C_3$) age groups in conservation of water. Nor was there any significant difference between the second ($C_2$) and the fourth ($C_4$) age groups in conservation of water.
Differences Between Older and Younger Children in Conservation of Number

Reference to Table 3 shows that, with respect to age, an F ratio of 11.290 (df 3, 144) was significant at the .01 level. After a Tukey's test of significance between means was performed (Table 8), it was revealed that:

(1) Children at the second age level (7 years, 7 months to 8 years, 6 months) did significantly better at the .05 level than children at the first age level (6 years to 7 years, 6 months) in conservation of number.

(2) Children at the third age level (8 years, 7 months to 9 years, 6 months) did significantly better at the .05 level than children at the first age level (6 years to 7 years, 6 months) in conservation of number.

(3) Children at the fourth age level (9 years, 7 months to 10 years, 6 months) did significantly better at the .05 level than children at the first age level (6 years to 7 years, 6 months) in conservation of number.

There was no significant difference in performance on conservation of number between children of other age levels.
TABLE 8
COMPARISON OF MEANS OF THE FOUR AGE GROUPS IN CONSERVATION OF NUMBER
(TUKEY'S POSTERIORI TEST)

<table>
<thead>
<tr>
<th>Group Mean</th>
<th>C₁</th>
<th>C₂</th>
<th>C₃</th>
<th>C₄</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.700</td>
<td>3.325</td>
<td>3.725</td>
<td>3.900</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>C₁</th>
<th>C₂</th>
<th>C₃</th>
<th>C₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>C₁</td>
<td>----</td>
<td>0.625 *</td>
<td>1.025 *</td>
<td>1.200 *</td>
</tr>
<tr>
<td>C₂</td>
<td>----</td>
<td>0.400</td>
<td>0.575</td>
<td></td>
</tr>
<tr>
<td>C₃</td>
<td>----</td>
<td>----</td>
<td>0.175</td>
<td></td>
</tr>
<tr>
<td>C₄</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td></td>
</tr>
</tbody>
</table>

HSD = q/₄ \sqrt{MS error/₄₀} = 0.584 (Critical)

Differences Between Older and Younger Children in Conservation of Area

An examination of Table 4 shows that, with respect to age, an F ratio of 5.446 (df 3, 144) was significant at the .05 level. Table 9 shows the differences between means of the four age groups in conservation of area. Tukey's post hoc test (Table 9) reveals that:

(1) There was a significant difference in performance at the .05 level between children at the oldest
### TABLE 9
COMPARISON OF MEANS OF THE FOUR AGE GROUPS IN CONSERVATION OF AREA
(TUKEY'S POSTERIORI TEST)

<table>
<thead>
<tr>
<th>Group Mean</th>
<th>$C_1$ 1.350</th>
<th>$C_2$ 1.500</th>
<th>$C_3$ 1.725</th>
<th>$C_4$ 1.900</th>
</tr>
</thead>
<tbody>
<tr>
<td>$c_1$</td>
<td>-----</td>
<td>0.150</td>
<td>0.375</td>
<td>0.550 *</td>
</tr>
<tr>
<td>$c_2$</td>
<td>-----</td>
<td>0.225</td>
<td>0.400 *</td>
<td>----</td>
</tr>
<tr>
<td>$c_3$</td>
<td>-----</td>
<td>----</td>
<td>0.175</td>
<td>----</td>
</tr>
<tr>
<td>$c_4$</td>
<td>-----</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{HSD} = \frac{q}{\sqrt{n}} \sqrt{\frac{\text{MS error}}{40}} = 0.383 \quad \text{(Critical)}
\]

age group (9 years, 7 months to 10 years, 6 months) and children at the youngest age group (6 years to 7 years, 6 months) in conservation of area.

(2) There was a significant difference in performance at the .05 level between children at the oldest age group (9 years, 7 months to 10 years, 6 months) and children at the second age group.
(7 years, 7 months to 8 years, 6 months) in conservation of area.

There was no significant difference in performance on conservation of area between children at the other age levels.

Discussion of Results

Figures 6, 7, 8, and 9 show the percent of children at each age level who were considered conservers as defined in this investigation, using clay, water, number, and area. In general, the percent of conservers increases with age with the youngest children having the smallest percent of conservers and the oldest children having the largest percent of conservers. Figures 7, 8, and 9 show that 75 percent of all children interviewed showed evidence of conservation of water, number, and area at the third age level (8 years, 7 months to 9 years, 6 months). It is of interest to note that only 70 percent of all children showed ability to conserve clay at the oldest age level (9 years, 7 months to 10 years, 6 months). This is surprising since the children play a lot with clay in modeling toys and they also help their parents in building mud houses. Otaala (1973), in working with Ugandan children, found that children showed poorer performance in conservation of clay than they did in conservation of other quantities such as water and pebbles.

The significant differences between older and younger children's performance on all conservation tasks in this
investigation support Piaget's contention that the ability to conserve increases with age.

Conditions in the Home and Their Relation to the Children's Performance on Conservation of Clay, Water, Number, and Area

A step-wise multiple regression (Statistical Package for the Social Sciences - Version 5.01) was performed to ascertain whether certain conditions in the home could be used as predictors of the child's performance on conservation. This step-wise multiple regression was computed for five independent variables: parents earning wages, type of house, chores done before and after school, number of siblings, and news media in the home. Each variable was examined for the proportion of variance in the child's score that was dependent upon or predicted by it. The proportion is expressed in percentage and is obtained by multiplying 100 by the change in R^2 (Guilford, 1965, p. 399). The summary tables for the step-wise regression are presented below.

An examination of Table 10 shows that only 8 percent of the variance in the total score on conservation of clay was contributed by the number of siblings the children have. The type of house in which the children live accounted for only 1 percent of the variance in the total scores for conservation of clay. One percent of the variance was
TABLE 10
INDEPENDENT VARIABLES AS PREDICTORS OF TOTAL SCORES FOR CONSERVATION OF CLAY

<table>
<thead>
<tr>
<th>Rank order</th>
<th>Multiple R</th>
<th>Multiple R²</th>
<th>Change in R²</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry of Independent Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of siblings</td>
<td>0.2861</td>
<td>0.0818</td>
<td>0.0818</td>
<td>1/158</td>
</tr>
<tr>
<td>Type of house</td>
<td>0.3182</td>
<td>0.1013</td>
<td>0.0194</td>
<td>2/157</td>
</tr>
<tr>
<td>Chores</td>
<td>0.3385</td>
<td>0.1146</td>
<td>0.0133</td>
<td>3/156</td>
</tr>
<tr>
<td>Parents earning wages</td>
<td>0.3406</td>
<td>0.1160</td>
<td>0.0014</td>
<td>4/155</td>
</tr>
<tr>
<td>News media</td>
<td>0.3409</td>
<td>0.1162</td>
<td>0.0002</td>
<td>5/154</td>
</tr>
</tbody>
</table>

corresponded by the type of chores the children do before and after school. The other variables contributed less than 1 percent to the variance in the total scores for conservation of clay.

An examination of Table 11 reveals that the number of siblings a child has contributed to 8 percent of the variance in the total scores for conservation of water. Chores done before and after school contributed to 2 percent of the variance. Two percent of the variance was accounted for by the type of house.

News media in the home contributed to 3.9 percent of the variance and the last variable (Parents earning wages)
TABLE 11
INDEPENDENT VARIABLES AS PREDICTORS OF
TOTAL SCORES FOR CONSERVATION OF WATER

<table>
<thead>
<tr>
<th>Rank order</th>
<th>Number of siblings</th>
<th>Multiple R</th>
<th>Multiple R^2</th>
<th>Change in R^2</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry of Independent Variables</td>
<td>0.2914</td>
<td>0.0849</td>
<td>0.0849</td>
<td>1/158</td>
<td></td>
</tr>
<tr>
<td>Chores</td>
<td>0.3347</td>
<td>0.1121</td>
<td>0.0272</td>
<td>2/157</td>
<td></td>
</tr>
<tr>
<td>Type of house</td>
<td>0.3746</td>
<td>0.1403</td>
<td>0.0282</td>
<td>3/156</td>
<td></td>
</tr>
<tr>
<td>News media</td>
<td>0.4245</td>
<td>0.1802</td>
<td>0.0399</td>
<td>4/155</td>
<td></td>
</tr>
<tr>
<td>Parents earning wages</td>
<td>0.4319</td>
<td>0.1866</td>
<td>0.0064</td>
<td>5/154</td>
<td></td>
</tr>
</tbody>
</table>

accounted for less than 1 percent of the variance in the total scores for conservation of water.

Table 12 shows that the number of siblings that the children have contributed to 5 percent of the variance in the total scores for conservation of number. The type of house contributed to 3 percent of the variance. Chores done before and after school contributed to 2 percent of the variance. The other two variables accounted for less than 1 percent each for the variance in the total scores for conservation of number.

Table 13 shows that the type of house children live in accounted for 2 percent of the variance in the total scores for
### TABLE 12

INDEPENDENT VARIABLES AS PREDICTORS OF TOTAL SCORES FOR CONSERVATION OF NUMBER

<table>
<thead>
<tr>
<th>Rank order Entry of Independent Variables</th>
<th>Multiple R</th>
<th>Multiple R²</th>
<th>Change in R²</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of siblings</td>
<td>0.2255</td>
<td>0.0508</td>
<td>0.0508</td>
<td>1/158</td>
</tr>
<tr>
<td>Type of house</td>
<td>0.2986</td>
<td>0.0892</td>
<td>0.0383</td>
<td>2/157</td>
</tr>
<tr>
<td>Chores</td>
<td>0.3422</td>
<td>0.1171</td>
<td>0.0279</td>
<td>3/156</td>
</tr>
<tr>
<td>News media</td>
<td>0.3563</td>
<td>0.1269</td>
<td>0.0098</td>
<td>4/155</td>
</tr>
<tr>
<td>Parents earning wages</td>
<td>0.3656</td>
<td>0.1337</td>
<td>0.0067</td>
<td>5/154</td>
</tr>
</tbody>
</table>

### TABLE 13

INDEPENDENT VARIABLES AS PREDICTORS OF TOTAL SCORES FOR THE CONSERVATION OF AREA

<table>
<thead>
<tr>
<th>Rank order Entry of Independent Variables</th>
<th>Multiple R</th>
<th>Multiple R²</th>
<th>Change in R²</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of house</td>
<td>0.1595</td>
<td>0.0254</td>
<td>0.0254</td>
<td>1/158</td>
</tr>
<tr>
<td>Chores</td>
<td>0.2209</td>
<td>0.0488</td>
<td>0.0234</td>
<td>2/157</td>
</tr>
<tr>
<td>Number of siblings</td>
<td>0.2320</td>
<td>0.0538</td>
<td>0.0050</td>
<td>3/156</td>
</tr>
<tr>
<td>News media</td>
<td>0.2354</td>
<td>0.0554</td>
<td>0.0016</td>
<td>4/155</td>
</tr>
<tr>
<td>Parents earning wages</td>
<td>0.2366</td>
<td>0.0559</td>
<td>0.0006</td>
<td>5/154</td>
</tr>
</tbody>
</table>
for the conservation of area. Chores done before and after school contributed to 2 percent of the variance, and the other 3 variables accounted for less than 1 percent each for the variance in the total scores for conservation of area.

Discussion of Results

The number of siblings the child has accounted for the greater percent of the variance in the total scores for conservation of clay, water, and number (8%, 8%, and 5%) respectively. Although the predictability value of this variable is not high, the results suggest that the number of siblings do affect the child's ability to conserve. These results are supportive of the findings by Mehryar (1972) that family size affects academic success.

It is of interest to note that even when all the variables are combined, they accounted for a small percent of the variance in total scores for conservation of clay, water, number, and area -- 11%, 18%, 13%, and 5% respectively. (Tables 10, 11, 12, and 13). This suggests that all these variables have very little influence on the child's performance on conservation tasks. Since these particular home background factors do not greatly affect the child's ability to conserve, the question arises -- what other factors in the child's home affect the child's ability to conserve?
In relation to the hypotheses set forth in this investigation several questions were raised. The results of this investigation as they relate to these questions are discussed below.

1. Do rural school boys perform as well on conservation tasks as do city school boys or city school girls?

As shown by the analyses of the data, there was no significant difference at the .05 level between the performance of boys and the performance of girls on conservation tasks. Tables 1, 2, 3, and 4 show that with respect to the interaction of sex and environment (AB) on conservation of clay, water, number, and area, the F ratios for this interaction failed to reach significance at the .05 level. However, this does not mean that there were no differences in performance between boys and girls. An examination of Appendix B Table 15 reveals that rural school boys had higher mean scores than city school boys in conservation of clay, number, and area. Also rural school boys had higher mean scores than city school girls in all conservation tasks. It is of interest to note that the rural school boys had the
highest mean score for conservation of area. All the rural school boys spend their time after school looking after cattle. The marked superiority of rural boys over all other children (city school children and rural girls) in conservation of area could be attributed to the fact that rural boys spend a great deal of their time exploring land and finding their way around in geographical area.

2. Do rural school girls perform as well on conservation tasks as do city school girls or city school boys?

Inspection of Tables 1, 2, 3, and 4 reveals that the F ratios for the interaction of environment and sex (AB) in the conservation of clay, water, number, and area failed to reach significance at the .05 level. However, an examination of Appendix B, Table 15 shows that the rural school girls had consistently higher mean scores than the city school girls in all conservation tasks. The only task in which rural school girls had a higher mean score than city school boys was in conservation of clay. The superiority of rural school girls over city school girls in all conservation tasks could be attributed to the fact that
rural school girls interact with a variety of objects in a diverse environment. Many of the rural school girls in this study help the family in cultivation in the family garden, they fetch water every day and often they collect firewood for cooking.

3. When categorized by chronological age (6 - 7½ years, 7½ to 8½ years, 8½ to 9½ years, 9½ to 10½ years), is there any difference in performance on conservation tasks between children of adjacent age levels; for example, do 6 to 7½ year-old children perform as well as 7½ to 8½ year-old children?

In general, there was no significant difference in performance at the .05 level between children of adjacent age levels except in conservation of water and number where children at the second age level (7 years, 7 months to 8 years, 6 months) did significantly better at the .05 level than children at the first age level (6 years to 7 years, 6 months). Table 16 in Appendix B shows the mean scores of children of different age levels in conservation of clay, water, number, and area. The fact that there was no significant difference in performance between children of adjacent age levels in all
conservation tasks is not surprising since there was only one year's difference in age between children of adjacent age levels.

4. Do children from the more expensive city schools perform better on conservation tasks than children from the low-cost city schools?

Appendix B, Table 17 shows the percent of children from expensive and low-cost city schools revealing conservation of clay, water, number, and area. Although the children from the more expensive city schools were fewer than those from the low-cost city schools (32 and 48 respectively), it appears that the children from the low-cost schools had higher percentages of conservers at the first three age levels than the children from the more expensive city schools. These results do not support the findings by Etuk (1967) and Lloyd (1971) that children from elite homes had a higher level of performance on conservation tasks than children from traditional homes. The children attending the more expensive city schools come from a more "advantaged" environment compared to those children who attend low-cost schools. All children from the more expensive city schools come from modern homes
(they have modern conveniences of electricity and water in their houses and at least one of their parents holds a good position in industry or in one of the professions). The more expensive schools contain better facilities for learning -- they have better qualified teachers, the classrooms are not overcrowded, and there is a variety of teaching aids available. One wonders then why children from these schools did not surpass those from low-cost schools in conservation tasks.

One hypothesis could be that children from the more "advantaged" homes do not have opportunities to manipulate objects in their environment in such a manner that they learn from this involvement. Children from the low-cost schools would normally learn to conserve while they do their chores before and after school, an opportunity that children from "advantaged" homes might not have since servants do all these chores. More research is needed in analyzing the type of environment (both school and home) from which these children come.

5. Do Kenya African children attain conservation at ages comparable to those of children from Western cultures?
It is Piaget's contention that when 75 percent of the children of a particular age group can successfully complete a task, it can be assumed that children of that age should normally be able to perform that task (Piaget, 1964). Lovell and Ogilvie (1960) reported that 73 out of 99 children of average age 9 years, 9 months showed conservation of substance. Elkind (1961) reported that the conservation of mass did not usually appear before the ages 7 to 8 years.

When Piaget's criterion is applied to this investigation, Figures 6 through 9 show that, except for conservation of clay children at the 8 years, 7 months to 9 years, 6 months, and children at the 9 years, 7 months to 10 years, 6 months meet this criterion. It is evident then that Kenya African children do attain conservation at ages comparable to those of children from Western cultures. The developmental lag in ability to conserve that has been reported in children from non-Western cultures (De Lemos, 1969; Heron, 1969; Zarour, 1971; and Dasen, 1972) was not found in this study.

Figures 2, 3, 4, and 5 also show a general increase in the number of conservers as
FIGURE 6

PERCENT OF CHILDREN AT THE 6.0 – 7.6 YEAR – OLD-LEVEL CONSERVING THE FOUR TYPES OF QUANTITIES
### Table

<table>
<thead>
<tr>
<th>Type of Quantity</th>
<th>Quantity Type</th>
<th>Rural Children</th>
<th>City Children</th>
<th>All Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Figure 7

Percent of children at the 7, 7 - 8, 6 year-old-level conserving the four types of quantities.
FIGURE 8
PERCENT OF CHILDREN AT THE 8, 7 - 9, 6 YEAR-OLD-LEVEL CONSERVING THE FOUR TYPES OF QUANTITIES
FIGURE 9
PERCENT OF CHILDREN AT THE 9, 7 - 10, 6 YEAR-OLD-LEVEL CONSERVING THE FOUR TYPES OF QUANTITIES
children get older. This pattern of increase in ability to conserve with age has also been found among western cultures.

An examination of children's explanations for conserving responses (Appendix B, Table 18) shows the majority of explanations that children gave were of the Identity type ("They were the same at the beginning," or "It is the same water that you started with.") and of the Indirect Action type ("You can roll it back into a ball," or "If you poured this back into the jar, they'd be the same."). The second largest category of explanations is one termed "Silence". In this case, children could see the invariance of quantity after transformations but gave no explanations at all for their judgment. This was the case especially with rural children. These children were shy and often looked down when they were asked to justify their answers. However, it is not surprising that quite a number of children gave no explanations for their judgment in view of the fact Kamba children are not accustomed to justifying their actions. Children are only asked "why questions" when they have done something wrong.
An examination of Appendix B, Table 19 shows that most of the explanations given for non-equality of quantity after transformations were of the perceptual type ("Because yours is longer," or "Because the water is in 3 cups."). Greenfield (1966) reported this type of explanation for non-conserving responses with the Wolof children in Senegal. Unlike Greenfield's findings, however, there were very few children who exhibited reliance on magical beliefs by giving action-magic type of explanations termed here "Romancing". ("Because you made it that way," or "Because you poured it into the bowl.") This investigator found only a total of 13 such responses.

6. Does the number of years that Kenya African children have spent in school affect their performance on conservation tasks?

Appendix B, Table 20 shows the percent of children at different grade levels exhibiting various categories of conservation. The trend is definitely one of increase in the number of conservers with increase in the number of years spent in school. These results must, however, be interpreted with caution since the children at each grade level were not of the same age.
Some children in Kenya, especially in the rural areas, do not enter school until the age of 9 or 10 years. This is partly because some parents cannot afford to pay school fees and also children are needed to help parents in the cultivation of crops.

**Summary**

This chapter has presented the results of the analyses of the data. The analyses were presented and discussed in five sections: (1) Differences in performance between the rural and the city school children on conservation of clay, water, number, and area. (2) Differences in performance between boys and girls on conservation of clay, water, number, and area. (3) Differences in performance between older and younger children on conservation of clay, water, number, and area. (4) Conditions in the home and their relation to the children's performance on conservation of clay, water, number, and area. (5) Questions related to the hypotheses of this study.

The next chapter presents a summary of the study, conclusions based on the data of the study, and implications for education and research in Kenya based on the study.
CHAPTER V
SUMMARY, CONCLUSIONS, AND IMPLICATIONS

In this chapter, the summary, conclusions, and implications of this study are presented in the following sections:

1) Summary - a description of the overview of the study.
2) Conclusions - based on the results of the study.
3) Implications for education and research in Kenya.

Summary

The purpose of this study was to determine what empirical links may be present between cognitive development and environmental factors in the child's development. To this end, the study investigated the effects of environment (rural versus city) on Kenyan children's performance on Piagetian conservation tasks of clay, water, number, and area. Also the effects of sex (boys/girls) and age on children's performance on conservation tasks were examined.

The subjects for this study were Kenya African school children ages 6 years to 10 years, 6 months. A total of 160 children were interviewed for this study. Of these, 80 children were from 10 rural schools in Machakos and the
other 80 children were from 10 city schools in Nairobi. The children were individually interviewed by the investigator using Piaget's clinical method. The treatment consisted of four conservation tasks using clay, water, pieces of wood (for number), and construction paper (for area). The children were asked to respond to two questions each for the conservation tasks of clay, water, and number, and to respond to one question for the task requiring conservation of area.

Six hypotheses were tested using Analysis of Variance. Also six independent variables -- father earning wages, mother earning wages, type of house, chores done before and after school, number of siblings, and news media in the home -- were examined to determine their predictive value on children's performance on conservation tasks.

Conclusions

On the basis of the results of this study, the following evaluations of the hypotheses were made.

H₀¹. There is no significant difference at the .05 level between the performance of Kenyan rural school and city school children on conservation of clay.

There was a significant difference at the .05 level in favor of the rural school children on their performance on conservation
tasks using clay. The hypothesis of no difference is therefore rejected.

H₀₂. There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on conservation tasks using water.

This hypothesis is retained since there was actually no significant difference in performance at the .05 level between rural school children and city school children.

H₀₃. There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on conservation of number.

There was a significant difference at the .05 level between the youngest rural school children (6 years to 7 years, 6 months) and the city school children of the same age level in their performance on conservation of number. The difference was in favor of the rural children.

There was no difference in performance between the rural and the city children at the other age levels in their performance on conservation of number. Therefore, this hypothesis is retained.
$H_04$. There is no significant difference at the .05 level between the performance of Kenyan rural school children and city school children on conservation of area.

There was actually no significant difference between the rural and the city children in their performance on conservation of area, therefore, this hypothesis is retained.

$H_05$. There is no significant difference at the .05 level between the performance of Kenyan boys and the performance of Kenyan girls on conservation tasks.

This hypothesis is retained since there was actually no significant difference in performance between Kenyan boys and girls on all conservation tasks.

$H_06$. There is no significant difference at the .05 level between the performance of older Kenyan children and younger Kenyan children on conservation tasks.

A. There was a significant difference at the .05 level between the oldest children (9 years, 7 months to 10 years, 6 months) and the youngest children (6 years to 7 years, 6 months) on their performance on conservation of clay.
There was no significant difference between the other age groups in their performance on conservation of clay.

B. There was a significant difference in performance at the .05 level between children at the youngest age level (6 years to 7 years, 6 months) and children at each of the older age levels (7 years, 7 months to 8 years, 6 months; 8 years, 7 months to 9 years, 6 months and 9 years, 7 months to 10 years, 6 months) in conservation of water.

There was no significant difference in performance at the .05 level between children at the other age levels on conservation of water.

C. There was a significant difference in performance at the .05 level between the youngest children (6 years to 7 years, 6 months) and children at each of the older age levels (7 years, 7 months to 8 years, 6 months; 8 years, 7 months to 9 years, 6 months; and 9 years, 7 months to 10 years, 6 months) in conservation of number.

There was no significant difference in performance at the .05 level between children at the other age levels.
D. There was a significant difference in performance at the .05 level between children at the fourth age level (9 years, 7 months to 10 years, 6 months) and children at each of the two youngest age levels (6 years to 7 years, 6 months and 7 years, 7 months to 8 years, 6 months) in conservation of area.

There was no significant difference in performance at the .05 level between children of the other age levels.

It can be concluded that in all conservation tasks there was a significant difference in performance at the .05 level between the youngest children and the oldest children. There was no significant difference in performance at the .05 level on all conservation tasks between older and younger children at the other age groups.

Since older children performed significantly better than younger children in all conservation tasks, this hypothesis was rejected.

H₇. Of the following independent variables, there is no one variable or combination of variables which is a predictor of children's performance on conservation tasks.
1. Father earning wages
2. Mother earning wages
3. Type of house
4. Chores done before and after school
5. Number of siblings
6. News media in the home

It was found that these independent variables (either individually or combined) had a low predictability value on the children's performance on conservation tasks. Therefore, this hypothesis is retained.

In relation to these hypotheses, the questions asked at the beginning of the study were answered as follows:

1. Do rural school boys perform as well on conservation tasks as do city school boys or city school girls?

   Rural school boys performed better than city school girls in all conservation tasks, however, these differences in performance were not significant at the .05 level. Therefore, it can be concluded that rural school boys perform as well on conservation tasks as city school boys or city school girls.

2. Do rural school girls perform as well on conservation tasks as do city school girls or city school boys?

   Rural school girls performed better than city school girls in all conservation tasks, however, these differences in performance were not
significant at the .05 level. Therefore it can be concluded that rural school girls perform as well on conservation tasks as city school girls or city school boys.

3. When categorized by chronological age (6 to 7$\frac{1}{2}$ years, 7$\frac{1}{2}$ to 8$\frac{1}{2}$ years, 8$\frac{1}{2}$ to 9$\frac{1}{2}$ years, and 9$\frac{1}{2}$ to 10$\frac{1}{2}$ years) is there any difference in performance on conservation tasks between children of adjacent age levels; for example do 6 to 7$\frac{1}{2}$ year-old children perform as well as 7$\frac{1}{2}$ to 8$\frac{1}{2}$ year-old children? Except for conservation of water and numbers where there is a difference in performance between the 6 to 7$\frac{1}{2}$ year-old children and the 7$\frac{1}{2}$ to 8$\frac{1}{2}$ year-old children, there is no significant difference in performance at the .05 level on conservation between children of adjacent age levels in this study.

4. Do children from the more expensive city schools perform better on conservation tasks than children from the low cost city schools? Except for children at the oldest age level where children from the more expensive city schools did as well or better than children from the less expensive city schools, there was a difference in performance on all conservation tasks between children from the more expensive
city schools and children from the low-cost schools. This difference was in favor of children from the low-cost city schools.

5. Do Kenya African children attain conservation at ages comparable to those of children from Western cultures?

On the basis of the results of this study, it can be concluded that Kenya African children attain conservation at about the same ages as children from Western cultures and also that Kenyan children give explanations for conserving and non-conserving responses that are almost identical to those given by children from Western cultures.

6. Does the number of years that Kenya African children have spent in school affect their performance on conservation tasks?

There is an increase in the number of conservers with an increase in the number of years spent in school. However, this increase in ability to conserve is confounded with age since there were children of differing ages at each grade level and, hence, it is difficult to say whether this increase is attributed to number of years spent in school or to age.
Implications

Results from the present study indicate certain implications for education in Kenya. These implications are presented here under the following headings: Teachers and Parents, Curriculum Planners, Teacher Education, and Recommendations for Further Research.

Teachers and Parents

The findings from this investigation suggest the following implications for teachers and parents.

1. The child's environment plays a significant role in his acquisition of logical thinking skills. Teachers, therefore, should provide a rich and stimulating environment for the children they teach. Provision of materials, however, does not mean provision of experience. The teacher should pay attention to the internal structuring of the learners because it is this internal structuring which ultimately defines experience. Interaction with the child, that is, occasional questioning of the child about his experience with some materials, should help the teacher understand the exact nature of the specific actions by the child.

2. The finding that Kenyan children of ages 6 years to 10 years, 6 months are at different stages in their ability to conserve suggests that learning environment should not be rich only in terms of variety, but also in terms of what Hunt (1961) calls the appropriate "match" between the
environment and the child. This implies that the teacher should get on the "inside" of the child by providing materials, asking questions, posing problems, et cetera, that match the intellectual structures of the child.

3. It was found that Kenyan children are not accustomed to justifying their responses. Teachers should help children cross the barrier from learning to thinking by having children reflect on their experiences. Children should occasionally engage in discourses in which they challenge each other both in terms of linguistic precision and in terms of ideas. Social interaction should not be limited to peers but teachers and other adults should pose questions to children that would force them to think of alternative ways of solving problems.

4. Piaget has discussed the significance of play in helping the child acquire appropriate conceptual and representational schemas (Piaget, 1951). Some Kenyan parents and teachers think play is a waste of time. Yet children use play to test certain physical principles. For example, considerable exposure to clay and opportunities to manipulate it might have accounted for the rural children's better performance on the conservation task using clay in this investigation. Parents and teachers should provide children with opportunities for free play for it is through play that a child may be confronted with the unexpected which might
cause cognitive conflict and thus force the child to reorganize his cognitive structure.

5. It is possible that some children in the present study who were unable to conserve had not had many opportunities to find alternative solutions to problems posed to them by adults. The belief by many adults and parents that there is "one correct way" of doing something prevents children from seeing alternative ways of solving problems. Parents should encourage children to discuss natural phenomena in their surroundings.

Curriculum Planners

1. This investigation has demonstrated the nature of children's thought at the concrete operations stage. Although all children were supposed to be at the same stage in cognitive development, there were some differences among children with a few of the oldest children unable to conserve. This suggests that as experts plan curriculum and teaching strategies, they should consider the nature of child thought. Activities that will enable those children at the Transitional and Non-conserving stages to become conservers should be included in the curriculum.

2. Effective cooperation of school, home, and educators should be sought so that the child's out-of-school experiences are related to his ways of thinking. Curriculum planners should involve parents and other community experts in the education of children. These significant other adults
should be invited to the schools to share their expertise with children. It is this active involvement with children in a learning situation that will help parents and other adults understand how the child thinks at different stages in his development.

3. In the present investigation, it was found that a relatively large number of children were unable to give reasons or to justify their answers when asked to do so. This inability to express oneself could have been brought about by the present linguistic confusion in the schools. Children are expected to learn and express themselves in English when they start school in Standard I. This happens at the time when children are beginning to master self expression in their own language. It is possible that the interference of a second language at this time retards the children in expressing themselves in their own language.

Teacher Education

At one of the few times when he addressed himself to the relevance of his theory to education, Piaget stated:

The principal goal of education is to create men who are capable of doing new things, not simply repeating what other generations have done...The second goal of education is to form minds which can be critical, can verify, and do not accept everything they are offered...so we need pupils who are active, who learn early to find out for themselves, partly by their own spontaneous activity, and partly through material we set up for them." (Duckworth, 1964, p. 175).
The implication of this statement for teacher training and teacher education is obvious.

1. Prospective teachers in Kenya should be allowed to work on an original investigation in which they find out how children think about some problem. (Perhaps an investigation similar to the present study but on a much smaller scale). It is only by working directly with children that prospective teachers will find how children view their world and consequently they (prospective teachers) will be forced to seek alternative ways of presenting different problems to children.

2. The problem facing teacher education in Kenya now is one of general education of teachers as well as the length and type of their professional training. Early this year professional training of teachers was reduced to one year in order to supply enough teachers for the large number of children enrolled in schools this year. Primary enrollment will increase each year since education is free now for children in Standard I through Standard IV. However, one year is not long enough for prospective teachers to learn the theoretical bases for education as well as to put that theory into action in the classroom. It is recommended that teacher training be extended to at least 2 years. Prospective teachers should be given ample time and opportunities to work closely with children in the classroom as participants as well as observers. Student
teachers should be given ample time to learn how to use classrooms as learning laboratories. An adequate knowledge base to translate human growth and development theory into practice can only be built as experimentation is undertaken in classroom laboratory settings.

3. Efforts should be made to help close the gap between theory and practice by having continuous professional renewal and career development for those teachers already out in the "field" so that their professional training does not terminate at the end of their preservice training. In-service workshops should be established at teacher training institutions so that new knowledge on education and child development can be easily disseminated.

Recommendations for Further Research

1. There is a need for more studies of the development of Kenyan children so that educational planning will not have to depend so much on information about the development of children in other parts of the world but will be based on knowledge of Kenyan children.

2. The importance of the physical as well as the social environment of children in the development of the concept of conservation has been stressed throughout this investigation. Further studies of children's environment should be carried out so that accurate analysis of the social and physical environment can be obtained. Once this has been accomplished, then a Piagetian investigation of this nature
can be carried out to link certain aspects of the child's environment to his ability to conserve, seriate, or classify objects.

3. A longitudinal study should be carried out with groups of children of various age levels, starting with three to four year-olds. The purpose of this study should be to examine in detail the antecedents of certain preschool notions that the child brings with him to school.

4. There is a need to study the role of early childhood experience (relationship of mother's attitudes and behavior toward the child, the influence of other adults in the extended family, child rearing practices, and the child's manifest of curiosity) in shaping cognitive development.

5. Most of the children in the present study were from one tribe -- the Kamba. This study should be repeated with children of other tribes to see if similar trends in development would be found.

6. Several studies done in Africa have mentioned the prevalence of magical and supernatural beliefs among Africans. This investigator has found no studies reporting the prevalence of magical and supernatural beliefs in primary school children in Kenya. There is a need for investigation concerning the magical and superstitious beliefs of children and the effect of these beliefs on children's views of the world around them.
Some of the outstanding problems of research in Kenya which have been mentioned above encompass learning, motivation, group behavior and other aspects of child development that might affect cognitive development. These problems cannot be solved by the efforts of one person. The solution lies in a multi-disciplinary research. It is hoped that scholars in various disciplines will undertake such research.

Summary

The present study investigated the effects of environment, sex, and age on Kenyan children's acquisition of the concept of conservation. This chapter presented the summary of the study as well as the conclusions drawn from the results. Implications for education in Kenya and recommendations for further research have also been delineated.
INTERVIEW FORMAT FOR THE CLAY TASK

Procedure:

Show the subject the two lumps of clay already shaped into balls.

Then proceed as follows.

"What is this?"

"Have you ever used it? In what way?"

"Now I want you to look at these balls of clay very closely. Is there the same amount of clay in each ball?" (If subject says "no" ask him to make the balls equal.)

"So if I used this (pointing to one of the balls) and you used that (pointing to the other ball) we would be using the same amount of clay." If the subject agrees with this statement, then proceed.

"Now watch, I am going to do something to this." (one of the balls of clay -- flattening it)

"What does it look like?" (Subject should say "round, flat, like a wheel.")

"If I used this (the flat one) and you used that, (the ball) would I be using more or less or would we be using the same amount of clay? Why or why not?"

"Now I am going to do something else to this." (the flat lump of clay -- making it into a 'sausage' shape)

"What does it look like?" (Subject should say "like a piece of stick, like a bone or like a sausage.")
"Now if I used this clay (sausage shape) and you used that (the ball) would I be using more or less or would we be using the same amount of clay? Why or why not?"
INTERVIEW FORMAT FOR THE WATER TASK

Procedure:

"Here I have water in 2 jars. I want you to look at it and tell me if there is the same amount of water in each jar." (If subject says it is not equal, ask him to make if equal. After subject is satisfied that the two amounts of water are equal, then proceed.)

"So if I drank this (pointing to one of the jars) and you drank that (pointing to the other), we would be drinking the same amount." After the subject agrees then say, "Now I am going to pour this water (taking one of the jars) into this bowl. If I drank this water (pointing to the bowl) and you drank this (pointing to the jar) would I be drinking more or less or would we be drinking the same amount? Why? Why not? (if subject says "no")

"Now I am going to pour this water (pointing to the bowl) into these three cups. If I drank this water (pointing to water in 3 cups) and you drank this (pointing to the water in the jar) would I be drinking more or less or would we be drinking the same amount? Why?"

If subject says no, then ask, "Why not?"
INTERVIEW FORMAT FOR THE NUMBER TASK

Procedure:

"Here I have some pieces of wood." (Let subject handle them.) "I am going to arrange these pieces of wood in a line like this (Arrange eight on a line about 1 1/2 inches apart.) Now count them aloud and tell me how many pieces of wood I have on the line." (Make sure subject says there are eight pieces of wood before proceeding.)

"Now, I would like you to take these pieces of wood (handing subject other pieces of wood) and arrange them on a line like mine. How many pieces of wood are there on your line?" (Make sure the subject agrees that there are the same number of pieces of wood on each line.)

"You agree that there is the same number of pieces of wood here (pointing to one line) and here (pointing to the other). Now, (bunching pieces of wood on experimenter's line together) are there the same number of pieces of wood here (pointing to the pile) as here (pointing to the line)? Why? If the subject says "no", then ask, "Why not?".

"Now I am going to take these pieces of wood (the pile) and I am going to arrange them on a line parallel to yours like this (arranging them about 3 inches apart).
"Is there the same number of pieces of wood here (pointing to the long line) as there are here (pointing to the short line)? Why?" If the subject says "no", then ask, "Why not?"
INTERVIEW FORMAT FOR THE AREA TASK

Procedure:

"Here I have two pieces of paper." (Let the subject handle the green pieces of construction paper.)

"Let's pretend that these pieces of paper are farms. Are they the same size?" When subject agrees they are the same size then proceed.

"We are going to use these pieces of wood (same used for the number task) for houses. Are all the pieces of wood the same size?" Let subject check them. When subject agrees they are the same size, proceed with this story.

"Here we have two farms and we have agreed they are the same size. The farms are covered with grass. Is there the same amount of grass in both farms?" When the subject agrees there's the same amount of grass proceed.

"Now each farmer is going to build houses on his farm. This farmer (pointing to one of the "farms") is going to build three houses this way (arranging houses close together) and this farmer (pointing to the other "farm") is going to build his three houses this way (arranging them about 3 inches apart in a triangular shape). Now, is there still the same amount of grass here (pointing to the farm with 3 houses close together) as there is
here (pointing to the other farm)? Why? If subject answers, "no", ask, "Why not?"
APPENDIX B
TABLE 14
Mean Scores of Children for Conservation of Clay, Water, Number, and Area

(Total possible score = 4.000 for Clay, Water, and Number, and 2.000 for Area)

<table>
<thead>
<tr>
<th>Children</th>
<th>Mean Scores for Conservation of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clay</td>
</tr>
<tr>
<td>Rural (N = 80)</td>
<td>3.175</td>
</tr>
<tr>
<td>City (N = 80)</td>
<td>2.675</td>
</tr>
<tr>
<td>Girls (N = 80)</td>
<td>2.938</td>
</tr>
<tr>
<td>Boys (N = 80)</td>
<td>2.912</td>
</tr>
</tbody>
</table>
TABLE 15
Mean Scores of Rural and City Boys and Girls for Conservation of Clay, Water, Number, and Area

(Total possible score = 4.000 for Clay, Water, and Number, and 2.000 for Area)

<table>
<thead>
<tr>
<th>Children</th>
<th>Mean Scores for Conservation of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clay</td>
</tr>
<tr>
<td>Rural Girls</td>
<td>3.275</td>
</tr>
<tr>
<td>Rural Boys</td>
<td>3.075</td>
</tr>
<tr>
<td>City Girls</td>
<td>2.600</td>
</tr>
<tr>
<td>City Boys</td>
<td>2.750</td>
</tr>
</tbody>
</table>
## TABLE 16
Mean Scores of Children at Different Age Levels for Conservation of Clay, Water, Number, and Area

(Total possible score = 4.000 for Clay, Water, and Number, and 2.000 for Area)

<table>
<thead>
<tr>
<th>Age Levels</th>
<th>Mean Scores for Conservation of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clay</td>
</tr>
<tr>
<td>6 years to 7 years, 6 months</td>
<td>2.525</td>
</tr>
<tr>
<td>7 years, 7 months to 8 years, 6 months</td>
<td>2.625</td>
</tr>
<tr>
<td>8 years, 7 months to 9 years, 6 months</td>
<td>3.175</td>
</tr>
<tr>
<td>9 years, 7 months to 10 years, 6 months</td>
<td>3.375</td>
</tr>
</tbody>
</table>
### TABLE 17

Percent of Children from Various City Schools Showing Conservation of Clay, Water, Number, and Area

<table>
<thead>
<tr>
<th>Age Levels</th>
<th>Schools</th>
<th>Percent of Children Showing Conservation of Clay Water Number Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 years to 7 years, 6 mo.</td>
<td>Expensive Schools (N = 8)</td>
<td>25 12 12 12</td>
</tr>
<tr>
<td></td>
<td>Low-cost Schools (N = 12)</td>
<td>42 58 58 58</td>
</tr>
<tr>
<td>7 years, 7 mo. to 8 years, 6 mo.</td>
<td>Expensive Schools (N = 8)</td>
<td>37 62 50 50</td>
</tr>
<tr>
<td></td>
<td>Low-cost Schools (N = 12)</td>
<td>67 83 83 83</td>
</tr>
<tr>
<td>8 years, 7 mo. to 9 years, 6 mo.</td>
<td>Expensive Schools (N = 8)</td>
<td>37 75 87 62</td>
</tr>
<tr>
<td></td>
<td>Low-cost Schools (N = 12)</td>
<td>75 92 83 75</td>
</tr>
<tr>
<td>9 years, 7 mo. to 10 years, 6 mo.</td>
<td>Expensive Schools (N = 8)</td>
<td>75 100 100 100</td>
</tr>
<tr>
<td></td>
<td>Low-cost Schools (N = 12)</td>
<td>83 83 100 92</td>
</tr>
</tbody>
</table>
TABLE 18
Number of Responses of Various Types of Explanations Given by Rural and City Children for Conservation of Clay, Water, Number, and Area

<table>
<thead>
<tr>
<th>Type of Explanation</th>
<th>Clay Rural City</th>
<th>Clay Rural City</th>
<th>Water Rural City</th>
<th>Water Rural City</th>
<th>Number Rural City</th>
<th>Number Rural City</th>
<th>Area Rural City</th>
<th>Area Rural City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silence</td>
<td>17</td>
<td>10</td>
<td>18</td>
<td>6</td>
<td>16</td>
<td>4</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Don't know</td>
<td>15</td>
<td>4</td>
<td>17</td>
<td>6</td>
<td>9</td>
<td>7</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Identity</td>
<td>33</td>
<td>44</td>
<td>65</td>
<td>82</td>
<td>84</td>
<td>80</td>
<td>55</td>
<td>52</td>
</tr>
<tr>
<td>Indirect Action</td>
<td>73</td>
<td>42</td>
<td>43</td>
<td>31</td>
<td>26</td>
<td>13</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Perceptual</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>14</td>
<td>28</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Compensation</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plus/Minus</td>
<td>1</td>
<td>6</td>
<td>-</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Includes 2 questions each for Clay, Water, and Number, and 1 question for Area
### TABLE 19

Number of Non-conserving Responses of Various Types of Explanations given by Rural and City Children on the Conservation Tasks of Clay, Water, Number, and Area

<table>
<thead>
<tr>
<th>Type of Explanation</th>
<th>Clay Rural</th>
<th>Clay City</th>
<th>Water Rural</th>
<th>Water City</th>
<th>Number Rural</th>
<th>Number City</th>
<th>Area Rural</th>
<th>Area City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silence</td>
<td>5</td>
<td>24</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Don't know</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Perceptual</td>
<td>8</td>
<td>15</td>
<td>8</td>
<td>9</td>
<td>3</td>
<td>12</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Romancing</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>12</td>
</tr>
</tbody>
</table>

Includes 2 questions each for Clay, Water, and Number, and 1 question for Area.
TABLE 20
Percent of Children in Different Grades Revealing Various Categories of Conservation of Clay (C), Water (W), Number (N), and Area (A)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Conservers</th>
<th></th>
<th>Transitional</th>
<th></th>
<th>Non-conservers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>W</td>
<td>N</td>
<td>A</td>
<td>C</td>
<td>W</td>
</tr>
<tr>
<td>Standard I</td>
<td>50</td>
<td>51</td>
<td>61</td>
<td>61</td>
<td>30</td>
<td>39</td>
</tr>
<tr>
<td>(N = 63)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard II</td>
<td>59</td>
<td>74</td>
<td>78</td>
<td>68</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>(N = 35)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard III</td>
<td>85</td>
<td>94</td>
<td>96</td>
<td>88</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>(N = 38)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard IV</td>
<td>83</td>
<td>93</td>
<td>93</td>
<td>91</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>(N = 24)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C
Categorizing Interview Data

Conservation of Clay

A. Conserver: The subject is considered a conserver if he maintains the notion that the amount of clay remains the same after two transformations (after it is flattened and after it is changed into a "sausage" shape) and also if he gives acceptable explanation for his judgement.

1. Acceptable Explanations

(i) Identity—reference to a previous state, for example, "It is the same clay that was in a ball shape and they were equal at the beginning," or simply, "They were the same at the beginning."

(ii) Indirect Action—reference to reversed or observed action, for example, "If you rolled it back into a ball, they would be the same," or "It is the same amount of clay, you just rolled it into a different shape," or "You can roll this into the same shape and you'll see they are the same."

(iii) Perceptual—reflecting appearance versus reality, for example, "It looks longer, but they are really the same," or "This is just a different shape."

(iv) Compensation—reference to different dimensions, for example, "This one is longer, but it is also thinner."

(v) Plus/Minus—reference to adding or taking away something. For example, "You did not add to it or take away any part of it, so they are still the same."
2. **Unacceptable Explanations**

(i) Silence— if subject gives no explanations at all.

(ii) Don't know— if subject indicates that he doesn't know the reason why "they are the same."

(iii) No reason— if subject says "For no reason" or "for nothing".

(iv) Romancing— if the subject gives irrelevant reasons. For example, "It is the same because you changed it."

B. **Transitional or Partly Conserving:** The subject is placed in this category if he says that the amount of clay is the same after two transformations but is unable to give adequate explanations for his judgment or if he says the amount of clay is an adequate explanation for that one judgment.

C. **Non-conserver:** The subject is placed in this group if he indicates that the amount of clay is not the same after two transformations. For example, "You have more clay" or "I have more clay."

1. **Explanations given**

   (i) Silence— if the subject gives no explanation at all.

   (ii) Don't know— if the subject says that he doesn't know the reason "why they are not the same."

   (iii) Perceptual— if the subject attends to only one aspect of the situation. For example, "The clay is more because it is flat."
(iv) Romancing— if he gives irrelevant explanations. For example, "This is more because you made it that way."

(v) No reason— if the subject says "for no reason," or "for nothing."
Categorizing Interview Data

Conservation of Water

A. Conserver: The subject is considered a conserver if he says that the amount of water remains the same after it is poured into a bowl and then into three cups, and if the subject gives acceptable explanations for his reasoning.

1. Acceptable Explanations

(i) Identity—"It is the same water that was in the jar," or "It was same at the beginning."

(ii) Indirect Action—"If you poured it back into the jar, you would see it is the same."

(iii) Perceptual—"It looks more, but it is really the same."

(iv) Compensation—"The bowl is wider than the jar and so the water looks less but it is really the same."

(v) Plus/Minus—"You did not add to it or pour it off."

2. Unacceptable Explanations

(i) Silence—if the subject gives no explanation at all.

(ii) Don't know—if he says that he does not know the reason why the amount of water is the same.

(iii) No reason—if he says "for no reason," or "for nothing."

(iv) Romancing—if he says "Because you poured it into these cups."
B. **Transitional or Partly Conserving:** The subject is placed in this category if he says the amount of water remains the same after it has been poured into a bowl and then into three cups, but does not give adequate explanations for his reasons, or if the subject says the water is the same after one transformation and gives adequate explanation for that judgment.

C. **Non-Conserver:** The subject is considered a non-conserver if he says that the amount of water is not the same after two transformations.

1. **Explanations given**
   
   (i) Silence—if the subject gives no explanation at all.

   (ii) Don't know—if the subject says that he does not know why the water is not the same.

   (iii) Perceptual—if the subject attends to only one aspect of the situation for example "The water is more because the bowl is bigger," or "Because it is in three cups."

   (iv) Romancing—if he gives irrelevant explanations, for example, "It is more because you poured it into the bowl."

   (v) No reason—if the subject says, "for no reason" or "for nothing".
Categorizing Interview Data

Conservation of Number

A. Conserver: The subject is considered a conserver if he maintains the notion that the number of pieces of wood remains the same after they have been bunched together and then spread out and if he gives acceptable explanations for his judgment.

1. Acceptable Explanations

(i) Identity—"They are the same pieces of wood that were on the line."

(ii) Indirect Action—"You just bunched them together" or "You can spread them out on a line like this and you'll see they are the same."

(iii) Preceptual—"They look fewer but they are the same."

(iv) Counting—"If you counted them you would find they are the same" or "Because there are eight here, and eight there."

(v) Plus/Minus—"You did not add to them or take away any."

2. Unacceptable Explanations

(i) Silence—if the subject gives no explanation at all.

(ii) Don't know—if he says he does not know why "they are the same."

(iii) No reason—if he says "for no reason" or "for nothing."

(iv) Romancing—if he says "Because you bunched them together."
B. Transitional or Partly Conserving: The subject is placed in this group if he says the number of pieces of wood remains the same after two transformations but does not give an adequate explanation for his reasoning or if he says the number is the same after only one transformation and he gives an adequate explanation for that judgment.

C. Non-conserver: The subject is placed in this category if he says the number of pieces of wood is not the same after the two transformations.

1. Explanations given
   (i) Silence--if the subject gives no explanations at all.
   (ii) Don't know--if he says he does not know why "they are not the same."
   (iii) Perceptual--if he says "the pieces of wood that are bunched together are more", or "The ones on the line are more because the line is long."
   (iv) Romancing--"They are more because you put them on a line" or "Because you bunched them together."
   (v) No reason--if he says "for no reason" or "for nothing."
Conservation of Area

A. Conserver: The subject is considered a conserver if he says that the amount of grass in the two fields remains the same after a rearrangement of the "houses" on the pieces of paper, and if he gives an acceptable reason for his judgment.

   1. Acceptable Explanations

   (i) Identity—"The fields are the same size and the houses are the same number and the same size."

   (ii) Indirect Action—"If you built these houses close together you would see that they are the same."

   (iii) Perceptual—"Because the houses are the same size you just have these ones further apart."

   2. Unacceptable Explanations

   (i) Silence— if the subject gives no explanation.

   (ii) Don't know— if the subject says he does not know why there is "the same amount of grass."

   (iii) No reason— if he says "for no reason" or "for nothing."

   (iv) Romancing— "Because you built the houses that way."

B. Transitional or Partly Conserving: The subject is placed in this category if he says the amount of grass is the same but does not give an adequate reason.
C. **Non-conserver**: The subject is considered a non-conserver if he says the amount of grass is not the same in the two fields.

1. **Explanations given**

   (i) **Silence**—if the subject gives no explanation.

   (ii) **Don't know**—if the subject says he does not know the amount of grass is not the same.

   (iii) **Perceptual**—"Because the houses are closer together here."

   (iv) **Romancing**—"Because you made them that way."

   (v) **No reason**—if the subject says "for no reason" or "for nothing."

   (vi) **Other**—Some subjects might say that the amount of grass is not the same because there is a larger compound where the houses are not close together and the grass in this compound has been removed.


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