AN ANALYSIS OF PRE-OPERATIONAL AND CONCRETE-OPERATIONAL THINKING IN CONTRASTING SOCIAL AND CULTURAL CONTEXTS.

A study of cognitive development in children from five to nine years of age.

Mi-Ryung (Miriam) Chung

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ABSTRACT

This enquiry is concerned with the examination of a particular aspect of Piagetian theory, the conservation performance of five to nine years old British and Korean children (N=360) in contrasting social and educational backgrounds.

The tests used were a) the Standard Piagetian Test, b) a revised test, c) a new test devised to allow children to reason in relatin to culturally familiar contexts.

The main findings are: (1) Children's ability to think logically was not satisfactorily assessed by administering logical and and mathematical tasks proposed by Piaget. Such ability was revealed better through test which took into consideration of the children's fmailiar conceptual experience. (2) An appropriate usage of child language in the tests affects the level of performance of young children in solving cognitive tasks successfully (This could mean that there is a mismatch between children's language and their thinking, (3) Almost all the children in this study, regardless of their ages (5-9) or their social and educational and cultural backgrounds, can think logically. However, their ways of understanding logical and mathematical problems

differ vastly among extreme cultural groups. This means that children's understanding of the logical structure of experimental tasks does not provide a satisfactory estimate of their "free" cognitive ability.

It is therefore suggested that any method of evaluating children's ability to think logically has to be adapted to the children's level of knowledge, their experience of applying such knowledge in their activities and their language proficiency.

In Piagetian theory, cognitive ability is equivalent to the ability to understand the structure and logic of mathematical tasks. On the contrary, the investigator suggests that cognitive ability of children is, in fact, a facet of their life experience. It is also argued that the ability to solve abstract tasks does not necessarily correspond to the ability to understand the principle of the knowledge concerned.

Declaration

I hereby declare that this thesis is my own work, having been completed within normal terms of reference and of supervision in the Faculty of Social Science, University of Edinburgh.

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TABLE OF CONTENTS

CHAPTER 1

General Introduction

This study is concerned with some problems in the interpretation of children's cognitive ability, and the application of a cognitive theory in relation to contrasting social and cultural contexts, and to children's language.

For about half a century Piagetian developmental theory has received a remarkable amount of study and commentary. This is due to the interdisciplinary nature of the theory: the biological analogy in cognitive development, the psychological aspect of child development, the nature of knowledge and its development, and related disciplines. Researchers specializing in these disciplines have studied the theory which has consequently created divergences of opinion about the meaning and the value of Piagetian theory.

The present enquiry focuses on this aspect of child psychology, with data collected from cross-cultural observations. It is a critical study based on the limited attention given by Piaget to the following questions: firstly "How can one fairly access children's ability to think logically?", and secondly, "What is the nature of child language in cognitive processes?"

There is an increasing body of data which

indicates that cultural, environmental and linguistic factors are the most important to take into account in understanding the cognitive ability of children, whereas Piaget has put only limited emphasis on these factors. It is, therefore, cultural, environmental and linguistic factors in relation to children's cognition that will be explored in this dissertation.

In Piagetian theory, success or failure in, for example, solving conservation tasks are taken as confirmation of the way in which a child gradually acquires the ability to think logically. In his experimental paradigm, cognitive ability seen as "logico-mathematical" ability, forms the basis of scientific knowledge. In the Piagetian theoretical framework, there is hardly any explanation about the children's diverse abilities which are readily observable in their natural course of life. Regardless of cultural background and different usages of language by children in different age groups, Piaget seems to suggest the use of the same questions (or directly translated tasks) to assess the cognitive ability of all children. Concerning the interpretation of ability in logical thinking there have indeed been alternative explanations to those of Piaget. For instance, Cole, Gay, Glick and Sharp (1971) have shown how contextual factors

are influential in general performance on reasoning tasks. They compared the performance of Kpelle rice farmers from Liberia with American University students in standard reasoning tasks. While the performance of the University students was as good as anticipated, that of the farmers was far worse. Not satisfied that the farmers' test performance was representative of their "real" ability, the authors used anthropological techniques in an attempt to discover the kind of reasoning used in the daily life of the Kpelle. On the basis of their observations, they were able to amend the tests using more familiar materials and situations. When the tasks involved estimating of quantity of rice, the performance of Kpelle farmers improved dramatically, whereas that of the American students declined. The authors therefore suggested the use of an observational methodology which examined the role of situations.

With regard to children's language, Elliot and Donaldson (1982) indicate the weakness of Piaget's theory concerning child language and argue that "Piaget's views on language appear to be largely offshoots of his epistemological position. That is, he does not seem to ask what is known about language and then see what this can contribute to epistemology"(p.157). This and many other empirical studies (Donaldson, 1978; Cole and Bruner 1971;

Walkerdine and Sinha,1975; ect.) point to the importance of child language and social context in any interpretation of the ability of the children to reason.

The present study examines two very different cultural groups of people, Korean and British (Oriental and European) which hitherto have not been directly compared. The present investigator, as a Korean who has lived over ten years in Britain, was keen to study young Korean and British children and look at the above mentioned problems more closely. The intention was that some modification of the experimental techniques might throw light upon the questions of evaluation and interpretation of the cognitive ability of children.

In this regard, British and Korean social, historical,and educational backgrounds,and also the patterns of family upbringing to which children are accustomed, would be taken into account in interpreting the cognitive performance of British and Korean children.

The particular focus of the investigation can be indicated by these main questions which will guide the review of literature, the collection and analysis of data, and the interpretation of findings.

1. How do young Korean and British children from different social and educational groups perform various tasks of conservation?

2. If there were any observed differences, what factors would account for them?

3. What suggestions can be made from the study of young Korean and British children for the better understanding of children's cognitive ability, and the application of a cognitive theory in different cultures?

This study offers a twofold opportunity: first to assess the actual adequacy or general applicability of the Piagetian system; and second to apply Piaget's theory of cognitive stages in assessing children's ability to think logically.

The foregoing brief discussion concludes Chapter 1. A historical review of the development of the individual within both Korean and British educational systems will be covered in Chapter 2. Then, in Chapter 3, a commentary on Piaget's cognitive theory will be given. Next Chapter 4 will contain a review of research findings relevant to the present study. Chapter 5 will describe the methodology of the experiments carried out on young British and Korean children(5-9 years of age). An analysis of the experiments will form Chapter 6. Then, Chapter 7 will report a qualitative analysis

of the children's responses while the final Chapter 8 will present the conclusions of the study.

CHAPTER 2

Background to the development of the individual in Korean and British culture.

2.1. Introduction

The present study is concerned with an examination of Piagetian tests of children's cognition in two cultures. It will be argued that the cultural context is of considerable significance and has to be taken into account when explaining the results of the experiment and attempting to evaluate children's ability to reason. In this chapter we shall, therefore, give some account of relevant aspects of Korean and British culture and society considering in particular general features of the education system.

This chapter will be divided into two main sections: 1)some details of growing-up in Korea, and 2) a brief description of the life of British children today.

2.2. Growing-up in Korea

2.2.1. Babyhood

A baby is born either in a hospital or delivered at home by a mid-wife, as is the custom elsewhere in the world. The baby is usually breast-fed by the mother unless she has very limited milk

or is in poor health. The baby sleeps with the mother and is constantly cared for by her. The baby is not separated from its mother all through his/her infancy. In some families, however, some of the caring is delegated to a maid, or to a grandmother.

2.2.2. Young children

When the baby grows to be a young child the mother acts as a playmate for the child, as the mother does not normally go out to work but occupies herself in caring for the children and in doing house work. Behaviour and habits affecting various activities of the child are most strongly influenced by the child's mother, with the father remaining an outsider. The paternal grandmother is usually closely associated with the family, and when a baby is born she is expected to come, even though she may live elsewhere. She looks after both mother and baby. If the grandmother comes to live in the house where the baby is born, she is quite likely to be the dominant influence in the upbringing of the child.

Koreans live in a family clan situation where elders are expected to be given great respect, and they in turn, instruct the younger members of the family. The views of grandmother exercise great influence on the philosophy of bringing up the child within the family. Sometimes there is a conflict between the mother's and grandmother's

value judgements in this respect. For example,the mother may want to rear the child in a more regimented way, but the grandmother may be more indulgent. The child is normally asked to obey the instructions given by the person in charge of his/her upbringing. Behavioural patterns of the child are therefore very much dependent upon the family tradition.

The child is always cared for by the mother, relatives, or very occasionally a part-time nanny. In this way a growing child is the responsibility of the whole family and of its clan. In a case where the mother fails to fulfil her child-rearing duty,she will be subjected to condemnation by the baby's paternal relatives who have control over the mother's behaviour. She is usually expected to follow the husband's tradition. It is in this way that children are guided and instructed from an early age. This does not, however, necessarily mean that the child is restricted in all aspects of life, but he/she is expected to follow certain family traditions within the freedoms that are allowed.

Brought up in such a way, children are almost wholly dependent on the family's way of thinking from birth until the age of five to six. These are the ages when they start systematic schooling,

respectively. Once they start school life, however, children usually become very attached to their class teacher. Teachers are accorded respect and normally have an "authoritarian" manner. This is derived from the Confucian concept of the teacher-pupil relationship which is one of the five rules. These are : maintaining a proper relationship between ruler and subjects; between parents and sons; between teacher and pupil; between husband and wife; and between friends. These rules have been the guiding ideals in Korean life for many centuries.

The mothers' role in the upbringing of young children is much greater than that of the father, even in a remote village. In fact, the more remote the area, the more traditional and rigid are the ideas adhered to.

Teaching methods are based on formal instruction, learning by rote and copying from the blackboard. Homework also plays an important part in the curriculum as it constitutes a large proportion of individual study. By the age of 8 or 9 the children are given homework of usually two hours duration per day on top of six hours spent in class. At the next lesson on the same subject the homework is checked, marked and the correct answers are provided. Here the influence of siblings and

parents is considerable in achieving satisfactory homework. Pupils who have a well educated mother can achieve better results. Access to television, radio and telephone is considerably easier for urban than for rural dwellers.

At school, children are always expected to be quiet during lessons. Even though they may have questions to ask, they therefore do not feel free to do so among their classmates in a situation of regimentation and unfamiliarity with the idea of individual questioning. Pupils are expected to think again before speaking out to raise a question. This attitude is in marked contrast to the classroom attitude of most British children. The habit also obtains ,at present,in secondary school and at university. It does not mean,however, that nobody is permitted to ask a question during the lesson. Rather, pupils are given a certain time for questions usually at the end of the lesson, or the teacher may allot extra time for questions.

It is noteworthy here that the level of basic literacy is ninety-six percent which is very high compared with other countries. In the remote rural areas where regular primary school attendance may be difficult, the children may be given help with reading and writing within the family circle.

From the above description we now have some

appreciation of the main features of child rearing and education in Korea in terms of the relationship within the family clans. These ideas can be extended by looking more closely at what happens in a typical Korean classroom.

2.3. A lesson observed in a Korean Primary school

Let us now give an account of a typical lesson in a Korean primary school.

Before starting the lesson in the classroom children have an assembly in the playground or gymnasium depending on the weather. Children from the same class stand in rows which mark each section for each class. The teacher usually stands in front of the rows and supervises the children to guide their behaviour during the assembly. Children are expected to be quiet and stand up straight when the head of the school makes a speech every morning. The speech is normally concerned with general morals and behaviour.Some heads are very keen to strengthen the 'school spirit'. The speech usually aims at a 'spiritual strengthening' in readiness for starting the lessons or attending school in general.

The method of class teaching is essentially the blackboard method, with up to sixty children in a class. The blackboard is always situated in the middle of the front wall, with the teachers

standing in front of it. Desks and chairs are usually placed in orderly fashion in several rows, so that all children are able to see the blackboard. One aspect which does not exist in the Western classroom is the respect paid collectively to the teacher before starting every lesson. A class monitor stands up when the teacher enters the room and says, loudly, 'Stand up' and then 'greet', so that all children bow to the teacher and the teacher also bows to the children. This tradition hails from Confucian teaching concerning the need for showing mutual respect between teacher and pupil. Such a relationship carries through during school lessons. For example, when pupils want to ask a question they must go through a formal procedure by first raising their hand and waiting for the teacher's response. Then the pupils normally stand up and ask their question loudly. There are times when a child can be dealt with individually, but this occurs rarely as there is insufficient time for the teacher to look after sixty individuals as well as to cover the required daily curriculum.

In such a situation the specific difficulties of an individual cannot be given much attention. The only aid provided is homework. Nearly every day all levels of primary school are provided with homework. In doing homework there are varying

qualities of individual study. Children who come from wealthier families are able to employ a college student as a daily tutor, and some of them get help from their well-educated mothers. Most rural school children have no chance of getting a private tutor.

It is evident from the above observation that a child can have individual attention only within the limits of the wealth of the family, whereas in Britain the educational system provides more opportunities for individual attention within much smaller classes (about thirty children). In Britain homework plays a less important role,at least until secondary school. The pattern of Korean pupils' freedom of intellectual behaviour is thus different from their Western counterparts.

To relate these experiences more directly to the topic of this thesis the content of the mathematics curriculum is examined . It is in such lessons that training in logical and mathematical thinking is provided.

2.4. Primary Mathematics in Korea

The Korean primary schools are centrally administered by the Ministry of Education and are provided with details of the mathematical syllabus for all grades and schools in the country. The following content is taken from Arithmetical

curriculum in the primary school (1979).

In grade 1 (5 years of age), children are taught numbers up to 100, by counting, reading and grouping. They are also taught the basic ideas of fractions (halves, quarters, etc.). Mental arithmetic, addition and subtraction up to 10 is also practised by the children. They are supposed to understand the mathematical signs of plus, minus, and equality and are also taught basic multiplication and division. They are expected to attain concepts such as: short vs long, wide vs narrow, thick vs thin, heavy vs light, time (pasts present, future), date (today,tomorrow,yesterday), direction,speed,money,shapes.

Towards the end of the first grade, children are helped to understand and answer mathematical questions given in sentence form, and they are expected to be able to count money through the mental exercises of buying and selling and to understand simple charts or diagrams for playing games.

Children of grade 2 (6 years of age) are supposed to be able to read and write numbers up to one thousand. The concept of grouping and fractions are introduced. They are suppose to memorize multiplication tables up to the "five times table".

In grade 3 (7 years of age), they are taught

to read and write numbers up to ten thousand. The principle of the positions of units, tens, hundred, thousands, is introduced. Multiplication and division are also taught. Memorization of multiplication tables continues up to the "nine times table". Simple addition and subtraction of decimals is also introduced. Measurements of length, width and volume - millimetres and centimetres, metres and kilmeteres, grams and kilograms decilitres and litres - are to be acquired by these children. The concept of angle is introduced and, various shapes and their heights and diameters. Children use simple geometrical instruments such as rulers and compasses to draw triangles, squares, circles,etc. Elementary graphic figures such as histograms and bar-diagrams and the concepts of "greater than" (>) and "smaller than"(<) are introduced.

In grade 4 (8 years of age), the concepts taught in earlier grades are exercised in a more complicated context. The exercise includes addition and subtraction involving hours, days, months and years. They are supposed to describe directions of places from maps,and calculate hour differences in different geographical areas. Calculation involving multiplication and division of larger numbers and understanding of the relation of

relations are expected; for example, children will be asked to fill up the blank; 0.306 = 3/10 + (____)/100 + 6/1000.

In grade 5 (9 years of age), the previous syllabus is expanded to utilise larger numbers and more complex sums. Children are taught sums involving fractions and decimals. They also learn the ratios, areas expressed in square units, volumes, speed, direction, highest common factor, simplification of fractions etc. The concepts of congruency and similarity of shapes are also taught.

In grade 6 (10 years of age),they learn to do sums on percentages, measurement of perimeters, volumes, areas, speed and direction. All the concepts taught in earlier grades are extensively practised by these children.

2.5. Opportunity for education in rural and urban area

It may be asked whether the characteristics of urban education are significantly different from those that one finds in rural areas, since this may have considerable bearing on the implications of the present empirical enquiry. In fact, conditions do vary considerably, even though primary education is compulsory and universal, and the curriculum and text books used are common throughout the country.

Differences arise as a result of the different social conditions in town and country rather than differences in administrative structure. Seoul, as the centre of political, cultural, educational industrial and administrative life, has been considerably exposed to Western influences particularly with the help of mass communication media. City dewellers have more opportunity to send their children to fee-paying private schools where the number of children in a class is much smaller than state schools and school facilities are modern and well equipped.

In rural areas, the distance factor affects the cost of building and maintaining small schools in a remote area, and in providing school supplies. Adequate accommodation for teachers is difficult to obtain, hence teachers are reluctant to be posted to such areas. A narrower, less adequate curriculum is provided in very small rural schools, due to lack of sufficient teacher expertise, spcialist skills and knowledge.

In the extremely remote rural area which the investigator visited, only a few people have radios. Books, magazines and newspapers are beyond the means of the peasant farmers. Primary school children from such an area will hardly have the opportunity to visit a city. In recent

years, however, the cultural conditions in such rural areas are rapidly changing with the help of the Saemaul (new village) education *.

2.6. Characteristics of Korean children's way of thinking

As was seen from a previous section, Korean children in general are not used to responding by answering questions or by giving reasons for their answers. It is common for a teacher to say to the children, "Think first before you ask a question". In other words, children are encouraged to think quietly which means in a sense that they are habituated to keep their ideas to themselves, and this characteristic is exercised in every aspect of social life. How they think is not usually discussed by others. For Koreans, the correct performance implies that the process involved is also expected to be correct.

This expectation based on the Korean social philosophy (in a broad sense) allows people to think in different ways and in their own social discourse, whereas Western people have much imaginative ways without this being evident from

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* "Samaul education was originated in the movement for extending the social function of education in the early 1960's. Underlying the movement was the principle that one of basic functions of school is to develop activities of the community" (Education in Korea, 1977, p.82.).

more open discussion which allows one to gauge to a certain extent how people are thinking.

It is not unusual in Western life for one to be able to guess how others think, whereas the opposite is the case in Korean society. The habitual mode of thinking for Korean children leads them not to respond spontaneously when they are asked to answer questions. Instead they spend time considering the question in silence before actually speaking out their answers. In other words, the answer is expected to be perfectly thought out internally before being given. This attitude of 'silent thinking' is sometimes misinterpreted by Westerners as disapproval or disagreement. Koreans are habituated to this dual system of expression; thinking first and then expressing the results of the thinking. When Korean children answer a question they do so directly, having thought out what they want to say in advance. For Western children, the process and product (thinking and expression) of thinking are complementary and spontaneous and they are more likely to be encouraged to speak out what they think and explain their reasoning. From early childhood such ways of spontaneous thinking and expression have been practised in daily life for British children, whereas Korean children might feel shame and loss of dignity if they had to show

their ways of thinking in the middle of a conversation with others. The differences between Korean and Western ways of thinking and expression are therefore quite distinctive.

2.7. Background of British children

2.7.1. Growing up in Britian

British babies are born either in hospital or at home (Newson 1963). Mothers are encouraged to breast feed and a high proportion of mothers do begin the baby's feeding by this method; however, by the time the baby is one month old, more than half of the mothers are not continuing to breast feed (Cheter,et al.1981,p.101).

The baby sleeps in a cot from birth so that the detachment from the mother is very early. Later the child is carried around in a "pram" or a motor car rather than on the mother's back as is the case in rural Korea. Some children also have to grow up rather independently, as many mothers work outside the home. Grandparents do not usually play much part in the upbringing of children and have relatively little influence in the domestic life of their children since extended family networks within close proximity are less frequent.

In most normal families, the mother is the central figure in the care of young children; however, in some families,the father may take an

active role in child rearing, helping the mother with bathing and playing with the baby (Minturn,1964 p.102).

Children are encouraged to play with other children at an early age and are exposed to a wide range of educational stimuli through books, toys and games, etc. British children tend to live in a nuclear family unit and their friendships are not usually with distantly related children unless relatives happen to live nearby.

British children at home and at school are commonly encouraged to express themselves as individuals in art, in written work, and verbally. Individual achievement and personal expression are particularly valued. In situations of conflict between parents and children, the British children tend to be indulged in and have their wishes accommodated. Discussion between children and parents is usually aimed at reaching an agreement on course of action rather than the parents stipulating what should be done according to custom or tradition. British children from the same family are often very different in behaviour and may form no close attachment to one another.

Moral education may occur through the application of Christian principles or through the use of general moral maxims such as "do as you would be done by" or "the greatest good of the

greatest number". Organized sports are sometimes thought of as leading to moral improvement. Linguistic skills are particularly admired and cultivated and children are encouraged to talk freely in class and in the family .

It is, however, noticeable that parents in different social groups attach importance to different aspects of child rearing and therefore certain differences in attitude between social classes may also be apparent. Newson (1963) states, "When class differences are under discussion, there is always the danger of making facile and sweeping generalizations. Each section of the community has its own prejudices about the other sections, and it is only too easy to interpret the behaviour of people in other class groups in terms of existing preconceptions which may themselves have their roots in the defence systems of one's own group. Members of one social class tend to conceptualize those of a different class in terms of a few well-defined stereotypes which may or may not be true, but which in any case take the place of real observation. In the field of child-rearing, for example, there is a stereotype of the upper-class mother, rather cold emotionally, providing material luxury for her children but depriving them of mothering by leaving them to the care of paid

nannies while she spends her time at bridge-parties and committee meetings-'not what you'd call a real family life', as one working-class informant said. On the other side, middle-class people seem to have two pictures of the working-class mother: the "poor but honest" type, over-worked, her house shabby but wellscrubbed, fond of her children in an undemonstrative way and ruling them with a rod of iron and the threat of father and the policeman; and the cheerful slut with the heart of gold, living in comfortable disorder and bringing up her children on a mixture of slaps and lollipops, fish-and-chips and love. Father is little in evidence in either of these pictures of working-class life, for he spends most of his leisure time at the pub on the corner"(p.153).

The absence of a single strong tradition to guide British child rearing practices, thus makes it difficult to describe a typical family. Rather the childhood experiences have to be taken into account.

British children are much less afraid to speak out in the classroom, even if they sometimes make mistakes in what they say. Such an attitude persists throughout higher education and into adult life.

In British primary schools at present not much emphasis is placed upon homework and textbooks are

kept at school rather than at home. A national guideline of such practice is found in the Plowden report (1967). It emphasizes that the knowledge should be subject to the interepretation of individuals in their search for understanding through discovery - "learning by discovery" takes precedence over "learning by description".

2.7.2. In a British Classroom

Any observer of a British primary school will usually find a noisy but free atmosphere. A small number of children,usually three or four, sit together to make a working group. Every individual child is looked after by the teacher and, according to his\her progress, the child is guided concerning what to do next. There are times for reading the same pages of a story book or for answering the same questions on the basis of what they read, but most other exercises, for example, solving problems in arithmetic, spelling etc. are carried out and marked individually. The role of teacher is less dominant, being an arranger of content or one who sets problems. In some schools there are class assistants, usually one person in a class, who helps individual children whenever required, even in a class of less than thirty children.

Another feature of the classroom for younger

children is that there are many toys and play-things around, such as a sandbox, a water container, a doll's house, painting easels, rugs on the floor, many craft models, wooden or plastic pieces, etc. in classes for the younger children. The older children are provided with more sophisticated materials such as glove-pupets,and simple scientific apparatus. There are generally plenty of things to play with.

The relationship between teacher and pupil is usually friendly and personal. The children are encouraged to speak out clearly whenever they have questions to ask. They are not quiet when they want to talk to each other, apart from the teacher's instruction such as "Talk quietly, others are trying to get on with their own work". Much emphasis is placed on play and individual activities in every sphere of learning.

2.7.3. Mathematics syllabuses for British children

A wide choice of text books, and the headteachers' freedom to choose the texts for the school, make a distinctly different situation compared with centrally provided Korean schools.

During the first four years of primary education the children successively learn the simple arithmetic of addition, subtraction, multiplication and division of numbers, money,

time, etc. Toward the end of the fourth year, they are taught to check answers of division sums by multiplication. Nine year old children are taught to work out sums of subtraction involving simple fractions. The sums are frequently given in descriptive forms. For example, an eight year old child may be given the following task:" How long will it take to fill 16 bags if each bag takes 3/4 minutes" (School Mathematics Project Book-1). Children of this age are also taught the concept of decimals and are expected to work out sums based on the four rules involving simple decimals.

In the last year of primary school,the children are consolidating concepts previously learnt. They are expected to solve problems involving decimal numbers, fraction, shapes, relations,measurement of volume, etc. It is also noticed that the tasks are given in descriptive forms.

It is useful to note here that the above concept-learning tasks in mathematics are exercised by the children using examples from real life and supplementary materials. To illustrate the variety of school curriculum that British children may enjoy one may give a list of activities that were observed by the investigator in a visit to a junior school(5-8 years);

-making three dimensional shapes with coloured string,

-construction of various mathematical solids from coloured paper,

-measuring others in the group by weight and height,

-constructive games and play with clay, wood, cloth, paper, paint, sand, water,etc.

-working out problems involved in an extended trip to continental Europe,

-solving problems of time concept using railway and bus schedules,

- making models to scale with wood,etc.

It may be noted that tasks were suited to children's individual interests and abilities rather than imposed upon them in a dogmatic way by the classroom teacher. For example, children progress through their textbook at their own rate and their work is marked individually which is possible for classes of twenty-five to thirty.

2.7.4. Quality of education in British schools.

Concerning the standard of education, at present there is considerable variation in the quality of primary education depending on either type of the school or geographical area chiefly due to the economic and social differences between different neighbourhoods. For this reason many British parents are prepared to spend a lot of time and money to enable them to move house into areas which are considered to provide good educational

facilities. The children attending schools in the private sector are from either wealthy families or professional families where the fees may sometimes be paid by their employers. They generally receive more personal attention in their classrooms than their state counterparts and a moderately strict discipline is enforced. Less than ten percent of the relevant population are in private sector schools.

This does not necessarily mean that the children in state schools are poor. The living standards of British people in general are shaped by the State, with the help of graduated systems of allowances. Therefore the majority of the British people enjoy a relatively high standard of living with a small elite and a minority of disadvantaged persons. Most British children are also exposed to the same influences of television and radio.

British country schools offer slightly less varied educational experiences than the city counterparts. For example country children will not have access to museums and other out-of-school experiences as much as city children. Parents have a lower standard of pay than industrial workers and the children do not generally continue their education beyond the statutory school leaving age of 16.

Concerning school conditions, the Plowden Report (1967) gives a lengthy discussion of education in rural areas. The poor physical conditions of buildings, staffing difficulties, changing social conditions, and pupil's performance in small schools are discussed in some detail.

2.8. Summary

There appear to be fairly clear cultural differences between Britain and Korea in attitudes towards rearing and educating children in Britain and in Korea. The underlying characteristics of different cultural groups can lead to the expression of children's cognitive ability in very different ways, even in relation to the same questions. For example, Korean children might be much less expressive and reluctant to describe the results of their answers to the question in experimental situaions. Because they are used to think 'silently'. It might also be the case that the way of solving mathematical problems for rural Korean children will be distinctly different from their city counterparts since the rural environments do not require as much abstract thinking as the city.

Another issue is the comparability of mathematics teaching in primary schools in the two countries. From a review of the nature and content

of elementary mathematics as taught in the two countries, it is apparent that the children cover more or less the same content during the first six years of schooling, however, sometimes topics are introduced in different ways and in different years of schooling,e.g. Korean children are, in general, introduced to a more advanced concept a few years earlier than British children. British children are given tasks more in descriptive forms (words) whereas Korean children are given tasks more in abstract forms (formula).

From the above description, it is clear that the British and Korean children have similar knowledge about primary mathematics. Therefore, it is theoretically justified to use the Piagetian tasks for these children. However, opportunities for them to improve their knowledge by homework and utilize their learned concepts were seen to be very different for urban and rural dwellers, and in different socio-economic groups in the case of Koreans. In the case of British children, the rural/urban difference can hardly be significant in terms of provision of school education and also their opportunities of utilizing learned concepts seem not as extrem as in Korean situation.

Bearing in mind the observed differences of

child rearing, educational, social and cultural contexts, and the similarity of mathematical teaching, the next chapter deals with an exposition of Piaget's theory. Particular attention will be paid to the source of his ideas and to the generalization of children's cognitive performance.

This will aim to examine whether Piaget's theoretical framework will allow children to have diverse modes of thinking in various intellectual and environmental situations.

CHAPTER 3

Piaget's theory of cognitive development with commentary

3.1. Introduction

Piaget's own thought in developing his cognitive theory is well illustrated in his work, Insight and Illusion of Philosophy (1972). Piaget reveals that in his youth he came to the conclusion that his understanding of the logic of life fitted into that of Aristotle whose concepts of form were precisely conceived as governing thought while at the same time corresponding to the structures of the organism (ibid.pp.6-7).

In other words, the structure of thought corresponded to the forms of things (or their essences) which in turn were known by their formal definition, arrived at by a process of classification of natural kinds. Thus, Piaget, like Aristotle, adopted a biological basis for his fundamental theory of knowledge. Piaget's dependence upon the biological analogy is further revealed in the following statements;

> "...every organism has a permanent structure, which can be modified under the influence of the environment but is never destroyed as a structured whole, all knowledge is always assimilation of a datum external to the subject structure", and "the normative factors of thought correspond biologically to a necessity of equilibrium by self-regulation:thus logic would in the subject correspond to a process of equilibrium"(ibid. p.8).

Piaget's interest in the relationship between biology and psychology is also revealed in his work, Biology and Knowledge (1971). The important consequence which flows from this is that the intellectual development of a child was assumed to proceed in definite stages, just as the animal embryo does according to the theory of recapitulation. Further discussion on biologism will be found later in this chapter.

Let us turn to his philosophical position. His thoughts, as he pointed out, were deeply affected by his earlier philosophical studies which determined the subsequent direction taken by his experimental work. However, a dissatisfaction with traditional philosophy is clearly revealed. He rejected metaphysics or believed that it was possible to do so. His concern was with "the search for the truth" and "how knowledge is possible". These are essentially epistemological questions. Piaget saw metaphysics as merely a path towards a "wisdom" or a rational faith, which he believed could be separated from scientific knowledge. He valued metaphysics mainly as a coordinator in judging universally valid knowledge and strategies:

> "...When it is a question of metaphysical problems involving the coordination of values judged to be of an essential importance, problems which thus introduce factors of conviction or faith, speculative reflection remains the only method possible; but remaining bound up with the

whole personality of the thinker, it can only lead to a wisdom or rational faith, and is not knowledge from the point of view of objective or interindividual criteria of truth"(1971b p.12).

The three main reasons given for discarding the metaphysical approach were firstly, the conflict between verification (employed in biology and psychology) which was one of the favoured notions of the philosophers of science of his day, and the speculative reflection characteristic of philosophy:

"The psycho-genetic analyses of the formation of concepts and operations, the logical analysis of the foundations of mathematics, provide methods of testing that individual reflection is unable to provide (ibid.p.12).

Here, individual intellectual judgement is not recognized for its own value. The second reason for rejecting metaphysics was what he took to be the evident dependence of philosophical ideas upon social or political changes. Such dependence revealed the inadequacy of claims of metaphysics to universal validity or truth. The third reason for this rejection was the tendency of philosophers to dictate to scientists on methodological matters even when they were totally lacking in experimental experience.

It may be seen from the foregoing discussion that, in Piaget's mind, there was a growing view of science emerging from the struggle against philosophy. Piaget ruled out metaphysics as well as positivism,though he accepted the label of

positivist for himself on the grounds that the traditional epistemology underestimated the activity of the subject and limited the scope of science, while for non-positivists,"Science is indefinitely open and can enquire into any problem, provided a method can be found, about which scientists agree". These struggles against philosophy and the endeavours to validate science confirmed Piaget as a scientist, but one with a profound interest in epistemology.

In Piaget's view science had the all-important role of demonstrating that there are fundamental principles underlying all natures, including the human species and mind. Nevertheless, his theory was not based on the view of science expounded by positivists, a view he explicitly rejected on the grounds that it reduced science to the cataloguing of facts and laws. He argued that on the contrary, knowledge or properties of objects and the relations obtaining between them do not reside in the objects themselves, but rather are constructed out of actions performed on them by a subject.

Knowledge in this view is supposedly from the "internalization" of the actions performed upon objects. Piaget's work showed that our concepts of logic, space, time, number, quantity, etc., were not given, according to some Kantian doctrine of the a priori, but undergo a process of development.

Logical concepts like negation or disjunction, as well as mathematical ones like number, were taken as having an operational character, and are not simply discovered as a result of some intellectual intuition, or by simply observing the world.

Piaget saw the difference between philsophical psychology and scientific empirical psychology as being chiefly one of method, in that philosophical psychology neglected objective verification and grounded itself in subjectivity, though claiming to arrive at objective knowledge through intuition. By contrast, scientific empirical psychology required objective verification where the subjective elements were minimal. Nevertheless, he wrote:

"There is no sharp division between scientific and philosophical problems, but scientific problems are more strictly delimited, the purpose of this delimitation being to state them in such a way to allow experimental and algorithmic testing" (ibid.p.18).

In brief, the Piagetian theoretical framework was constructed by linking selected elements from various regions of European intellectual culture; biology he took as his model of an exact natural science yielding certain knowledge, and he took over numerous biological analogies;in its philosophical aspect the framework exhibits an empiricist rather than speculative metaphysical tendency; from psychology he adoped a behavourist tendency.

Below follows a brief account of his views of scientific knowledge, conservation ability, structuralism, genetic epistemology, mental stages, social context, biologism and on his original experiments.

3.2. On Knowledge and scientific knowledge

A leading feature of Piaget's view of knowledge is that he sees it as a process rather than in a static condition. He mentions that,

> "knowlege is currently becoming to be considered more and more as a process rather than as a state".He further asserts,"The attribute of intelligence is not,in fact, to contemplate but to 'transform' and its mechanism is essentially an operational one...It is therefore action itself and not perception alone which provides an appropriate point of departure"(1972b, pp.47-48).

Piaget explains the way of transforming the objects of knowledge as if it maintains two complementary processes: One consists of modifying their positions, movements or properties in order to explore their nature: the other consists in enriching the object with new properties or relationships which conserve the previous properties or relations, complementing them, however, through systems of classification, ordering in correspondence, counting, or measuring, etc. The latter processes he calls 'logico-mathematical activities'. These two ways constitute the sources of scientific knowledge. Thus

transformations have their source in actions, both physical and mental and he states,

"It is for this reason that the concept cannot be reduced to simple abstractions and generalization from the basis of perceptual data. It arises essentially from constructions (through constructive generalization and not only through abstraction of common part) which are ties from the beginning to action itself"(ibid.p.49).

The fundamental transformation of knowledge viewed as being static, moving to progressive, led Piaget to re-state the question of relationship between epistemology and the psychological formation of ideas and operations. In re-stating his progressive view of knowledge he is critical of the empiricist tradition because he considers empiricism to have had recourse to a simplistic psychology which he considers to rest merely on experience or empirical knowledge. For Piaget, experience itself can never become knowledge unless it has gone through a process of progression. This progression of knowledge is parallel to the successive mental stages which form the embryological analogy as he states,

"Developmental psychology moreover represents an integral part of developmental embryology (which ends not at birth, but on arrival at that state of equilibrium which is the adult stage), and the intervention of social factors does not detract from the validity of this assertion, because the organic development of the embryo is also in part a function of the environment" (ibid. p.17).

One may wish to raise the question: "Does Piaget explain diverse ways of children's creative

interpretations of facts or things around them, particularly in different social and cultural settings?" This question will be discussed later.

3.3. Conservation performance and social contexts in the Piagetian system.

Empirical evidence of a child's conservation ability in relation to liquid volume, substance weight, length, number etc. is taken by Piaget as confirming and demonstrating the way in which the child gradually acquires knowledge. The basic concept of the Piagetian conservation tests is to distinguish apparent volume change from real change. Piaget assumes that cognitive ability is equivalent to logico-mathematical ability which can be assessed by conservation tests.

From the results of conservation tests, Piaget insisted that, "ideas of conservation are the product of a system of logical construction" (Piaget 1972b, p.23) He further suggested that logical thinking is functioning alone by means of a system of logical construction whereas experience always circumscribes logical thinking. He said,

> "Before the laws of thought, processes are established, these relationships orginate in the general patterning of activity, but neither the active nature of this process, nor the fact that a certain kind of experience is necessary before the subject is able to perform operational deductions, prevent these relationships from expressing the subject's powers of logical construction as opposed to the physical properties of the object" (1972b, p.23).

(1972b, p.23).

In the Piagetian theoretical framework there is no way to explain the child's learning through everyday life - that is, everyday life of different culture and context. Piaget suggests the use of the same question or a directly translated question to assess children's cognitive performance regardless of cultural background or linguistic differences between various nationalities of the world. For example, as has been described earlier in the test of conservation of liquid, children are usually given different types of cylindrical glasses;tall and narrow, wide and short, and asked whether the amount of liquid has changed when the liquid is poured from one type of glass to the other. These tasks, for example, are used to judge children's cognitive ability regardless of their different cultural backgrounds or daily experience in the particular society to which they belong. This theory becomes particularly controversial when considering the relationship of the intellectual skills displayed by people in non-Western cultures.

Mathematical and scientific thought is central to Western culture and perhaps it is not surprising that Piagetian tasks are therefore very good indicators of the kind of thinking which is highly valued in terms of Western cultures. However, it

could be argued that there are other traditions of thinking which produce different results from the logico-mathematical kind of thought process, and one may suspect that such an analysis might well be possible for those who live in a different culture. If this is the case, Piagetian tasks are likely to cause a significant distortion of the understanding of the real picture of cognitive operation of people in very different cultures.

This, however, is not to say that Piaget entirely ruled out the social factors in his theory of cogntion. Piaget's view on the influence of social context upon mental development may be discussed in this quotation:

> "It is true that the development of the child is always influenced by the social milieu". He goes on to say: "It is no less clear that even when he receives ideas already prepared by the social milieu, the young child transforms them and assimilates them to his successive mental structures in the same way as he assimilated the milieu formed of the things that surround him" (Piaget 1950b vol.1 p.17)1.

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1. "Il est vrai que le dévélopment de l'enfant est toujours influencé par le milieu social... Mais il est non moins clair que, même lorsqu'il reçoit des notions déjà toutes préparées par le milieu social le jeune enfant les transforme et les assimile à ses structures mentales successives, de la même manière qu'il assimile le milieu formé par les choses qui l'entourent..."
In Piaget, Jean (1950), Introduction a l'epistemologies genetique. vol.1 p.17.

Piaget's explanation of the development of the human faculty of cognition as resulting from the interaction between the individual and the environment means that each individual constructs rather than inherits his cognitive structures. He states,

> "the third fundamental factor is social interaction and transmission. Although necessary and essential, it also is insufficient by itself. Socialization is a structuration to which the individual contributes as much as he receives from it, whence the interdependence and isomorphism of operation and cooperation" (Piaget and Inhelder, 1969 p.156).

To be sure, Piaget does see society as the milieu within which cognitive development occurs; but he gives no adequate account of the way in which it may affect the biological processes of assimilation and accommodation. While it appears that Piaget is well aware of the possible significance of the social context, he makes no effective use of it within his theoretical system of explanation of cognitive development.

3.4. On Structuralism

Structuralism as expressed by Piaget provided a more formal expression of his belief in a fundamental unity regulating the universe. Since this was consistent with his other ideas of constructivism, equilibration and genetic

epistemology, his structuralism must be understood within this framework.

For Piaget, a cognitive structure was comprised of three fundamental characteristics, i.e., wholeness, transformation, and self-regulation. By 'wholeness' was meant the structure whereby the elements of a mental structure were subordinated to laws, which were not reducible to the product of cumulative associations. They conferred on the whole, as such, over-all properties distinct from the properties of its elements. 'Transformation' was characterized as the continuous formation of structured wholes,"always simultaneously structuring and being structured" (Piaget 1971a, p.10).

"The third characteristic of structure, self-regulation, entailed the maintenance and closure of a structure and also its conservation with stable boundaries, even in the process of transformation. For example, adding any two whole numbers yields another whole number"(ibid.p.14).

These characterics of structures were analysed by Piaget in several sciences: in particular, mathematics, physics, biology,linguistics, social science and psychology, the purpose being the implementation of such analysis as a very powerful instrument which would reinforce his idea of the universality of cognitive structures. Here we are particularly concerned with the application of these concepts in psychology.

Piaget argued that the process of "construction" obeyed specific laws, and the structures were not thought to be there at the beginning as in a priori models, but they were present at the end of the genesis. This necessity of having the end-product is a very important point for debate. The essence of this construction corresponded to a constant process of "equilibration" through the dual functions of "assimilation" and "accommodation", gradually and systematically increasing in degree of complexity to give rise to the several stages of development, i.e., sensori-motor, pre-operational, concrete-operational and formal operational. These stages supposedly obeyed the rule in mathematics, whereby the less complex structures were in congruence with the structure of groups.

As regards the construction of cognitive structures, "the lived" which has resulted from experience could, according to Piaget, only have a very minor role in the construction of cognitive structures, for these belonged not to the subject's "consciousness" but to his operational behaviour (ibid.p.68).

The subject of these constructions was thus only an epistemic subject, which abstracted from experience logical schemas and discarded the

experiences themselves as empty shells, using only the schemas in subsequent action. Such a subject was the "universal" individual who possessed common mechanisms, and therefore models of "artificial intelligence" which can provide a cybernetic theory (of assimilation and accommodation) to show how this epistemic subject actually functions, may in principle be produced. But the personal subject was not eliminated altogether because it was the centre of activities which formed the basis of the process, and was continuously detaching itself from its intellectual egocentrism through a liberating and generalizing "decentering".

There is, for Piaget, a necessary interdependence between genesis and structure. He states:

> "Genesis is simply transition from one structure to another, nothing more;...Structure is simply a system of transformation, but its roots are operational; it depends, therefore, on a prior formation of the instruments of transformation-transformation rules of laws" (ibid.p.14).

The problem of genesis is therefore more than a question of psychology, it is also an epistemological one which referred back to fundamental issues of structuralism in cognitive development. This is the reason that genetic epistemology became so crucially important in Piaget's overall theoretical framework. Genetic epistemology is treated as the location on the

theoretical level of the source of the problem of the origin and development of knowledge from its most elementary forms to its highest level in scientific thought.

3.5. On Genetic Epistemology

Genetic epistemology was given great prominence by Piaget in the resolution of scientific problems. In fact he saw the genetic problem as asking questions concerned with the progress of all scientific knowledge, with two dimensions: one arising from questions of fact, the other from questions of validity, thus stated,

> "If it were a question of validity alone, epistemology would merge with logic...(and) if epistemology were only a question of facts, it would be a psychology of cognitive functions, which would not be able to resolve questions of validity... It is therefore only through the functioning of this collaboration that the requirements of fact and validity can be equally respected" (Piaget 1972b, p.6).

Another important aspect of Piaget's concern of the nature of knowledge was "historical" and "psychogenetic". The psycho-genetic approach entailed a definite empirical or "scientific" component, as the child's development was investigated experimentally. Thus we are told to have an interdisciplinary undertaking and Piaget suggests,

> "In this way genetic epistemology originated in an essentially interdisciplinary field of research that endeavours to study of meaning of forms of

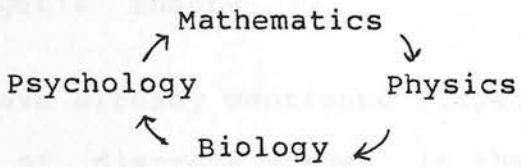
knowledge, of operational structure or of concepts, by referring on the one hand to their history and...to their logical aspect...and finally to their psychogenetic formation or their relations with mental structures" (Piaget 1972a p.75)

The outcome of the two-fold process was what Piaget called genetic epistemology. It entails the study of the history of ideas and the psychology of development.

Another important aspect of Piaget's system is to be found in what he refers to as the "circle of the sciences". According to the influential theory of the French positivist philosopher, Auguste Comte, there was a natural hierarchy of the sciences, which represented both their historical development and a "logical" hierarchy: mathematics -astronomy-physics-chemistry-physiology-sociology (August Comte; Tableau synoptique de cours de philosophie positive - from the paper presented at the college de France at the end of nineteenth century. (Unpublished memorandum prepared by D. Oldroyd in 1976 at Oxford University).

Historically, these sciences appeared in this order, but one may also say that social phenomena might be explained in terms of physiology, physiology in terms of chemistry, and so on, up to mathematics. Piaget,however, objected to it. Instead of the Comtian linear hierachy of sciences, Piaget saw a circle of knowledge - a circle that was even expanding as scientific knowledge

developed. In a simple form, he represented the circle as follows (Piaget, 1972b, p.83):



He further explained his commitment to this cyclic order as follows:

"The object is never understood except through the individual's thought processes, but the individual does not understand himself except by adapting himself to the object. Thus man cannot understand the universe except through logic and mathematics, the product of his own mind; but he can only understand how he has constructed mathematics and logic by studying himself psychologically and biologically, or in other words, as a function of the whole universe" (ibid. pp. 82-83).

Thus the cyclic order was the only way of understanding truth, scientific knowledge, universally accepted fact,etc. For Piaget, the 'circle of science'demonstrated the interdependence of the sciences, which found its fulcrum in psychology, which was the location of the understanding of thought and of cognitive development. Piaget had to pre-suppose knowledge as prior element of reason and nature, i.e, subject and object. In this sense there was an element of Kantianism in his system.

Since biological analogy proposed by Piaget is the most important aspect in child psychology, a further discussion of biology and knowledge

follows.

3.6. Cognitive Development and Biologism in Piaget's Theory

We have already mentioned Piaget's fundamental doctrine of discrete stages in the process of cognitive development. As a first point of criticism it may be helpful to say something about the intellectual ancestry of this doctrine. Respecting these states, Piaget wrote :

"(1) Their order of succession is constant, although the average ages at which they occur may vary with the individual, according to his degree of intelligence or with the social milieu...(2) Each stage is characterized by an overall structure in terms of which the main behavior patterns can be explained. (3) These overall structures are integrative and non-interchangeable. Each results from the preceeding one, integrating it as a subordinate structure, and prepares for the subsequent one, into which it is sooner or later itself integrated" (Piaget and Inhelder 1969 pp. 153).

Moreover, he made it clear that he believed that these stages of mental development could be regarded as analogous to the anatomical stages that may be discerned in the developing human embryo; "Child psychology must be regarded as the study of one aspect of embryogenesis"(ibid.p.vii). And further the first sensori-motor stage was to be regarded as taking over from the earlier stages of embryonic development, in the manner indicated by Point 3 above. He stated further,

"Each of (the stages of mental development) extends the proceding period, reconstructs it on a new level, and later surpasses it to an ever greater degree. This is true even of the first period, for the evolution of the sensori-motor schemas extends and surpasses the evolution of the organic structures which takes place during embryogenesis"(ibid. p152).

But how legitimate is the analogy that Piaget seeks to draw between mental development and the stages of embryonic growth?

Embryological studies were of considerable importance in the nineteenth century, and formed an important part of the evidence for the evolutionary theory of Darwin and his followers. Meckel and Serres supposed that the human embryo passed through successive stages which approximated adult forms of fish, reptiles, birds and mammals. However, Von Baer took the rather different view that the early stages in the development of an animal are not like the adult stages of other animals lower in the scale, but resemble the corresponding early stages of those animals (Beer 1958, p.3). Then Haeckel, in his "theory of recapitulation" or "biogenetic law", supposed that the embryonic development of an animal represented a kind of accelerated version of the evolutionary history of its species. In Haeckel's words: "Ontogeny recapitulates phylogeny"; or as G.B. Shaw put it as "During its life-history an animal climbs up its family tree"(ibid.p.7). But modern biology

prefers an interpretation closer to Von Baer's original formulation.

There is, of course, no doubt that modern embryology still accepts a modified version of the doctrine of stages in embryonic development. The question, however, is the extent to which such a picture provides a satisfactory analogy for theories of cognitive development in children to follow. We should note particularly that Darwin himself was disposed to consider mental development as a kind of prolongation of embryological development. He supposed that variations appear at corresponding ages of offsping and adults (Darwin 1900, pp.610-619). And in the Descent of Man (1894) he added the idea that acquired characteristics tended to be transmitted particularly to offspring of the same sex at the same age as they were acquired by the parents; and this applied to mental powers just as much as particular physical attributes (Darwin, 1894, p.565). Moreover, his embryological theory, briefly stated, was that variations appeared in stages in the gradual development of embryos; and these differences, when fully manifested in the adult forms, accounted for the differences in the adult forms of different "taxa" (classificatory groups) and explained also the phenomena of embryological recapitulation (Darwin, 1900, p.619). Thereby

"community in embryonic structure reveals community of descent" (ibid.p.617).

It may be argued also that Piaget has been disposed to "slide" from embryology into theories of cognitive development, just as Darwin did before him. Piaget's interest in biological investigations is well known. He tells us that from his childhood he was an naturalist, and that he published short notes on molluscs at the early age of 15 (Piaget 1972a). These early investigations were followed up in the 1920s by a series of papers on the adaptation of fresh-water lamellibranchs to different environmental conditions (Piaget 1971b). Later he devoted a whole book to a consideration of epistemological problems from a biological point of view, seeking to explain the age-old problem of the correspondence of the truth of mathematical deductive systems (e.g. Euclidean geometry) to the "fact" of the real world by the hypothesis that "physical knowledge is an assimilation of the real world into logico-mathematical structures"(ibid. p.339). It is clear that a radical "biologism" runs right through Piaget's whole system and had an important formative effect on his view of the successive stages of mental development.

3.7. Stages in Cognitive Development

Piaget's theory of cognitive development was based upon models derived from his early biological investigation. The core words used in Piaget's analysis are "assimilation" and "accommodation". From his early studies of molluscs it appeared to Piaget that even simple creatures are not mere passive receptors of stimuli. They adopt their structures according to the stimuli received, incorporating some information about their surroundings to their schema of action. These particular interpretations of animal behaviour were parallel to Piaget's later theory of mental structure and intelligence, and also formed the basis of his theory of cognition. In Piaget's view, the two essential processes in cognition are adaptation and organization. Adaptation is the state of equilibrium reached when balance of organization occurs, that is, a balance between assimilation and accommodation.

The basic pattern in mental organization Piaget terms a "schema". He argues that schemata are derived originally from sequences of actions, such as sucking, grasping, etc. but are broadened by experience and extended to apply to objects in a variety of situations.

The child's mind assimilates or adds more to the basic pattern of organization of the action. This process is called assimilation.Infants have

schemata of actions and perceptions but later schemata become representational, i.e., things and events are represented by words and symbols. In order to make information fit into a pre-existing schema, certain distortions may be made. This accounts for the faulty reasoning of the young child who assigns incorrect causes to effects, or vice versa. When it becomes impossible to fit new evidence into the existing schema (i.e. when there is cognitive dissonance), the schema must be modified to accommodate it. This is called accommodation. Accommodation is initiated by the appearance of a problem or situation which cannot be met by the application of the existing schema or mode of response. Distortion in this case is not acceptable and the child reorganizes his understanding of the situation so that the new elements make a coherent pattern. The new schema thus permits a new adaptation to the environment, and through accommodation a new equilibrium point is established. Assimilation at the new level of organization will ensue, until the schemata in use are again found wanting.

According to Piaget's theory and its supporting observational data, all mental activities,including their cognitive aspects, pass through certain definite stages as they move from

one stage to another. This ascending process is compared by him to the process of physical growth. Thus we read,

"Mental growth is inseparable from physical growth;the maturation of the nervous and endocrine system, in particular, continues until the age of sixteen (Piaget and Inhelder 1969 p.vii).

It also appears to Piaget that mental activity can only ascend. He divides it into four stages:

1.Sensori-motor stage (birth-2 years)
2.Pre-operational stage (2-7 years)
3.Concrete-operational stage (7-11 years)
4.Formal operational stage (11 years plus)

There is, however, no standardization of the experimental procedure on which these generalizations are supposedly based and there is no attempt at measurement unless it can be called measurement to define a number of distinct developmental stages. A systematic view of Piaget's theory of mental development is summarized in the following section.

3.7.1. Sensori-motor stage

This initial level of cognitive development is characterized by the general co-ordination of motor and sensory actions. Mental action is accordingly expressed by the motor skills of the child. It suggests that the child is unable to cognize his/her surroundings in a mature sense but is limited only to his non-cognized physical actions. Piaget divides this stage into six sub-stages and implies that this shows the gradual growth of

children's mental behaviour. In the succeeding paragraphs, these six sub-stages are described.

Sub-stage 1 (birth-1 month approx.): This period begins with exercising sensori-motor schemata within the capacity of a few reflexes, e.g., sucking, grasping, crying, moving arms.

Sub-stage 2 (1-4.5 months aprox.): In this stage "primary circular reaction" is shown. The first acquired adapations are made by varying and combining schemata. The child begins to suck anything he can grasp, turns his head as he follows with this eyes, repeats actions for their own sake, not for ends.

Sub-stage 3 (4.5 - 8/9 months): This is the period of "secondary circular reactions". The child tries to reproduce a schema of action that satisfies. He becomes an initiator rather than just a responder. He anticipates what will happen, experiments with his limbs, extends his range with eye-hand coordination. He makes no true exploration, however, nor can he make minor changes to re-produce the original situation. His reactions are for a simple end - that of maintaining a result in the external environment.

Sub-stage 4 (8/9 - 11/12 months): Coordination of secondary schemas - at this stage the child may be crawling, standing, beginning to

walk and speaking. From exploratory discovery behaviour he gains notions of how to do things and he is able to select and regroup schemata appropriate to his ends. Games such as dropping and finding appear. Imitation of visual and auditory actions increase.

Sub-stage 5 (11/12 - 18/24 months): This is the period of "tertiary circular reactions". In this stage an intentional and inventive accommodation appears. The child not only repeats an action which has produced a new result but varies the action to see what will happen next. Repetition plus variation leads to further notions of the object, and extends to imitative activities and games. The new is tried for its own sake, emphasis is on the means, and curiosity grows. He now has some simple notions of causality, space and time.

Sub-stage 6 (18-24 months): This is the period of internalization of "sensori-motor schemata". The child is replacing sensori-motor groping by the rapid, even spontaneous organization of well known mental schemas. He is beginning to represent the external world internally by images, memories and symbols. He does not think in images but uses images as an aid to internalization which is still on a motor basis. He looks for things where he expects them to be found. Imitation without a model

present begins. At about 21 months the normal child makes the change from a predominantly non-verbal to a verbal organism. Environmental deprivation can occur as early as Sub-stage-2. The infant needs affection,attention, and conversation, plus the stimuli of objects, happenings and interaction to provide him with the needed opportunities to learn to organize his activities mentally. It is during this period that memory develops, and the acquisition of primary notions of conservation, space, time and physical causality occurs. It is obvious that achievement in this period underlies all future advances in cognitive development and is of fundamental importance.

3.7. 2. Pre-operational stage (2-7 years approx.)

This is a primarily a transitional period as it is not marked by a stable equilibrium. The sensori-motor stage of concrete operations represents a new order of equilibrium. Piaget sometimes combines this stage with stage 3. He treats ages 2-11 as one large stage having three substages namely the pre-conceptual, the intuitive and the substage of concrete operatons. The following paragraphs deal with these substages.

Sub-stage 1 (4-4.5 years): This is a preconceptual substage but the child is involved

with symbol formation. During the sensori-motor stage he learned to form mental images with the result that the two dominant characteristics of the preconceptual stage are imaginative play and language acquisition. Lack of experience, however, prevents him from using true concepts. Language is an accompaniment to action and gradually assumes a directive function. Play and imitation are devices allowing the ego to be integrated into reality.

Sub-stage 2 (4.5 -7 years): The child's thinking is dominated by his own individul perceptions. He cannot make comparisons mentally, but builds them up one at a time in action. He is unable to see simple relations. There is a lack of direction in thinking. He begins to form some concepts and gives reasons for his beliefs and actions. Comprehension of one to one correspondence between related objects develops gradually. The end of this substage is marked by the apprehension of the principle of conservation of quantity.

During the pre-operational stage the child is noticeably disequilibrated in his conceptual thinking. He often falls into self-contradictions. Much of the child's everyday behaviour is, however, integrated and begins to show signs of logical thinking in so far as his language is tied to behavioural schemata.

It may be easy to underestimate the child's

ability on the basis of negative responses to simple logical questions or problems or to over-estimate his ability on the basis of positive responses, for such responses may not, at this stage, be a true indication of the child's cognitive processes and abilities.

3.7.3. Concrete Operational Stage

This is a period when the ability of cognition is transformed from an actional to an operational stage. During this period the child is able to internalize actions in the form of representations and this facilitates the logico-mathematical operation which permits reversible mental operation. The most distinctive feature of concrete-operational thought is its reversibility. The operations are, however, not yet independent which means that inversion and reciprocity are used independently, therefore limiting the unification of the system of operations. Throughout the concrete-operational period, for specific varieties of conservation of weight, length, liquid, etc. responses become "operatory" which means among other things that the child begins to understand and is able to solve conservation problems.

By the time the child is seven years old, his thought processes are becoming more and more stable, and he acquires rudimentary conceptions of

time, space, number, and general logic. Growth within this stage is marked also by the gradual building up of the ideas of conservation of matter and length, and later of weight and volume. Pre-concepts give way to true concepts as the child learns to deal with the properties of the immediately present world. The concept of reversibility is possible for the first time. During this period, the private image gradually assumes communicable symbolic form. The limitations of the "pre-concept" are replaced by the usefulness of the fully articulated concept. The child "decenters"his thinking and escapes from complete domination by his perception. He is,however, still limited to those mental actions which envisage the use of concrete objects. The child's problem here is to try and understand the relationships between concrete operational groupings already acquired.

3.7.4. Formal Operational Stage

At the formal operational stage, the previous limited logical thought of classes and relations is subsumed under a logic of proposition. It is possible at this stage to construct a logically perfect structure which unifies different concepts in one mental system. During this period, which begins at 11 and continues for 3 or 4 years, adult

forms of reasoning appear, and the basic principles of causal thinking arise. The child is able to make full use of hypothetical reasoning in order to attack problems from the angle of all possible combinations. Controlled experiments can be made to observe the effects of altering variables. The hypothetical reasoning does not reach its peak until the age of 14-15. It is however, emphasized that those who have not had the necessary experience can not successfully pass through the preceding stages to reach the formal operational stage.

Further discussions on cognitive stages will be presented in the final chapter.

3.8. Summary

The Piagetian structural model serves to explain the mental structure in the acquisition of knowledge, but does not explain the development of an individual in the context of a particular society and in diverse ways of utilising and acquiring knowledge in different situations. Individual differences in the acquisition of knowledge in a particular society might well be more important than appears from Piaget's treatment where this difference is a trivial matter. Piaget has not allowed for the possibility of there being various models of cognitive development in

different contexts and individuals. His main assumption is that the cognitive process should be generalized, and it is analogous to the science of embryology. His experimental material and methods indicate that he is not interested in investigating the different ways of acquiring knowledge and individual differences whereas it is an important area in psychological investigation of child development.

If we take a "hypothetico-deductive" view of the structure of science, and follow the falsificationist views of Sir Karl Popper (1963) then we should have no reason to object if Piaget formulated his psychological theories on the basis of analogies drawn from the science of embryology. Methodologically,this may be perfectly acceptable. It does not matter, Popper says, where hypotheses are derived from, so long as they are subjected to the most rigorous experimental tests once they have been formulated.

We should, however, take note of the particular analogy that Piaget employed in the formulation of his doctrine of the successive stages of mental development. For example, in the case of the development of animal embryos the various stages are - in the last analysis - related to the several very broad divisions of the animal kingdom, which may be supposed to have arisen in

the long evolutionary development of animal organisms. Here natural selection, geographical isolation, and divergence have given rise in time to the various animal taxa, according to the fundamental Darwinian mechanism. Yet can we say that there have been analogous processes that may have given rise to the supposedly distinct stages of mental development which Piaget's system upholds? It would seem not. It may be, therefore, that when Piaget's system is subjected to the appropriate experimental tests it may be found wanting, despite the fact that a considerable quantity of experimental evidence in its favour has in fact been produced.

Some critical comments on this system of mental stages, briefly outlined, are:

Piaget sees the characteristics of the child's learning as being as much a part of the child's accommodation to, and assimilation of his environment as they are in lower animals. As the growth of the child's knowledge parallels this gradual evolutionary adaptation, the knowledge becomes mature enough to make a child's formal mental operation possible.

To be sure, Piaget does see society as the milieu within which cognitive development occurs; but he gives no adequate account of the way in

which it may affect the biological processes of assimilation and accommodation. So that while it appears that Piaget is well aware of the possible significance of the social context, he makes no effective use of it within his theoretical system of explanation of cognitive development.

Some of Piaget's interpretations of his experiments may also be questioned. For example, in commenting on a child's inability to recognise conservation principles. Piaget wrote:

"What is most striking at this first stage is the inadequate quantification of the perceived qualities, and the lack of co-ordination between the quantitative relations involved in the perception... The real contradiction lies in the fact that the child attempts to justify his opposing statements by resorting to explanations that they cannot co-ordinate one with another, and that lead to incompatible statements."
..."the child behaves as though he had no notion of a multi-dimensional quantity and could only reason with respect to one dimension at a time without co-ordinating it with the others" (Piaget 1952, pp 9-10).

Piaget concluded on the basis of his test that the child at this early age had not yet acquired the ability for multi-dimensional thinking (ibid.p12).

A further point to note is the way in which very wide and general conclusions were made by Piaget on the basis of a limited number of tests performed on children of one Western culture only. Can one make inferences about the development of intellectual skills amongst all humans on the basis

of such experiments? This ,of course, is the problem with which the present investigation is specifically concerned.

CHAPTER 4

Review of relevant literature

Having thus given some accounts of Piaget's investigation of cognitive development in children and the role that these studies played in his overall psychological theory, noting particularly the biological features of his system, it is now appropriate to give a synopsis of some more recent findings that pertain to the subject of the present enquiry.

It is impossible, and probably unnecessary, to analyse all the works that have a bearing on this present inquiry. To include everything would make this dissertation undesirably extended. Modgil and Modgil (1976), for example, have pointed out the fact that there is a remarkable amount of study and commentary on Piagetian ideas, saying that, "Perhaps in no other areas of psychology is there so much cross-cultural and cross-social class empirical research data available as on the Piagetian tasks". The present survey therefore focuses attention particularly on recent works which are concerned with the role of cultural context and language in relation to children's cognitive development. And since the present enquiry takes a critical position in relation to

Piaget's theory by reason of its insufficient attention to contextual factors, greater emphasis will be given to works that are critical of Piaget's position.

In order to give some structure to the survey the following review sections will be employed: a) Experimental work showing the problems of generalization of cognitive performance, measured by certain testing materials, b) work on mental states, c) the influence of culture and environment in the performance of cognitive tasks, d) the influence of language in the performance of cognitive tasks,e) how very young children (birth to 6 years) reveal their intellectual performance.

4.1. Experimental work showing the problems of generalizability of cognitive performance.

Bruner's (1966) study on liquid conservation dealt with the growth of the child's "ability to recognize that, though a particular magnitude has changed its appearance, it is still the same magnitude". The experiment designed by Patricia Nair and carried out on five year old children (N=40) drawn from a kindergarden in a Boston suburb, involved the investigation of their understanding of the identity of quantity of water. The water was moved from one vessel to another but with the water supposedly "owned" by a wooden duck

who "takes the water with him" in moving from one "lake" to another.

In this study Bruner observed different ways in which children understand the principle of conservation and suggested that "conservation responses and nonperceptual reasons are stimulated by **reminding** the child first about identity. Identity is present in most children who do not have the idea of conservation, but it is obviously not integrated with a notion like invariance of amount. Prodding the child to consider the identity of two things seems to lead him to be more perceptual and less conservational in the immediate context. Remember, however, that this same prodding ultimately succeeded in pushing him on to conservation judgement...Once the distinction has been made between identity and equivalence, then the child is able to relate the two into a system in which he can say, for example: They are the same water, but they do not look the same. Finally, this can be translated into linguistic equivalence: they are the same amount" (pp.191-192).

This study indicates that the growth of the ability to comprehend the idea of conservation (liquid in this case) cannot be equated with the general intellectual development of the child. In the studies of Lovell and Ogilvie (1961) junior

school pupils (6-9 years) were tested individually to examine the development of the concept of weight and volume. In the weight test, the authors concluded that "while results very similar to those of Piaget were obtained using his criteria for invariance of weight, it is shown that the children who are conservers of weight in this type of test are often non-conservers in other tests of conservation of weight". It is therefore suggested that while ability to think logically may be necessary, it is not a sufficient condition for conservation of weight. Actual experience of the physical world seems to play a more important role than Piaget would allow.

In the same year, Lovell conducted the conservation of volume test. The subjects (N=190) were also junior school children. The results "supported Piaget as regards...the gradual development of concepts of volume". However, the author criticised Piaget for using single-volume tests to decide if a child could fully understand the concept of volume. The reason for the argument was thus described, "in the development of this(volume) concept, as in the growth of other concepts the child has to learn to eliminate irrelevant factors. This is a slow business. It is possible, but not certain, that children could learn more quickly about volume by being exposed in

school to learning situations when the effectiveness of the relevant and non-effectiveness of the irrelevant variables could be made evident in the same experiment".

Lovell implies here that the limited number of testing materials for examining mathematical concepts is insufficient to test general ability relating to those tests. Specific tasks can only serve to test specific ability.

Hyde (1970) carried out a replication study of Piaget's investigation, described in The Child's Conception of Number, to verify the cognitive developmental stages and respective characteristic responses of children living in Aden whose cultural background varied and was different from those of Piaget's subjects. Of the children (N=144) in this sample 48 were Europeans, and 24 Somalis. Half were male and half female. Ages ranged from six to eight. These children attended local schools with the same type of syllabus, but were taught in different languages. All children were tested out of school with the help of parents at home. Among other tests the children were examined for their understanding of conservation of quantities (weight, volume, substance), cardinal and ordinal one-to-one correspondence and additive and multiplicative compositions. Non-verbal

intelligence tests were also given to the sample children. The procedure and techniques of the administration of these tests were modified versions of those developed by Piaget.

Hyde posed the questions:(1)" Are the stages applicable to each test independently or (2) do the tests represent a definite progression in the child's conception of number?" The author said, "There is some disagreement in answering Piaget's question. Many children with "A" grades in some tests were at "C" stages in the other".

He also investigated whether there was any significant difference in the results obtained from children of different communities in Aden. The author found that the responses of the children in different Aden communities were qualitatively very similar,that is, "the order of difficulty of tests was the same for all communities for each age range. The results, however, turned out to be quite different when comparisons were made between the quantitative results of the different communities; that is some were in advance of others even though the rate of progress was not significantly different for the different communities". The main variable was apparently age and community. The author concluded that "the European scores, as anticipated from the raw data, were significantly higher than those in the other communities; "when

age ...(was) considered, the variance between the three groups...(was) significant". However, it appears that the age at which responses characteristic of Piaget's stages appeared varied between the communities. There was not any significant association between the amount of formal schooling and the success achieved on the test.

Hyde clearly indicated that the rate of children's intellectual development is gradual. However, the rate was apparently different from one ethnic group to the other. From this study, Hyde concluded that, "children do not always reason in the way that Piaget describes. In other words, there is no logical necessity for them to arrived at a correct solution by a given route, since children's logic is not necessarily an incomplete version of adult logic. It apears to have its own characteristics" (p.197).

Feldman (1974) carried out an investigation to examine the Piagetian hypothesis that "development has the same hierarchical structure in all cultures undergoing successful adaptation".

The sample of children was selected from three different cultures; Eskimo children of Alaska's North Slope, and children in the mountain region of Kentucky and in Hawaii. Their ages ranged from seven to nineteen years. The Coloured Blocks Tests which is "a specially contructed non-verbal

test of logical thinking was used. The test represented three Piagetian stages and formed a series which began with simple perceptual drawing from the response set" (p.62).

The results suggest that the sequence of appearance of cognitive abilities following one stage to another stage was confirmed. However, the author insisted that the adaptation which "governs cognitive growth consists of constant interaction between the person and the environment".

These researchers tend to agree with Piaget that the rate of cognitive development is gradual; however, they would not accept that the results of certain tests allowed them to make generalized judgements of children's intellectual abilities in related fields as a whole.

4.2. Is there a clear division in the mental stages as Piaget suggested in terms of its quantity and quality?

Carey (1974) has studied the conservation ability of three year-olds and seven year-olds using standard Piagetian conservation tests of liquids. The authors claimed that"making conservation judgements and justifications is a skill, the possible constitutents of which are: the separable sources of relevant information in the

children's task analyses, original equality or inequality, the nature of the transformation, relative heights and widths of the liquids". Failures were considered to have occurred when the children were simply less skilled in manipulating and integrating these constituents.

These findings and arguments are in agreement with those of Bruner and Koslowsky (1972) who argued that there are no differences between people in the process of acquiring skills. Instead the differences that have been found reflect domain-specific, local rather than global, developmental differences. Carey further stated that there was no qualitative cognitive difference between children at different ages. That is, the differences between three-year-olds and seven-year-olds could not be expressed in terms of the former being pre-operational while the latter were operational.

Lovell's (1960) study concerned the validity of Piaget's studies of the conservation of substance, carrying out the standard tests with the deformation of balls of plasticine. Contrary to Piaget's claims, Lovell found that the children investigated did not reveal a clear-cut distinction in their thinking with respect to conservation and non-conservation. Some children at the intermediate level often learned to understand what was

happening during the course of the investigation. And the results obtained seemed to depend on the precise nature of the situation presented to the children. Lovell argued that the children who had reached the operational level were unable to give an adequate account of their reasoning, and tended to rationalize their answers when pressed to do so.

4.3. Culture and contexts on cognitive performance

De Lemos'(1973) study was designed to investigate the development of the concept of conservation among Australian Aboriginal children, testing Piaget's conservation tasks of quantity, weight, volume, length, area and number among two groups. The first was the Hermannsburg mission, which has a relatively longer and closer contact with the European way of life, and the other was at Alcho Island mission which has been more recently established and is more isolated from European contact. Although the Aborigines' living standard was generally poor and the influence of European contact was limited, there were some differences between the two groups.

The total number of the sample was 145 children (65 from Elcho Island and 8Ø from Hermannsburg) and their ages ranged from eight to fifteen years.

The results were that a "fifty percent level

of success was not usually achieved before ten to twelve years and in some cases was not achieved at all. While there was a general tendency for conservation to be achieved with increasing age, this did not necessarily show a uniform progression, particular in the Hermannsburg group where some of the younger age groups showed performances equal to, or better than, those of the older age groups". It was also found that "more children succeeded in the test of weight than that of quantity and the conservation of area is achieved much later than those of quantity and length".

De Lemos therefore argued that the stage of development described by Piaget is simply the product of Western culture and training, and is not general in stage characteristics of all cultures. The poor performance of the Aborigines was attributed largely to the extreme differences in physical and cultural background of these children as compared with normal European children.

The author concluded that "genetic factors affecting the average intellectual potential of these children may therefore have contributed to the retardation in the development of conservation concepts. However, the retardation cannot be attributed entirely to genetic factors, and it is likely that environmental and cultural factors play

an important role in the development of concepts such as conservation".

Dasen and others(1973) also attempted to examine the environmental effects of reasoning ability in adopted Aboriginal children. It was assumed that these adopted children, had they been reared under similar conditions, would not have performed at a superior level to Aboriginal children of comparable age group reared in missions or government settlements.

The number of subjects in this study was thirty-five children (M=15,F=2Ø) with the age range from five to seventeen. Information on the background of children was obtained such as medical history, tribal orgin,and social status of the adopting families. The tests used were,conservation of quantity, conservation of weight, horizontality, seriation, reclassification, the Nixon test, and the Peabody Picture Vocabulary Test (PPVT form A).

The authors concluded from the above study that "the performance of the children on four of the tests was equal to that of comparable European groups. In the two tests of conservation, however, their performance was intermediate between that of the comparison European and Aboriginal groups". The authors explained the above findings and suggested that "a possible explanation for their relatively

poor showing on these tests is that the two conservation tests demand an advanced level of verbal competence; the subject has to be able to justify his conclusion with fairly sophisticated explanations. Those children, demonstrating conservation but unable to justify it, receive a lower classification than those who can justify it".

In one of the conservation tests used, the European comparison sample was drawn from a population which would not be representative of the average Australian population in respect of verbal fluency. Canberra children, making up the comparison group for the conservation of quantity, tended to come from very high socio-economic levels of the population. The adopted Aboriginal children,however,were living with families who would not be expected to have such an advantage in verbal fluency. It is possible, therefore, "that the comparison being made is not a "fair" one and that the deficit of our experimental group is being over-estimated. A second possible explanation is that the conservation tests provided a more accurate estimate of untutored intellectual ability."

This study suggests that verbal fluency will positively influence the ability to provide explanations and so affect the performance of conservation of quantity. Verbal fluency

is, needless to say, an advantage usually found in the population of high socio-economic level.

Dasen (1972) carried out an experiemnt to assess the relative development of logico-mathematical operations and of the spatial operations among Aborigines. The hypothesis was that the Australian Aborigines because they depend traditionally on hunting in groups, and travelling for long distances in a barren environment, would develop spatial operations relatively earlier than logico-mathematical operations.

The sample consisted of forty-five children, aged six to sixteen years, and twenty adults, who were tested in two different locations in central Australia: the Areyonga Settlement (low-contact group) and Hermannsburg mission (high-contact group). The control group, eighty European children, was tested in Canberra. The general result was that in both the Europeans of Canberra and in the Aborigines of central Australia, the states described by Piaget were found to occur in the same order, and the reaction to the tests, as well as the answers and explanations given by the children, corresponded to those reported by Piaget. In relation to the relative development of logico-mathematical and spatial operations, the Canberra sample children were seen to acquire logico-mathematical operations earlier than spatial

operations whereas Aboriginal children acquired spatial concepts earlier than logico-mathematical concepts.

From these results, the authors concluded that "a specific departure from the pattern of cognitive development typically found in European children may be produced by ecological and cultural characteristics". It was also indicated that the deviation does not affect the notion of a hierarchical succession of stages, but shows that environmental factors can influence not only the rate of development, but also the "homogeneity" of the operational structures within each stage".

When the results were analysed with regard to the influence of European contact, they were significant at each age level only after ten to eleven years of age, the higher contact group having better achievement in logico-mathematical concepts.

The conclusion was that "the cross-cultural approach provided a decentration of Piaget's theory towards the cultural dimension". The author insisted upon the necessity of providing pre-schooling as early as possible, with an extensive research programme to assess the effects of various methods, because "the precise knowledge of the way in which cognitive structures develop in Aboriginal

children should eventually stimulate the development of testing methods and curricula based on psychological factors."

Dasen and his colleagues (1979) carried out conservation tests with Baoule children in West Africa and tried to find out if it was possible to bridge the "developmental" lag by training them. For that purpose they trained the Baoule children for 6-9 days with liquid tasks. After the training period, the same children were tested with liquid and class inclusion tests again. The authors discovered that the training effect was significant, and concluded that,

"There is not only transfer from conservation of liquids to other conservation concepts, but there is also transfer from one conceptual area to another, e.g., between conservation and classification. In this respect, our results are exactly parallel to those of Inhelder et al (1974), and indicate,...that the acquisitions were truly operatory and that, during training the children's mode of reasoning had altered in an essential way (Inhelder 1974, p.257)".

They think "that the "lag" was attributed to differences in competence; the training was sufficient to bridge the developmental lag"(p.57). Therefore in the end they come to accept the "competence" model suggested by Bruner (1966).

Seagrim and Lendon (1980) carried out an experiment with Aborigines between seven and seventeen years of age. The aim of the study is described as "to discover what the child is capable of, rather than to compare children for other purposes". Their test battery consisted of "six tests which fall into three groups. In the first group there were two tests of conservation, those of quantity and of weight. In the second there were two tests of classification, one a test of reclassification and the other a matrix test. In the third there was a test of seriation and a test known as the test of horizontality, which involves the abstraction of the principle of the force of gravity in an elementary form"(p75).

All the tests and testing materials are similar to those used by Piaget and the authors argue that "the use of everyday objects for this kind of tasks is particularly risky in cross-cultural work because criteria of equivalence and of distinction differ markedly between cultures"(p.79).

The findings are described as follows : These children "achieve and use concepts of identity (conservation) of order (seriation), of classification and of abstract forces (the surface level of liquids) at comparable ages and without special tuition...they have the same capacity to acquire the forms of

knowledge of the physical world that Piaget has ascribed to white middle-class children brought up in a Western culture".(p181) They also found that some Aboriginal children were not committed to conservation judgement. The possible reasons suggested for such observations are that "they may simply be missing the point of the test - that their attention was not concentrated on the real issues involved. Alternatively, they may have been overcome by shyness during the test" (p.112).

Another interesting observation from the above study was that some individuals regressed rather than advanced or remained stable over successive years. One finding was that young children (6-7 years) performed better than those in immediately succeeding age groups. They noted that "regression on the tests of conservation are of more theoretic interest and occurred sufficiently frequently to be worth examining".

Dempsey (1971) attempted to compare the conservation of time concept among children of different cultures from five groups: Pima, Papago,Navajo indians in Arizona, Mexican-Americans and middle-class Anglos.

The total number of subjects was 45 children, consisting of 15 children from each age group of seven, nine and eleven years. The children were

tested for conservation of, simultaneity of, and conservation of, order of events. These were replications of Piaget's conservation of time experiments and the procedures followed by Lovell and Slater (1960).

The results showed that no group tested was able to conserve simultaneity in any of the tests used at any of the ages tested. In the simple order of event tasks only the Anglo children were able to conserve at age seven. By age nine all except Navajo and Apache had conserved and by age eleven all except Apache children had conserved. In the increasingly hard order of events test, none of the groups had achieved conservation by age nine and only Anglo, Mexican-American and Pima achieved conservation by age eleven".

Cole and his colleagues (1971) intended to find out whether culture and context affect performance at the formal operational level. The subjects of their experiments were Liberian Kpelle rice farmers and school children, with control groups in the U.S.A.

The free-recall technique (to test the ability to recall the number of items from the test text) was used with five repetitions of the experiment to study cultural differences in memory. The investigators used both familiar and unfamiliar material in their tests,e.g., the use of folk

stories for the Kpelle rice farmers provided a "familiar" context, whereas the subjects found the normal wording of the tests "unfamiliar" to them.

From the first performance, using ordinary wording, three main tendencies were found: 1.The number of items recalled was relatively small, 2.there was no evidence of semantic or other organization of the material, on the part of the subject, 3.there was little or no increase in the number of items recalled with successive trials, whereas the American control group showed better recall, and considerable improvement with repeated trials. Thus, the Kpelle rice farmers performed significantly less well than their American counterparts. However, when the materials for recall were incorporated into folk stories, the Kpelle rice farmers showed a vast improvement in their powers of recall.

The investigators concluded that "a set of rather specific skills associated with remembering disconnected materials out of context underlies the differences observed in the standard versions of the free-recall experiment with which they begin". Moreover the investigators were unable to begin the job of identifying these skills, their relevance to traditional activities, or the teaching techniques that could be expected to bring existing memory

skills to bear on the "alien" tasks of the school. They also suggested the necessity of re-examination of the distinction between "performance" and "competence". It was evident that poor performance was due, in part, to unfamilar context. In other words, level of performance does not necessarily fully reveal underlying competence.

Cole and Bruner (1971) have been concerned with cultural differences in psychological processes. They suggested that the differences in performance have to be accounted for by the situations and contexts in which the competence is expressed. And they argued that situational factors are often important determinants of performance. The importance of cross-cultural studies and their bearing on the role of "situational factors" in psychological research was emphasized, though it was noted that the precise role of "situational factors" was somewhat vague and required further investigation. Further it was remarked that: "A concern with the relation between "psychological process" on the one hand and "situational factors" on the other hand has long been a kind of shadow isssue in psychology, surfacing most often in the context of comparative research".

Price-Williams (1969) found that the effect of pottery-making was limited to the conservation of

matter (substance) in one sample, whereas in another sample, transfer occurred to conservation of number, liquids, weight and volume.

In Adjei's study (1977), pottery-making was found to have a significant effect on the conservation of substance, weight and volume in a group of Ghanaian adults, whereas in children, the effect was significant on weight only.

The above studies in general suggest that different cultural groups are likely to respond differently to particular experimental situations. Therefore there is little alternative to carrying out psychological experimentation that bases its inferences on the comparison of both formal experimental and situational variations.

4.4. On child language and cognition

Irvine's (1978) experiment with Wolof adults was concerned with the variables affecting cognitive performance. The subjects were unschooled Wolof adults aged about twenty-five to fifty-five. Conservation and non-conservation responses were compared with Greenfield's study (1966), as the two studies were based on the same Wolof village. The tests used were the standard Piagetian conservation test using liquids. The tests were held individually at the tester's residence.

The Wolof experiment proved that "there is no

pair of words in Wolof corresponding precisely to English terms such as equal level or equal amount, although there are some that come close; Wolof words for "equal" are "to lo" and "yem which do not by themselves distinguish equal level from equal amount. Thus distinctions relevant to the conservation tasks can not be readily expressed in Wolof, should its speakers need or wish to do so". From the observation and the results gained in the above experiments Irvine asserts that the statement "This one is more (kii moo-i genn)" is ambiguous, since the word "more" can refer to either the quantity or the level of the water.

Irvine concluded that "cultural conventions about the organization of talk, the kinds of questions asked in an interview, and the presence of strangers are factors strongly influencing the outcome of an experiment". The results also suggest that "one should be extremely cautious in inferring subjects' cognitive processes from their verbal behaviour and one should be especially cautious about concluding that some cognitive process or principle is absent because of a lack of verbal evidence of its presence. That people (Wolof) do not talk about things does not mean they are unable to think about them".

Donaldson (1970) studied the ways which children interprete the words in the experimental

tasks and proposed:"...when a child interpretes what we say to him his interpretation is influenced by at least three things (and the ways in which these interact with each other)- his knowledge of the language, his assessment of what we intend (as indicated by our non-linguistic behaviour), and the manner in which he would represent the physical situation to himself if we were not there at all".

Donaldson (1978) observed children using their language and suggested that "even pre-school children can frequently reason well about the events in the stories they hear. However, when we move beyond the bounds of human sense there is dramatic difference... Thinking which does more beyond these bounds, so that it not longer operates within the supportive context of meaningful event, is called often "formal" or "abstract" (p76).

In Pratoomraj and Johnson's study (1966), 32 children from four to seven years were presented with five problems aimed at determining whether they had attained the concept of conservation. "Four kinds of questions concerning quantity were asked to the subjects following the manipulation of stimuli (e.g. rolling 1 of 2 clay balls into a sausage shape): "Is it the same? More? Less? Different?" Eight children in each age group were presented with a given kind of question. Three

types of conservation tasks were presented: "questions of prediction, judgement, and explanation".

They conclude that "Piaget's finding of an increase in conservation with age was confirmed. Sex differences were insignificant. The kind of question had very little effect. The type of conservation task had a significant effect on maturity of response at younger but not older age level". They also found that most conservation responses were made to questions involving prediction, the next to questions of judgement, and the least to questions of explanation.

LaPointe and O'Donnell (1974) found that among preschool children who could give conservation responses, few could produce correct explanations and suggested that young children's verbal expression is not necessarily relevant to their reasoning abililty.

4.5. How do very young children show their cognitive ability?

Donaldson (1978) rejects certain features of Piaget's theory of intellectual development. In her study she quoted his work with particular reference to children's conception of space and criticized his claim that children under the age of six or seven are very bad at communicating, because they are bad at decentring or that they are highly "egocentric". Against Piaget, Donaldson insisted

that "the motives and intentions of the characters are entirely comprehensible, even for a child of three... thus it is not at all hard to convey to the child what he is supposed to do; he apprehends it instantly".

Gelman (1972) studied children's ability to grasp the concept of number invariance. He carried out an experiment to find out whether children had a logic of classification that could be used on numerically and non-numerically defined sets.

The results showed that for small numbers, children as young as three years old possessed a concept of number that was independent of the dimensions of length and density. Also these young children possessed a logic that treated the cardinal numbers of a set as invariant under spatial displacement. The investigator concluded that the conservation task entails, at a minimum, a test for logical capacity, the control of attention, correct semantics and estimation skills. Thus the ability to conserve represents a sophisticated level of cognitive development in which many separate abilities are involved.

In contrast to Piaget's account, the investigator suggested that the child possesses a logical system for manipulating number before he reaches the state of concrete operations. The results are

consistent with the view that simple invariance rules and a basic concept of number provide the foundation for the further development of an understanding of number properties and complex numbers. How this capacity leads to the development of complex skills and how it is used with larger numbers remained unsolved but further investigation was suggested.

Hughes (1975) found that even three and half year olds could successfully solve the three-dimensional object problem.

Braine (1969) examined Piaget's work on the development of intelligence in children and tested the validity of Piaget's theory in the context of the development of length measurement, and concepts of order. In this study Braine questioned Piaget's belief that performance of inferences and logical operations in relation to measurement emerge at the approximate age of seven years in the average child. The argument was based on the following experiment:

"a length between the stimuli could not readily be perceived but had to be inferred, using the rule A>B, and B>C, $\therefore$ A>C. This rule has the status of an axiom in the logic of measurement. The subjects did not manipulate any measuring instruments during the tasks so that skill in the use of measuring rods was not a controlling factor. Every time the child

made a correct response he obtained a small piece of candy, so that he was not motivated only by the inherent interest in the tasks. Tracing the development of the inferential response in children makes it possible to subject Piaget's view to empirical test that the inferences fundamental to length-measurement develop in children at around age 7 years"(p.173).

The subjects comprised eighteen boys and twenty-three girls who ranged in age from 3.6 to 7.0. They were mostly from low-income families.

The apparatus consisted of 15 upright pieces of wood painted a turquoise colour, screwed to a flat base painted black. The tasks consisted of a series of discrimination problems with the stimuli (the upright) presented in pairs.

The results showed that a regular development appears to occur, and that in this sample the threshold age at which 50% of children made the inference studied is somewhere between 4.2 and 5.5. Further evidence that the children who were successful in the measuerment trials found the longer or shorter upright by inference is provided by the fact that all these children were able to find the correct uprights in Phase-3, when the bases of the upright were at different levels (p.180).

This experiment provided evidence that the children use an inferential procedure in measurement and are successful in this at the age of four years. The author added here that "it would be incautious to assert that this (4.2-5.5) is the earliest age at which these inferences can be elicited in average children"(p187).

From the findings of this experiment Braine critized Piaget's definition about the specific age at which the inference basic to measurement develops. As one of his conclusions regarding the possible influence of language and the interpretation of outcomes,Braine suggested that "the inference A>B, B>C ∴ A>C (where" > "is interpreted "longer than"), which has the status of an axiom in the logic of length measurement, is generally available to children at least two years before the age at which Piaget locates its development... The difference between Piaget's experimental procedures and those used here suggest that these factors influence the development (especially, comprehension of the meanings of words and phrases such as "measure", "same length",etc.). The effect of these factors is probably to conceal the reasoning ability of many of Piaget's subjects" (p.202).

Bryant and Trabasso (1971) carried out an experiment with children aged four, five and six

years, to find out whether they could or could not make deductive transitive inferences.

The experiment was divided into two main stages, the first a training stage and the second a testing stage. In the training stage it was ensured that the children got to know the four initial direct comparisons A>B,B>C,C>D and D>E.

The results showed that the four-year-olds were correct in 78 percent of the BD trials, the five-year-olds in 88 percent and the six-year-olds in 92 per cent. Bryant considered that even children as young as four years can combine separate perceptual experience inferentially, provided that they can remember the information which was to be combined. The investigator suggests that, "this is strong evidence that young children can make transitive inferences very well, and therefore that Piaget's and Smedslund's hypothesis about children and inferences is far too pessimistic" (p. 46).

The investigator furthermore looked at the possibility that the children remember the absolute length of B and D without having to connect B and D through their common relations with C. In this consideration he carried out another experiment to find out whether young children can make inferences even when they do not know the absolute lengths of the rods involved. In this second experiment, "the

procedure was identical to that of the first experiment except for one detail; at the end of each training trial, after the child had made his choice, he was only told whether he was right or wrong. He was never shown the whole length of any of the rods, and thus only saw them sticking out an inch from the top of the black block. He was, therefore unable to learn the absolute length of the rods" (p. 47).

The results showed that the four-year-olds' answers to the BD question were 82 percent correct and five-year-olds 85 percent.

The investigator concluded that, "This experiment demonstrates conclusively that young children are capable of making genuine transitive inferences" (p.47).

He therefore criticised Piaget's theory and made this points,

"The first is that Piaget's theory about logical development must, to some extent, be wrong. His experiments did not ensure that children could remember the comparisons which they were asked to combine inferentially, and it now seems clear that children can manage this sort of inference provided that they can remember the information on which the inference has to be based. The second point is that this evidence shows that children have the logical

mechanism for using framework cues as a basis for organizing and categorizing their perceptual experience through perceptual inferences" (p. 48).

4.6. Summary

From the foregoing description of the literature it can be seen that there are various opinions and approaches to investigating the validity of Piaget's theory of cognitive development, and that the various authors have differing interpretations concerning conservation performance.

Dasen, Seagrim, Lendon, DeLemos and Berry, for example, closely followed the theory, and conducted experiments within the Piagetian framework. However, they tried to improve the ambiguous part of Piagetian theory. They usually used only Piagetian tasks in testing people from non-Western cultures such as Eskimos, Aborigines and Baoule etc. Moreover these investigatiors used the English language in testing Aborigines.

After using Western tests and materials on these groups of people who are culturally very different, the experimenters concluded that their cognitive development was slower than that of their Western counterparts. The term "time-lag" is often used to describe the number of years which people lag behind in reaching certain Piagetian stages.

All this Piaget would agree with, since he was not unaware of the influence of the social milieu in child development. However, the interpretation of the meaning of such "time-lag" is still open to question.

It is noted here that although abundant data have been collected cross-culturally by these followers of Piaget, their contribution rests on an assumption of the correctness of the major tenets of Piagetian theory. On the whole their work seems to do little to clarify the more ambiguous aspects of Piagetian theory, particularly in relation to the aspects of intellectual development upon which the theory of mental stage is based.

Another problem is that they administered tests to people from non-Western cultures in the English language, which is not their mother tongue.

In contrast, other researchers who adopted a more critical stance towards Piagetian theory, put forward a different hypothesis which they tested to make inferences about interpretation of children's cognitive ability. Bruner, Cole, Greenfield, Bryant and Donaldson are all critical of Piagetian methods of assessing children's cognitive ability and the definitions of the mental stages, although for different reasons.

Bruner emphasized the importance of situations and contexts, and suggested that one should examine

children's "competence" rather than performance levels to evaluate their cognitive ability. Bruner's suggestions seem to be significant in determining whether failures in Piagetian tests are failures of reasoning, or are states of unrevealed "competence".

Concerning the nature of child development, Bryant, Donaldson and others have provided various kinds of evidence, showing the ways in which children interpret experimental tasks, and those capabilities in dealing with logical and mathematical problems which do not fit into the mental stages proposed by Piaget.

Elliot and Donaldson (1982) also challenged Piaget concerning his ideas on child language, and criticized Piaget's lack of concern with the role of language in the development of thinking. They suggested that Piaget's "neglect or partial interest" concerning child language can only be explained if Piaget is considered as being a genetic epistemologist rather than a developmental psychologist (p.157).

Bearing in mind the above mentioned criticisms the present research focuses on the aspect of child development from cross-cultural perspective, and investigates the effects of varying both the instructions and the contexts

within which conservation is investigated.

For the purpose, dual methods of psychological experiments and anthropological observations are employed. Starting from the original Piagetian tasks, equivalence of these tasks are sought in the everyday experience of children in a remote rural area. By contrasting results from the conventional tests with those derived from their familiar contexts, it is possible to make inferences about performance. In this way we will know the reason why they are failing in one test and being successful in the other test (if this is the case) before starting to judge whether they are lagging behind in their development, or whether their ability is simply not revealed.

The two cultures involved in this study are those of Britain and Korea, which are very different in their cultural traditions. The subjects used for the experiments were children from different ecological backgrounds who were supposed to belong to either the pre-operational or concrete-operational stages.

The language used for the experiments was the mother tongue of the children, that is, English for British and Korean for Korean children.

The new tests and testing materials were developed after initially administering the Piagetian tests. In addition to the Piagetian tests

there were complementary tasks, devised by the present investigator, which took account of the specific needs for those children who failed in the original Piagetian tasks. In order to do this, observational evidence was used, and new hypotheses were put forward.

The present enquiry is ,therefore, distinctly different from that of Piaget and his followers, since it provides tasks which allow one to infer possible causes of failures, prior to any judgement of performance. Furthermore, it attempts to analyse these factors which affect the failures in both aspects, those in the field of child psychology and of cultural context in cognition. In this way, it may now be possible to evaluate the location of Piagetian theory in relation to child psychology and in a cross-cultural perspective.

The experimental design is therefore a complex one, unlike the "single test approach" employed by previous researchers. The details of the methodology used for the present investigation is described in the next chapter.

CHAPTER 5

The Experiment

5.1. Introduction

The experimental work to be described in this chapter is concerned with the examination of a particular aspect of Piaget's theory of cognitive development, testing his views by means of experiments carried out with children from various educational, social and cultural backgrounds. The tasks chosen for testing were conservation of liquid, substance and discontinuous quantity. As has been mentioned previously and will be discussed in detail below, this study focussed on Piaget's treatment of the nature of children's language, and social and cultural factors in his theory of cognitive development in relation to educational practice.

The aim of this investigation is to find out children's ability to think logically with different types of tasks, and to consider the influence of social and cultural contexts and of the characteristics of children's language in cognitive development. For this purpose, an experiment has been set up with groups of British and Korean children (5-9 years of age) with

differing experiences in terms of upbringing, education, socio-economic status and culture. In order to examine the effects of language and experience, three sets of tests were given. Firstly, the normal Piagetian tests of conservation, then those tests with procedural changes, and finally an entirely new test in which conservation was tested in terms of contexts more familiar to rural children.

The study attempts to find answers to a series of questions:

1. Is the way of expressing possession of the conservation principle consistent among young children from differing social and cultural groups?
2. Is the children's language sufficiently consistent for adults to be able to judge their ability to reason in an adequate manner?
3. Is the performance level in solving conservation tasks influenced by familiarity?

5.2. Organization of the experiment.

There are two parts to this investigation: Experiment one is the work carried out with Korean children in Korea and in Britain. These children come from three different social groups, i.e., city, town and a remote rural area. Their age ranged from five to nine. Experiment two is the

work carried out in Britain with British children aged five to nine. These children come from three different schools, i.e., "independent" (fee-paying), state school (urban), and state school (rural). The experiments were carried out between 1977 and 1981.

5.3. Methodology of the Experiments.

For the kind of research that is envisaged it seems clear that the usual Piagetian experimental paradigm is insufficient by itself, since a programme is needed both to **generate** and **test** hypotheses. The research design is therefore modelled on one which was discussed by Cole and Scribner (1974).

(1) This design was intended to investigate cultural differences in communication in North Liberia, but it could equally well be applied to any cross-cultural investigation of cognition, as the design takes full account of contextual differences of people. The procedure is in three steps:

1. A systematic enquiry into the task-specific sources of difficulty that are experienced in the formal experimental situation.

"This calls for a research programme in which we (the investigators) manipulate various features of the experiment so as to uncover the component

processes involved in poor communication, and to determine what particular conditions regulate which specific processes" (Cole & Scribner 1974, p.184-190).

2. A systematic investigation of "situations of everyday life" in which the child appears to perform at a level substantially different from that which is observed in the experimental situation.

3. A return to the experimental situation, to test specific hypotheses as to what makes for good performance in formal or naturally occurring situations.

Through this alternating process, from observation in natural settings to experiments in artificial or laboratory settings, one may be able to understand the complex relations involved between learning processes in different cultural situations. In short, it is suggested that the problem be tackled through the twin method of experiment and observation, the two being deployed in such a way as to allow a continual interaction between them.

5.4. Sampling method

Since the present investigation hopes to discover the effects of cultural and social conditions on intellectual behaviour, it is important to sample subjects who display sufficient

variations to allow an examination of the relationship between them. It is also necessary to have samples representing the population of that culture and a sufficient range of behaviour to allow generalization. In such consideration, a system of sampling was used which ensured that the sample included urban and rural groups of children.

For the Korean sample, one school from each social stratum, i.e.,city, town, and rural area, was chosen to represent the intellectual activities of such areas. It was necessary when selecting the British sample to consider both social stratum and type of school, fee-paying, urban, rural, as the social stratum is not necessarily representative of the social class or the different intellectual activities.

It is inevitable that there will be disproportionate numbers of children selected from each stratum because the target population of the stratum exists in an unevenly balanced proportion, whereas a similar number in the samples is necessary for statistical analysis. Moreover, since the purpose of the present study is not just to compare the performance level but to find out the underlying factors of performance in each stratum, the disproportionate stratified sampling technique is considered to be satisfactory. The numbers of children in each sample and their ages are shown in

the following table.

5.4.1. The Sample Distribution

The sample used in this study consisted of 360 children distributed about evenly between sexes among the age groups. The subject's ages ranged from five to nine. The distribution of the subjects together with their educational and family backgrounds is summarized in table 5-1.

Table 5-1 Sample Distribution

	Korean children			
Sample	1	2	3	4
School Env.	Private City	State Town	State Rural	State London
S-Eco.	Prof.	Mix.	Farm.	Prof.
Age	5-7	5-7	5-9	5-9
No.	30	30	50	50
	British children			
Sample	5	6	7	8
School Env.	Private City	State Town	State Rural	State City
S-Eco.	Prof.	Mix.	Farm	Work
No.	50	50	50	50

5.5. The Korean Children

In this section, characteristics of children in each of the Korean samples will be described.

From a centuries-old agrarian state, Korea is rapidly changing into an industrialized country. Therefore there are differences in life style between the urban and rural populations. In Seoul,

the capital city with a population of 7 million, life style and education are very much Westernized, and the children are widely experienced because they grow up in the city which is the centre of culture, education, international communication, etc. The cost of living in Seoul is nearly three times as high as in the other towns.

The various life styles encountered in everyday life and education provided opportunities to examine the significance of extreme social contexts within the same culture. The quality of education and degree of wealth can, in general, be defined in terms of the geographical dwelling area in the present Korean situation (see 2.5. for detailed explanations).

Sample-1 were attending a private (fee-paying) primary school in Seoul. Typical professions of the children's parents were company executive, medical doctor, consultant, politician, and the like. These children have a great deal of opportunity to utilize what they learn from school in everyday life situations.

Sample-2 comprised children attending a state school in a town located in the Chungchong province in the central region of South Korea. The standard of living is considered to be average for Korea. Most parents of the children were owners of small cotton factories, bicycle dealers, shopkeepers, and

small landowners.

Sample-3 comprised children attending a state school in a remote rural area in the extreme south of Korea, Cholla province. The parents of the children are mainly engaged in farming and fishing on a small scale. There was only one school in the village and there was no kindergarten, therefore young children (5-year-olds) came to school with their elder siblings by the invitation of the headmaster, for the experiment. In the real life situation they have hardly any opportunity to make use of what they learn at school. They learn mathematical measurements in the class, but use traditional measurements in real life situations. For example, the size of a farm field is measured by the number of bags of rice produced by the farm, not by hectares.

Sample-4 comprised Korean children living temporarily in Britain. The parents of the children are professionals or diplomats who have lived in Seoul where the life style and education are very much Westernized. One of the distinctive features of these families is that mothers invariably do not work, as this is the convention for Korean upper classes, and their prime concern is to give the best possible education to their children. In nearly all cases both parents were

graduates. The mothers become home-tutors and check children's school work and provide their children with additional school activities. Although the children have enjoyed life in British schools, it was observed by the investigator during her visits to families that the childen were missing opportunities to work and play using their native language. In order to alleviate their emotional anxiety, the investigator, in collaboration with the Korean Embassy and the Korean Residents' society in Britain, established a play school where they could meet on Saturdays. It is a school where 5-11 year old children meet and enjoy playing and singing together, singing being of special interest to them. Lessons are given in their own language, Korean. The experiment for these children was carried out mainly in this school.

5.6. The British children

In Britain, unlike Korea, the type rather than the location of a school is generally related to the quality of education and to the social status of the parents.

The children in the sample were taken from different types of schools:

Sample-5 consisted of the children from an independent school (fee-paying school) located at the city of Oxford. Most of the parents of the children were Oxford University lecturers or staff,

company executives, lawyers, doctors and those of equivalent socio-economic status. This school sometimes offers opportunities to research students for their experiments, which may account for the fact that the children were more experienced in an experimental situation.

Sample-6 consisted of children attending a state school located in Oxfordshire. The people who live in this are are engaged in various jobs in secondary industry, and the school from which the children were drawn is considered to be a typical state primary school. The parents of the children are shopkeepers, office workers, dairy farmers, school teachers, publicans and the like.

Sample-7 consisted of children attending a primary school in a village, sixty miles south-west of the city of Edinburgh. There was only one primary school in the village which has a population of eight hundred. After finishing primary education at this school, children go on to the secondary school which is 16 miles away. The parents' jobs are mostly those of farm workers or ancillary traders, e.g., dealers in agricultural equipment, shopkeepers and tractor drivers.

Sample-8 consisted of chidren attending a state primary school in the city of Edinburgh. In this city centre area, the parents' jobs are varied.

However, an effort has been made to select children from non-professional families only.

5.7. The Tests

Concerning Piagetian tests, there have indeed been a great deal of slightly modified ways of administering them, depending on the reseacher's interpretation of the tests. This is mainly due to the lack of precision at the original stage.

It is now necessary to clarify the present investigator's view concerning Piaget's original tests. In order to avoid an unnecessarily long discussion, only items on conservation of liquid tests are discussed.

5.7 1. Commentary on Piaget's Original Test

The original tests of conservation used in Piaget's early work were described in his book La Genese de Nombre chez l'Enfant (1941), which is available in English translation under the title, The Child's Conception of Number (1952). In this text, descriptions are given of the tests devised by Piaget to investigate children's abilities to think logically.

Since the present investigation has as one of its aims the examination of the suitability of the Piagetian tests for the children in different social and cultural contexts, the original will be outlined briefly. Piaget described his method as follows:

"The child is first given two cylindrical containers of equal dimensions (A1 and A2) containing the same quantity of liquid (as is shown by the levels). The contents of A2 are then poured into two smaller containers of equal dimensions (B1 and B2) and the child is asked whether the quantity of liquid poured from A2 into (B1+B2) is still equal to that in A1. If necessary, the liquid in B1 can then be poured into two smaller, equal containers (C1 and C2), and in case of need, the liquid in B2 can be poured into two other containers C3 and C4 identical with C1 and C2. Questions as to the equality between (C1+C2) and B2, or between (C1+C2+C3+C4) and A1,etc. are then put" (Piaget,1952, p.4).

The test is further described:

"...the liquids are subdivided in a variety of ways, and each time the problem of conservation is put in the form of a question as to equality or non-equality with one of the original containers. Conversely, as a check on his answers the child can be asked to pour into a glass of a different shape a quantity of liquid approximately the same as that in a given glass, but the main problem is still that of conservation as such" (ibid. p.4).

Piaget then described a specific example: a child, Clairette, has her glass (A1) three quarters full of orangeade; the other child, Odette, has the same amount of lemonade in her glass (A2). There was another child, Blas, 4 years Ø months, who presumably watched what was going on between Piaget and the two girls (whose ages were not given). They were asked at the same time whether they had the same amount of liquid. The answers from them were, "the same". Next, Clairette poured her drink into two glasses, B1 and B2, each of which became half full, then the question to Blass (seemingly) was: "Has Clairette the same amount as Odette?" The

answer was: "Odette has more". The next question was, "Why?", for which the answer was, "Because we've put less in" (The child pointed to the levels in B1 and B2, without taking into account the fact that there were two glasses.) Odette's drink was then poured into B3 and B4, following which the children said, "It's the same".

Odette's drink was then put aside (presumably) and Clairette's drink was poured from B1 and B2 into a long thin tube (L). And then the children were asked who had more to drink. The answer (presumably from Clairette) was, "I've got more." When asked, "Why?", the answer was, "We've poured it into that glass (pointing to the level in L) and here (B3 and B4) we haven't."

The children were challenged once again by being asked, "But were they the same before?" The children answered, "Yes". So another question followed, "And now?" The answer (presumably from Clairette) was, "I've got more".

Clairette's orangeade was then poured back from L into B1 and B2. Piaget said, "Look, Clairette has poured hers like Odette. So is all the lemonade (B3+B4) and all the orangeade (B1 and B2) the same?" The answer - given with conviction - was, "It's the same."

Clairette next poured her B1 into a small glass, C1, which then became full, while B2

remained half full. The next question was, "Have you both the same amount to drink?" Clairette (presumably) answered, "I've got more." "But where does the extra come from?" asked Piaget. "From in there (B1)" was Clairette's answer.

This brought the question: "What must we do so that Odette has the same?" The answer was, "We must take that little glass" (pouring part of B3 into C2). Piaget then asked, "And is it the same now, or has one got more than the other?" Clairette answered, "Odette has more." "Why?" "Because we've poured it into that little glass (2)." Piaget again asked, "But is there the same amount to drink, or has one got more than the other?" Clairette's answer was, "Odette has more to drink." "Why?" "Because she has three glasses" (Piaget 1952, p.6).

The question and answer session proceeded further in this way, but the details need not be given here. It should be noted, however, that the record of conversation is such that it is difficult to say precisely who is speaking at any given moment. Let us simply say, therefore, that we have a record of a four-year-old Swiss child's reasoning on conservation, which revealed that the principle of conservation of liquids was not yet understood.

Piaget also carried out tests on the conservation of discontinuous quantity, e.g., using

beads of different colours. A record of his experiment with Gfe, aged 5 years Ø months can be reconstructed as follows :

Piaget: "There are as many red beads in A1 as green ones in A2."
Gfe: "They're the same."
Piaget: "Now listen, if I thread the red beads on one string and the green ones on another, will the necklaces be the same length?"
Gfe:"Yes, both will be the same."
The green beads are then poured into a wider container P.
Piaget: "Will there be the same amount?"
Gfe: "No, more green."
Piaget: "Why?"
Gfe: "Because they're all flat; they won't be on top of one another."
Piaget: "And if we do this with the red ones?" (pouring A1 into L)?
Gfe: "More red ones."
Piaget: "And if we make a red necklace and a green one, will they be the same?"
Gfe: "No,this one (red) will be longer, because there are more here (L)" (Ibid. p.22).

Older children, such as Pel (6 years Ø months), gave different responses. This child said, "It's the same in the little glasses as in the big one" (Ibid.p.33). Still older children could explain the reasoning with some degree of sophistication. Kor (8 years 6 months) said, for example, "That glass (P) is wider, it goes out more at the sides, so they don't go up so fast (as in L)". Or, "If we wanted to make it (G) narrow and high, it would be as narrow as the other (E), but higher" (Ibid.p.35).

Piaget also carried out tests on "conservation of substance", which were described in his book,

published in 1941: Le Developpement des Quantites Physiques chez l'Enfant. The experimental procedure was summarised in English in 1969 in P. Fraisse and J. Piaget (eds.), Experimental Psychology - Its Scope and Method, vol.8, Intelligence. Here we read,

"The subject is shown a ball of clay and asked to make another ball of the same size and weight. One ball, A, is left on the table as evidence and the other is transformed into a sausage, a pancake, a number of pieces, etc. The subject is asked first whether there is still the same amount of substance in B as in A and why" (p.157).

From his investigations on children of different ages with this test, Piaget claimed:

"Three successive stages can be observed in the case of each of the notions studied. At first there is lack of conservation when the object is modified. This is followed by transitional reactions (Conservation is assumed but without certainty and in the case of some transformations only). Finally conservation comes to be affirmed and regarded as evident throughout the various transformations of the ball of clay" (Ibid., p.158).

Piaget obtained the following percentage results with this test, for children of different ages:

Age	5	6	7	8	9
Conservation	16	16	32	72	84
Non-Conservation	84	68	64	24	12
Transitional	Ø	16	4	4	4

Here some comment on the techniques and assumptions of the experiments themselves seems relevant. Firstly, it is pointed out that the number of children investigated in each experiment

was small and that they came from middle class European families (Piaget's own relatives and their friends), and the testing materials used varied from child to child. Also, the questions asked of each child varied considerably.

A further point is that Piaget showed some tendency to "push" the children in the direction that he, as an adult, thought was appropriate, using adult conceptions to interpret the children's simply-worded responses. Or he posed questions in ways that might lead to certain responses. For example, when Piaget asked questions of the kind,

"If we pour the lemonade and the orangeade back here, will the orangeade come up higher or will they be the same?" (Piaget 1952, p.7).

This asks the 5 year old child to envisage a situation, and to explain some action performed before him. Furthermore, a number of Piaget's tests could be examining short-term memory as much as reasoning power. To answer some of the questions correctly, the children had to remember earlier configurations of the test substances. Therefore, the tests did not discriminate clearly between the children's power of memory and their abilities to reason about the processes taking place in the tests. Besides this, ability in linguistic expression on the part of the children is required

in order to answer Piaget's questions successfully. One can therefore not be sure to which extent the tests were tapping cognitive abilities or linguistics skills.

5.8. Tests used in the present investigation

The tests used in this study were:

1. Piagetian conservation tests of liquid, substance and discontinuous quantity for all children in the main study (N=360),
2. Revised Piagetian Tests of liquid, substance and discontinuous quantity for all children in the main study (N=360),
3. New Test-A of conservation of liquid,substance and discontinuous quantity for the Korean rural children (N=50), 4. New Test-B of conservation of liquid, substance and discontinuous quantity for some British rural children (N=100). The details of the tests will be described in the following sections.

The Piagetian Test

5.8.1. Conservation of Continuous Quantity (liquid)

Materials: Two identical beakers of 75ml (wider glasses) A-1 and A-2, two identical beakers of 40ml (smaller glasses) C-1 and C-2, one beaker of 75ml (taller glass) B, one beaker of 75ml(medium height)

D, and a bottle of orange juice. A similar amount of the juice (60ml) was used throughout the experiments.

Procedure: The same amount of juice was initially prepared in beaker A-1 and beaker A-2. The investigator poured a little juice from one beaker to the other so that the child was presented with uneven amounts of juice before the experiment started. As soon as the child sat down in front of the desk where the two beakers of juice were on display, she/he was asked to describe the amount of orange juice and to make them equal in both beakers. Any child who could not discern the difference was excluded from the experiment. After the preliminary session, juice from beaker A-1 was poured into the taller beaker B and then the child was asked to compare the relative amounts of juice in A2 and B.

Question: Which glass (A2 or B) has more juice in it? Or is there the same amount of juice in this and that glass?

Why do you think so?

The juice was poured back into beaker A-1 from beaker B. Then the juice from beaker A-1 was poured into beaker B and the juice from beaker A-2 was poured into beaker D. The child was then asked to compare the amounts of juice in B and D.

Question: Which glass has more juice in it, this or that (glasss B or glass D)? Or is there the same amount of juice in them ?

Why do you think so?

The juice was then poured back from beaker B and beaker D into beaker A-1 and A-2, respectively. From beaker A-2, the juice was poured into beaker C-1 and beaker C-2 in equal amounts. The child was then asked to compare the amounts of juice in beaker A-1, and C-1 and C-2 combined.

Question: Which one, this glass (A-1) or those two (glass C-1 and C-2) has more juice? Or is there the same amount of juice in this glass that those two combined?

Why?

5.8.2. Conservation of Substance

Materials: Two pieces of plasticine of the same size, P-1 and P-2, whose diameters were approximately 2cm and the amounts of which were always the same throughout the experiment.

Procedure: The child was presented with two pieces of plasticine, P-1 and P-2, and assured by the experimenter on each occasion that there was actually the same quantity of plasticine in both pieces. The child was asked to make a sausage with plasticine P-1 and a ball with plasticine P-2. The child was then asked to determine whether there was

the same quantity of plasticine in the sausage and the ball.

Question: Which one has more plasticine the ball or the sausage? Or is there the same amount of plasticine in them ? Why do you think so?

The altered form of ball and sausage of plasticine were returned to their original shapes. The child was asked to make two balls with plasticine P-1 and a thin square piece of blanket with P-2. The child was then asked to compare the amount of plasticine in the blanket and the two balls.

Question: Which one, the blanket or the two balls, has more plasticine? Or is there the same amount in the blanket and the two balls combined? Why do you think so?

5.8.3. Conservation of Discontinuous Quantity

Materials: Two packets of sweets with the same amount in each packet, S-1 and S-2. Two identical glasses A-1 and A-2, one taller glass B, two smaller glasses, C-1 and C-2.

Procedure: The child was presented with two packets of the same amount of sweets, S-1 and S-2. The sweets in packet S-1 were transferred to wide glass A-1 and the sweets in S-2 were transferred to taller glass B. The child was then asked to

determine whether there was the same amount of sweets in the taller and the wider glasses.

Question: Which glass has more sweets in it (glass A-1 or glass B)? Or is there the same amount of sweets in them? Why do you think so?

The sweets in glass B were returned to glass A-2. The child was assured that the amount of sweets in both glasses was the same. Then the child and the experimenter simultaneously picked up sweets one after another from glass A-1 and transferred them to glass C-1 and C-2 so as to have an equal amount of sweets in glass C-1 and C-2. After doing this, the child was asked to determine whether there was the same amount of sweets in glass A-2, and glass C-1 and C-2 combined.

Question: Which glass has more sweets in it (glass A-2 or glass C-1 and C-2 combined)? Or is there the same amount of sweets in this and those(indicating the objects).

Why do you think so?

5.9. A Justification of the Piagetian Test

It is emphasized here that it is inevitable to amend to a certain degree Piaget's original testing forms described in The Child's Conception of Number (1952), due to the lack of precision and consistency on the part of experimental procedures. This is not to underestimate Piaget's efforts to

provide children with a playing situation in the original experiment but to avoid ambiguities in his experimental procedures. The more precise desciptions thus allow ready replication without ambiguity creating possible confusions in interpretation.

In the Piagetian Test used here there are therefore (1) the same number of questions for each child on each occasion, (2) the same materials were used throughout the investigation, (3) the question forms were consistent.

5.10. The Revised Test

5.10.1. The rationale of the Revised Test

The variation of the experimental design used here is, as described earlier, to generate new hypotheses. Therefore, the most important aspect of the whole experiment was to observe children's attitudes in every possible aspect, for example, their usage of language, their manner of answering questions and their facial expression and speed of responses. In doing so, it was hoped to find out if there is any less explicit part in the test which might jeopardise the evaluation of children's "real" ability to solve given problems. The various intellectual attitudes revealed by children during testing with the Piagetian Test were vital in

deciding the ways in which to revise the presention of the Piagetian Test.

The following observations were useful in an attempt to revise the test: The verbal question forms which were essential for the clinical method of testing seem to be understood by the children in various ways. Thus, for example, the investigator asked, 1) Which glass has more orange juice, the taller or the wider glass? 2) Or is there the same amount of juice? Why do you think so?

Instead of answering the question, some children challenged the investigator and asked,"What do you mean by more? Do you mean it looks more?" The children's immediate dissatisfaction was the confusing element in the question. There were others who interpreted the question forms in a different way from the previous cases. For example, the children accepted the same question forms without questioning, however, they revealed the ambiguity of the question forms in their answers. Let us examine a typical pattern of the answer:

Question: Which one has more juice in it, the taller glass or the wider glass? Or is there the same amount of juice in both glasses? Why do you think so?

Answer: Part-1; There is the same amount of juice in both glasses (correctly answered). Part-2; Because this glass is tall and that glass is wide.

Let us analyse their answers. By judging the first part of the answer which was correct, they were logical, but the second part was an illogical statement since they described the matter as if "wide" could be equated with "tall". Where is the discrepancy which leads children to produce an illogical answer to the latter part of the question? Let us assume the question was like this; "Why then is the level of orange juice in one glass different from the other? Should one judge such children to be "illogical" when in fact a part of the question is imprecise and open to different interpretations?

From such observations more appropriate question forms could be identified, which led to the development of the Revised Test.

5.10.2. The tasks in the Revised Test

The tasks in the Revised Test were exactly the same as they were in the Piagetian Test. However, three toy animals (a teddy bear, a rabbit, a dog) were introduced, one of which was credited with the right answer. The child had to point to the animal which she/he believed to have made the correct response. We may call it a "let us find out situation".

Procedure : The experimenter started by saying, "Three animals were going to drink the orange

juice, and before drinking they had a chat. The Teddy Bear said, "I have more juice than the Rabbit", the Rabbit said,"I have more juice than the Teddy Bear", and the Dog said "Both of you have the same amount of juice." The animal who answered correctly was varied by the experimenter while children were being tested. The questions were: Which animal's answer is correct? (or Who was right?) Why ? (or Why is the "dog" right?)

In summary, the Revised Test remained within the Piagetian framework of the tests but aimed to question from the children's point of view, but not by imposing the adults' intention on the child answering the question. To achieve this aim the question forms in the Revised Test were organized in such a way that the children were expected to explore the tasks first of all and then judge the matter in their own terms.

5.11. The background of New Test-A

After the administration of the Piagetian and the Revised Tests to the remote rural Korean children it was observed that these children were slower in response and often did not give verbal responses but looked at the tasks and the investigator in turn for some considerable time. Some of them finally answered the first question

but frequently they did not respond to the second question. Now this silence requires an explanation. It was also noticeable that the overall results of the performance by these children were significantly poorer than those of their city counterparts. It was, therefore, decided by the investigator, following the experimental design adopted for this study, to observe these children's daily activities revealing their use of mathematical concepts or principles of conservation of quantity. For example, these children in remote rural Korea, although learning mathematical concepts at school by using the same textbooks as city children have hardly any opportunity to make use of what they learn at school, whereas their city counterparts have ample opportunities, as mentioned earlier in Chapter 2. Indeed, the rural children learn measurements in the metric system in class, but use traditional and conventional methods in their real life situation. By dealing with different kinds of fish, they learn what size and what shape will match the containers. The following few examples will illustrate the kind of experiences these children will get in their everyday life. A six year old boy was met by the investigator at his home. The father of the boy was a fisherman bringing all sorts of fish in a large carrier. The boy was helping the adults to sort out

fish in different containers. There was an eel about 50cm long, among other fish. The investigator said, "Look, there is a long eel, we need a long container for that, and then the investigator tried to fetch a long container lying nearby. The child immediately said, "Teacher, we don't need the long container, because the eel can make himself a round shape when he gets into the bucket". In this observation, it is reasonable to say that the child used the principle of conservation in this daily activity, since he knew the fact that the long eel could become a smaller and rounded eel without changing the quantity of the eel itself, although the shape of the container has changed. This boy failed in all tasks in the Piagetian and the Revised Tests. Later it was found that he performed successfuly in all items in the New Test-A.

Another example of activity by older girls (8-9 years of age) is as follows. In cooking rice for varying numbers of the family and relatives on different occasions they need to use different sizes of cooking bowls and different amounts of rice and water on each occasion. In this regard they not only use the concept of proportion but also have to be sensitive to the principle of conservation in controlling the amount of water to

cook the rice. The water is usually gauged by the level of water coming above the rice depending on the amount of rice underneath. In adjusting the amount of water, they have never used measuring cups but instead used their perceptual judgement. In doing so, the principle of conservation has been implicitly utilized by them. One can find many such examples by observing and participating in the children's daily activity. Here we have questions: Do these children have the ability to conserve quantity or not? Is it fair to judge them as failures in understanding the principle of conservation on the basis of poor experimental performance?

The New Test was devised in an attempt to answer such questions.

On the ground of the above observation of rural Korean children's daily activity, a new hypothesis was generated: The remote rural Korean children, although having failed in the Piagetian and the Revised Test which were originated in the West using methods and materials familiar to Western or Westernized children, might be successful if the tasks were to be devised with materials and in circumstances more familiar to them. In order to test the new hypothesis, several tasks incorporating children's familiar activities were devised by the present investigator and this

test is called New Test. The details of the test are described below.

5.12. The tasks in the New Test-A

5.12.1. The Cow-watering (continuous quantity) Test

The children were taken to a well and were allowed to play games until their turn came for testing. All the village children did some manual work after school and it was natural for them to draw water from the well to give to the calves.

Materials: Two calves,one (C-A) with a drinking bowl much smaller than the other's (C-B) were in the shed. The following water containers were available: a "Daeya" is usually used as a washing basin (approximately 25cm in diameter and 12cm in height), a "hamjipak" (A-1 and A-2) is usually used for washing vegetables (approximately 60cm in diameter and 15cm in height), a bucket (B-1 and B-2) is usually used to convey water (40cm in height,18cm in diameter). These containers were made of either non-transparent plastic or aluminium.

Procedure: The investigator said to the child, "Let us give the calves their water. They are both young calves, therefore we must not forget to provide each of them with the same amount of water." The child was helped by the investigator in drawing up

the water from the well. The child was asked to pour one daeya-full of water into hamjipak A-1 and two daeya-fulls into identical hamjipak A-2. Similarly the child was asked to pour one daeya-full of water into bucket B-1 and two daeya-fulls into identical bucket B-2. The child was then asked to choose two containers among four and to give both calves the same amount of water.

Instruction: The experimenter said, Please give the calves their water now.

Question: Do both calves have the same amount of water to drink or not? Why?

The drinking bowl for one calf is smaller than the other, so that the smaller bowl is fuller than the other. In asking reasons for their answers, one had to remember that these rural children have not been encouraged to tell reasons in their conventional conversation. It is also true that an indirect rather than a direct question form is also considered to be polite in their cultural context. In such considerations, the way of asking reasons for the answer was modified; for example, the experimenter asked, "If I ask you why do you think this calf and that calf drink the same (or different) amount of water, what would you answer?" When the child seemed not to understand the intention of the questioner, the question was rephrased as, "Why then is the bowl of this cow

fuller than the other?"

The other point to be mentioned here is that as the water containers and drinking bowls used for this test were not transparent, the level of water in each container has to be gauged from the top. In this situation the use of "daeya" as a measuring unit was useful, although not essential, to make clear to the child the equivalent amount used in each transfer before answering the question.

5.11.3. The Shell (Discontinuous Quantity) Test

Materials: Shells collected by the children from the beach. Locally obtained glasses, a wider glass A, a taller glass B.

Procedure: The experimenter said, Let us play with shells. I will ask you some questions and you are expected to give your own opinion. All right? The answer was "Yes". This gesture was necessary to create more friendly atmosphere between the experimenter and the children. The children were told that they would have shells to make necklaces.

The children and the experimenter sat down on the beach and divided the shells into two piles by giving each child the shells, one by one. The experimenter poured one pile from her hand into a wider glass A and nother identical pile of shells into a taller glass B. While pouring shells into the taller glass, the experimenter dropped some

shells and said, "I dropped some shells". There were fewer shells in glass B than in glass A, although the level of the shells in glass B was higher than in glass A. The child was expected to determine which would make the longer necklace of the shells.

Question: Suppose you make your necklace with these shells (glass B) and I make mine with those shells (glass A), whose necklace will be longer? Why?

5.11.4. The Clay (Substance) Test

Materials: It was possible to play with clay on the beach. Two lumps of the same amount of clay were prepared by the children. The children were told that they were going to build houses and that they would be asked questions about them.

Instruction: The experimenter said,"Use the clay in front of you and make two houses. We need to build a small house and a big house. In building houses, each child used his/her hands to shape a bowl of clay, holding it inverted, following which s/he moulded the clay on the back of one hand. For a small house s/he made a small empty space with his/her hand, and for a big house the space became bigger and the clay walls thinner. After building the houses, each child was asked questions separately.

Question: Do both house have the same amount of clay or does the bigger house have more clay (or has the small house less clay)? Why?

5.12. Summary of the New Test-A

New Test-A was developed out of observations of the children's daily activities in relation to the concept of conservation. The testing items were familiar to the children in both the conceptual and the material sense. Accordingly the tasks were consonant with the aim of testing the children, that is, to find out whether or how children could think logically.

In short, the New Test-A is designed to take social, cultural and linguistic contexts of the children, and the level of their knowledge, into consideration.

5.13. The background of New Test-B

New Test-B was devised by the investigator after administering the Piagetian and the Revised Test to British children in England. It was considered to be reasonable at this stage to test British rural children with tasks which were comparable to New Test-A used for rural Korean children and the following observation has been made in prior to the devision of New Test-B.

When the experimenter monitored schools in rural areas in Britain it was noticed that the

British rural children who come from farming families are not comparable to those of similar Korean background in terms of provision of formal education and the impact of modern culture.

British rural children have similar daily life experiences to those who live in urban areas, except that the rural children have more opportunity to see what is going on in the farms and in the countryside. The young British rural children do not actually participate in farm work as most of the work is done by automatic machines which generally require one or two adults. However, by living in a rural area the children become familiar with animals and crops. All school age children attend their local schools and so enjoy the benefits of formal education just as their urban counterparts do.

Concerning the testing materials, there is no reason for using livestock, of which they have no first-hand experience, whereas such work is the daily routine for Korean rural children in remote areas. New Test-B toy animals were therefore used instead of the actual livestock used in New Test-A.

Another aspect considered in administering the New Test-B was the fact that children in the younger age groups (5-6) performed very poorly in

the Piagetian Test but showed a significant improvement in the Revised Test. In order to examine whether the poorer performers have the ability to grasp conservation principle of not, a gradual process was adopted in the New Test-B. Therefore, among three items in the New Test-B, the full notion of the conservation principle was introduced gradually in three stages. In item-1, a measuring unit was used, in item-2, an uneven amount of discontinued quantity was used while item-3 was equivalent to the Piagetian tasks of sbustance.

5.13.1. Conservation of Liquid

Materials: Two identical beakers of 75ml, beaker A-1 and beaker A-2, two identical beakers of 50ml, beaker B-1 and beaker B-2, two toy cows, a bottle of milk, one male doll (Bob) and one female doll (Susie).

Procedure: The child was presented with one male doll who has his cow, cup C1, glass A-1 and glass B-1; and one female doll who has her cow, cup C2, glass A-2 and glass B-2. The experimenter said, "Bob and Susie were milking cows. Bob was milking his cow and poured one cup of milk into the long glass B-1 and two cups of milk in wide bottle A-1. Susie was milking her cow and poured two cups of milk into long glass B-2 and one cup of milk into

wide glass A-2. This procedure was then demonstrated with the experimental material.

Question: Which glass, this or that (indicating glass A2 and B2) has as much milk as in that one (indicating B1 or A1)?
Why do you think so?

5.13.2. Conservation of Discontinuous Quantity

Materials: A bag of barley, two identical transparent cups, cup A-1 and cup A-2, one tall transparent glass B and one wide transparent glass C.

Procedure: The experimenter transferred five spoonfuls of barley into cup A-1 and six spoonfuls of barley into cup A-2 from the bag. The child was assured that there was more barley in cup A-2 by comparing the level of the two cups. The barley in cup A-1 was then transferred into tall glass B and the barley in cup A-2 was transferred into wide glass C.

Question: Which glass has more barley in it? Why?

5.13 .3. Conservation of Substance

Materials: Two lumps of plasticine of equal amount, A and B, and one toy dustbin, C, which had a narrow mouth and another toy dustbin, D, which had a wide mouth.

Procedure: The child was presented with two lumps of plasticine and was asssured that each lump had the same amount of plasticine in it. The experimenter said,"We are going to make lids for the dustbins". Then the child and the experimenter made lids for the dustbins C and D with lumps of A

and B, respectively. Then the child was asked to determine whether the amount of the plasticine remained the same when the size of the lids was different.

The question was, Is there the same amount of plasticine in lids C and D or not?

Why?

In summary, the New Test-B was devised taking the following considerations into account:

1) to reduce the possible verbal misunderstanding by replacing leading questions with more realistic questions;

2) the testing procedures are introduced gradually in a increasing difficulty.

In order to get general patterns of responses and to confirm the suitability of the use of New Test-B for British children, a pilot study was conducted.

5.10. The Pilot Study

The pilot study was carried out in two different areas, i.e, a mixed industrial city (ABE) and a farming area (MON). There were twenty children: four children in each age group from five to nine years of age. The parents' jobs were varied: builder, architect, medical doctor, factory worker, office clerk, teacher, hotel manager and

farmer.

The aim of the pilot study was twofold: firstly, to test the suitability of the tasks for the British children in Scotland, and secondly to examine the effect of the order of administering the tests.

In the original New Test-B there was more than one question in each task. These questions were, in the liquid test, "Which glass, A-2 or B-2 has as much as Bob has in glass A-1? Is there the same amount of milk in B-1 and A-2?"; and in the discontinuous quantity test, "Which glass has more barley in it, B or C? Is there the same amount of barley in glass B and C or not?"

The substance test : There are two identical pieces of plasticine, A and B. Plasticine A is divided into two lumps of the same amount and size, A-1 and A-2. There are three toy dustbins, C, D, E, which have their lids made with lumps of A-1, A-2 and B respectively. The questions are, "Is there the same amount of plasticine in lid C and D or not? Which dustbin has the most plasticine in it of C, D or E? Which lid, C or E, has as much plasticine in as it D? Which lid, C or E has more plasticine?"

These questions were used just to observe children's ways of responding to each question. There was no difference in children's responses to

the different questions since the children answered almost all questions correctly. Another aim of the pilot study was to examine the "order effect" in conservation performance: in the previous experiments with British and Korean children, the Piagetian Test was administered first and then the Revised test, and lastly the New Test-B, however, in the pilot study the order was reversed.

The scoring procedures were exactly the same as on previous occasions. The boys and girls were equal in number. The results of these children's performance are shown in the Table below:

Table 5-1: The number and percentages of conservers in each test

Age	Piaget		Revised		New	
	N	%	N	%	N	%
5	Ø	Ø	1	25	4	1ØØ
6	1	25	3	75	4	1ØØ
7	1	25	3	75	4	1ØØ
8	2	5Ø	4	1ØØ	4	1ØØ
9	2	5Ø	4	1ØØ	4	1ØØ
Total aver %	6	3Ø	15	75	2Ø	1ØØ

The above results show that these children performed somewhat better in the Revised Test than in the Piagetian Test and also that they performed dramatically better in the New Test-B than in the Piagetian Test.

The results also demonstrated that the testing order did not alter the trend of the results, i.e. most children tested on previous

occasions performed better in the Revised Test than in the Piagetian Test, and rural children performed significantly better in the New Test-A than in the Revised and the Piagetian Test.

The importance of the pilot study was that it provided the investigator with information from which the later choice of locations for the experiments could be made. It was also interesting to see a hierarchy of successful performance among tasks: all the children tested were very successful in the New Test- B, then to a lesser degree in the Revised Test, and then least in the Piagetian Test.

CHAPTER 6

Statistical Analyses of the Experimental Results

6.1. Introduction

The children's performance in the conservation of liquid, substance and discontinuous quantity in three different tests, that is, the Piagetian Test, the Revised Test and the New Test, were calculated as frequencies of conservers in each age group and in each task of liquid, substance and discontinuous quantity. The differences of performance among tests, sample groups and age groups are further analysed using non-parametric tests, such as the "sign test" and "chi-square test". The reasons for choosing non-parametric tests were firstly that the data are not measurements but sets of frequencies and they are not homogeneous, and secondly that the frequencies obtained are not drawn from a normally distributed population, but under distribution-free or directional conditions. The sign-test was used for the small group comparisons since the test signifies any change occurring at an individual level of performance; chi-square tests were used for the larger group comparisons. The level of confidence chosen for testing the significance of differences in

performance was either at 5% or 1% level according to the accepted conventions in social science research.

6.2. Scoring of the performance

There were three items relating to the liquid task, two items to substance and two items to discontinuous quantity in each of the Piagetian and Revised tests. Each item was credited with a score of 1 if the items were correctly answered, otherwise a zero score was given. Children who achieved a score of 2 in each task were considered as conservers and those who scored less than 1 were considered as non-conservers.

In the New Test there was one item in each task. Children scoring 1 in each task were considered as conservers, otherwise as non-conservers.

6.3. Organization of the experiment

There are two experimental settings in the present investigation: experiment 1 is the work carried out with 160 Korean children and experiment 2 deals with the work carried out with 200 British children.

Besides the main experiment, a follow-up study was carried out with 50 British rural children (5-9 years old).

There were 36 small groups of ten children

totalling 360 children in all and both the Piagetian and the Revised tests were administered to them. The New Test was administered only to 50 Korean children in a remote rural area.

The investigator conducted the experiments in Britain and in Korea. In most schools there was an assistant who lived in the same area where the experiment was conducted. The order of the presentations of the tests was consistent throughout the main experiments: the children were given the Piagetian test first, then the Revised test and the New test last. However, the effect of order was investigated by reversing the order for the group in the follow-up study.

The order of presenting the tasks of liquids, substance and discontinuous quantity was systematically varied in the Piagetian and the Revised tests.

6.4. Experiment-1

There were 160 Korean children who were divided into four sample groups, i.e., Sample-1 consisted of 30 children attending a Westernized school, Sample-2 consisted of 30 children attending a typical school in a town, Sample-3 consisted of 50 children attending a remote rural school, Sample-4 consisted of 50 children who were living temporarily in London and attending a British school. There were 10 children in each age group in

each sample. Boys and girls were evenly balanced in number in all sample groups.

The number of conservers in each age group for Korean children in the Piagetian and the Revised tests in each task of liquid, substance, and discontinuous quantity is shown in Table 6-1.

6.5. The result of the performance in the Piagetian and the Revised tests for the Korean children.

Given the overall results of the conservation performance by the Korean children in a tabular form, some salient features of these children's performance relating to the earlier questions will be pointed out here.

6.5.1.

It is seen from the results that the children in the older age groups performed better, in general, than in the younger age groups in both Piagetian and the Revised tests. However, when individual performance is considered there are exceptions in almost all sample groups. For example, there was one 5-year-old who achieved the maximum scores whereas a 9-year-old in the same sample group (Sample-2) received zero score in both tests.

6.5.2.

All the conservers in each age group performed

Table 6-1:Number of conservers in the Piagetian and the Revised Tests for the Korean children (N=10 at each age level in each sample).

		Sample-1 city			Sample-2 town			Sample-3 rural			Sample-4 London		
	Age	Pia	Rev	Prob	Pia	Rev	Prob	Pia	Rev	Prob	Pia	Rev	Prob
Liq.	5	2	8	.01	2	5	NS	0	0	NS	1	8	.05
	6	2	8	.01	3	7	NS	1	3	NS	3	9	.05
	7	8	9	NS	3	9	.05	1	4	NS	8	10	NS
	8							1	5	NS	9	10	NS
	9							4	7	NS	10	10	NS
Total		12	25		8	21		7	19		31	47	
Sub.	5	1	8	.01	1	4	NS	0	1	NS	2	7	.05
	6	2	9	.05	2	7	.05	1	2	NS	4	7	NS
	7	8	9	NS	4	9	.05	1	3	NS	7	10	NS
	8							1	5	NS	9	10	NS
	9							4	7	NS	10	10	NS
Total		13	26		7	20		7	19		32	44	
D.Q.	5	1	8	.01	2	5	NS	0	0	NS	1	6	.01
	6	3	8	.05	3	8	NS	1	2	NS	3	9	.01
	7	8	9	NS	4	9	.05	1	3	NS	7	10	NS
	8							2	5	NS	9	10	NS
	9							4	6	NS	10	10	NS
Total		12	25		9	22		8	16		30	45	

better in the Revised Test than in the Piagetian Test. The age range at which this happens varies; for sample-1 and sample-4, it is age 5 and 6, for sample-2, it is age 7 and for sample-3, it is age 7-10 (though less clear).

6.5.3.

The results from the Table showed variations in the level of performance among sample groups. The significance of such variations, will be further analysed here. Also the differences of performance among the three tasks of liquid, substance and discontinuous quantity conservation can be seen in Table 6-2. The value of Chi-square for the set of three frequencies in each sample was calculated.

Table 6-2: Number of conservers in each task in each sample and the significance of difference of performance among tasks.

	Piagetian Test					Revised Test				
	Liq.	Sub.	DQ.	X2	Prob.	Liq.	Sub.	DQ.	X2	Prob.
S-1	12	11	12	.06	NS	25	26	25	.00	NS
S-2	8	7	9	.25	NS	21	20	22	.10	NS
S-3	31	32	30	.07	NS	47	44	45	.14	NS

As can be seen from the result, there was no significant difference among the tasks of liquid, substance and discontinuous quantity conservaton.

6.5.4.

There was a tendency for Westernized Korean children to perform better in the Piagetian and the Revised tests compared with their town and rural

counterparts.

6.5.5.

There was a varying degree of difference of performance among sample groups. However, an obvious pattern of the level of group performance in the Piagetian and the Revised tests was that the most successful group consisted of London dwellers (Sample-4) and the least successful performers were those in a remote rural area. This apparent difference between these extreme groups will be further analysed including the results of the New Test-A .

6.6. The results of the New Test-A

It is noted here that the order of presenting tasks was not varied in the New Test-A, unlike the other two tests, in that the children were taken first to a well where cows were available for the liquid test, and then down to the sea shore where clay houses were built for the substance test, and finally to a dry sand ground to play with shells for the discontinuous quantity tasks. It was reasonable to complete one task at a time in such a experimental setting where the testing materials were to be found in the a natural environment.

The results of the performances in the New Test-A together with the significance of differences among the tests are shown in Table 6-3 .

Table 6-3. The number of conservers and the significance of differences between tests for the rural Korean children (N=10 at each at each age level, Sign Test used)

Age	Task	No. of Conservers New	Rev.	Piaget.	Probability → New-Rev.	New-Pia.
5	Liquid	6	0	0	.01	.01
	Sub.	5	1	0	.01	.01
	D.Q.	6	0	0	.01	.01
6	Liquid	6	3	1	NS	.01
	Sub.	6	2	1	NS	.01
	D.Q.	6	2	1	NS	.01
7	Liquid	8	4	1	NS	.01
	Sub.	7	3	1	NS	.01
	D.Q.	8	3	1	.05	.01
8	Liquid	8	5	1	NS	.01
	Sub.	7	5	1	NS	.01
	D.Q.	9	5	2	NS	.01
9	Liquid	8	7	4	NS	.01
	Sub.	8	7	4	NS	.01
	D.Q.	9	6	4	.05	.01

6.6.1.

The levels of success of these children in the New Test-A range from 5-9 out of 10 and this is similar to the rate of the successful performance by the rest of the children in the Revised test.

6.6.2.

All the children, regardless of age, performed significantly better in the New Test-A than in the Piagetian test.

6.6.3.

The performance difference between the New Test-A and the Revised Test was greatest for the youngest

children.

6.6.4.

A comparison of the rate of success in different tasks is calculated using Chi- square test. There was no significant difference among tasks of liquid, substance and discontinuous quantity.

6.6.5.

Is there any difference of performance in conservation tests between girls and boys? Table 6-4 shows the data relevant to this question.

As can be seen from the analysis there was no significant difference in frequency of the successful performance in the conservation tests between boys and girls. However, when the total number of conservers of all age groups are compared, there were slightly more boys than girls.

We have so far given the summary of the findings from the performance by the Korean children (N=16Ø) in the Piagetian, Revised and the New Test-A. A further discussion of the above findings will be followed by the analysis chapters.

Table 6-4. Number of Korean boys and girls who were conservers in each test in each age group.(Fisher's 2x2 Table test used)

		Pigetian Test			Revised Test			New Test			
N	Age	Boys	Girls	Prob.	Boys	Girls	Prob.	N	Boys	Girls	Prob.
40	5	2	2	NS	8	12	NS	10	2	2	NS
40	6	4	5	NS	16	11	NS	10	4	2	NS
40	7	13	7	NS	13	7	NS	10	4	3	NS
20	8	6	4	NS	8	7	NS	10	3	1	NS
20	9	7	7	NS	10	7	NS	10	5	3	NS
Total		32	24		55	44			18	11	

6.7. Experiment-2

This section deals with the statistical analysis of the results of conservation performance by the British children. There were 200 British children who were divided into four samples: Sample-5 comprised 50 children attending an independent school in England; Sample-6 contained 50 children attending a state school in England; Sample-7 was made up of 50 children attending a rural school in Scotland; while Sample-8 contained 50 children from non-professional families, attending an inner-city state school in Scotland. Again the age-range was from five to nine, and there were ten children in each age group in each sample with boys and girls evenly balanced in number.

The Piagetian and the Revised tests were administered to all the British children. Number of correct responders in the two tests in each item of liquid, substance and discontinuous quantity are shown in Table 6-5.

6.8. The result of the performance by the British children

We have seen an overall picture of conservation performance. Here some salient findings which related to the problems in question will be pointed out.

Table 6-5. Number of conservers in the Piagetian and the Revised Tests for the British children. (N=10 at each age level in each sample)

		Sample-5 Ind.			Sample-6 State			Sample-7 Rural			Sample-8 State		
	Age	Pia	Rev	Prob	Pia	Rev	Prob	Pia	Rev	Prob	Pia	Rev	Prob
Liq.	5	2	9	.01	2	6	NS	1	5	NS	0	3	NS
	6	5	10	.05	2	9	.05	1	3	NS	1	4	NS
	7	8	10	NS	8	10	NS	2	7	.05	2	5	NS
	8	10	10	NS	10	10	NS	4	8	.05	6	9	NS
	9	10	10	NS	10	10	NS	7	9	NS	9	9	NS
Total		35	48		31	45		15	32		18	30	
Sub.	5	2	7	.05	1	7	.05	1	4	NS	1	2	NS
	6	4	9	.05	2	8	.05	1	4	NS	1	4	NS
	7	9	10	NS	5	9	.05	2	8	.05	3	5	NS
	8	10	10	NS	10	9	NS	6	9	NS	6	8	NS
	9	10	10	NS	10	10	NS	9	10	NS	9	9	NS
Total		35	46		28	43		19	35		20	28	
D.Q.	5	2	8	.01	2	5	NS	1	5	NS	1	3	NS
	6	5	9	NS	2	6	NS	1	4	NS	1	5	NS
	7	9	10	NS	5	9	NS	3	6	NS	3	6	NS
	8	10	10	NS	8	8	NS	4	8	NS	8	9	NS
	9	10	10	NS	10	10	NS	6	9	NS	9	9	NS
Total		36	47		27	38		15	32		22	32	

6.8.1.

The British children performed better in the Revised test than in the Piagetian test with varying degrees of difference among sample groups. The age range at which most children can succeed with the Revised test but not with the Piagetian test are about 5-6 years for sample-5 and -6, 6-8 years for sample-8, and 7-8 years for sample-7.

6.8.2.

The difference of performance among tasks of liquid, substance and discontinuous quantity is analysed using Chi-Square test for the British children and the result is shown in Table 6-6.

Table 6-6: A comparison of performance differences among tasks

		Piagetian Test					Revised Test				
N	Sample	Liq	Sub	D.Q.	X2	Prob	Liq	Sub	D.Q.	X2	Prob
50	S-5	35	35	36	.23	NS	48	46	47	.04	NS
50	S-6	31	28	27	.32	NS	45	41	38	.59	NS
50	S-7	15	19	15	.66	NS	32	35	32	.18	NS
50	S-8	18	20	22	.60	NS	30	28	29	.06	NS

The above result shows that there was no difference in performance among tasks of liquid, substance and discontinuous quantity.

6.8.3. When the individual performance is compared, however, there are variations. For example, a 5-year-old in Sample-8 achieved maximum scores while a few 7-year-olds in Sample-6 failed to be conservers.

The comparatively poor performance by the children in Sample-7 and -8 will be further

analysed including the result of the New Test-B.

6.9. The results of the New Test-B

The results of the performances in the New Test-B for the children in Sample-7 and Sample-8, and the significance of differences between the Piagetian, Revised and the New tests are reported in Table 6-7. The Sign test was used to decide the level of significance. Some distinct natures of their performance are summarized here.

6.9.1

The level of the performance in the New Test-B (70%-100%) by British children in Sample-8 and Sample-9 was, in general, much higher than their performance in the Piagetian and the Revised tests, and was similar to the level of success by the children in Samples 5 and 6 in the Revised test.

6.9.2.

In order to test the difference among tasks, Chi-square tests of independence were used (X^2 = 0.92 df=2). There was no significant difference of performance among the tasks of liquid, substance and discontinuous quantity in the New Test-B.

Table 6-7: Number of conservers in three tests and the significance of differences in the performance between the tests.(N=10 at each age level)

Sample-7 N=50				Probability		Sample-8 N=50			Probability	
	Age	New	Rev	Pia	New-Rev	New-Pia	New	Rev	Pia	New-Rev	New-Pia
Liq.	5	7	5	1	NS	.01	8	3	0	NS	.01
	6	10	3	1	.01	.01	9	4	1	NS	.01
	7	10	7	2	NS	.01	8	5	2	NS	.01
	8	9	8	4	NS	.01	9	9	6	NS	NS
	9	10	9	7	NS	NS	10	9	9	NS	NS
Total		46	32	15			44	30	18		
Sub.	5	9	4	1	.01	.01	7	2	1	NS	.01
	6	9	4	1	.01	.01	9	4	1	.01	.01
	7	9	8	2	NS	.01	10	5	3	.05	.05
	8	9	9	6	NS	NS	10	8	6	NS	NS
	9	10	10	9	NS	NS	10	9	9	NS	NS
Total		46	35	19			46	38	20		
D.Q.	5	7	3	1	.05	.01	9	3	1	NS	.01
	6	10	4	1	.01	.01	9	5	1	NS	.01
	7	10	5	3	NS	.01	10	6	3	NS	.05
	8	9	9	4	NS	.01	10	9	8	NS	NS
	9	10	9	6	NS	NS	10	9	9	NS	NS
Total		46	30	15			48	32	22		

6.9.3.

The performance on conservation tests of boys and girls was compared (Fisher's 2x2 Table test used): there were 31 boys and 27 girls among 58 conservers in the Piagetian test, 55 boys and 54 girls among 99 conservers in the Revised test, and 18 boys and 11 girls among 29 conservers in the New Test-B. None of the differences were significant.

6.10. The follow-up study.

It might be claimed that the order of presentation of the tests could have affected the outcome. In order to clarify this matter a follow-up study was carried out in a farming area in the Scottish borders. The details of this study are as follows.

There were 20 children comprising four children in each age group from five to nine years. The parents' occupations were varied; builder, architect,medical doctor, factory worker, office clerk, teacher, hotel manager,farmers and farm workers.

The children were given three tests in the reverse order from the previous experiments; the New Test-B first, then the Revised Test and the Piagetian Test last.

The scoring method, testing procedures and the testing materials were the same as previous

occassions. Table 6-8 shows the results of this experiment.

Table 6-8: Number of conservers in each test and the difference of performance among tasks. (N=4 at each age level, Chi-square test used)

	Piagetian Test					Revised Test					New Test				
Age	Liq	Sb	DQ	X2	Prob	Liq	Sub	DQ	X2	Prob	Liq	Sub	DQ	X2	Prob
5	Ø	Ø	Ø	Ø	NS	1	1	1	Ø	NS	3	3	3	Ø	NS
6	1	1	1	Ø	NS	3	3	3	Ø	NS	4	4	4	Ø	NS
7	1	1	1	Ø	NS	3	3	3	Ø	NS	3	4	4	.Ø1	NS
8	2	2	2	Ø	NS	4	4	4	Ø	NS	4	4	4	Ø	NS
9	4	4	4	Ø	NS	4	4	4	Ø	NS	4	4	4	Ø	NS
Total	8	8	8			15	15	15			18	19	19		

6.10.1.

The results show that there was no difference of performance among tasks of liquid, substance and discontinuous quantity. Although the order of presentation was different from the previous occasions, the result are very similar, that is, there was no difference in the rate of success among tasks.

6.10.2.

The differences of success between the tests were analysed with data from each age group combined to give total number of conservers in each task. It is reasonable to combine the data from each age group to examine the differences of the performance since there is a tendency that their performance improve gradually according to age.

Chi-square was used to test the significance of the differences. The number of conservers among 20 testees and the significance of differences of their performances shown in Table 6-9.

Table 6-10. A comparison of performance difference between the tests.

Ages	N		Pia	Rev	New	Probability Pia-Rev X2	Prob	Rev-New X2	Prob
5-9	20	Liq	8	15	18	2.13	.05	.27	NS
5-9	20	Sub	8	15	19	2.13	.05	.47	NS
5-9	20	DQ	8	15	19	2.13	.05	.47	NS

The results demonstrate that these children performed signficantly better in the Revised test than in the Piagetian test. They also performed slightly better in the New Test-B than in the Revised, on each task, though the success rate was generally too high for this difference to reach statistical significance. In the main experiments it was seen that all the British and Korean children tested were most successful in the New tests, then in the Revised test, and they were least successful in the Piagetian test. This trend is repeated here although the order of presentation of the tests in the follow-up study was different from the main experiments. Further discussions of these findings will be made in the last chapter of this thesis. In this chapter we have seen, in general, how the changes in test materials or

procedure affect the number of children from different cultural and social backgrounds who are classified as conservers. But our data also contain a wealth of detail about the errors of reasoning made by children as they tackled the various tasks. Chapter 7 examines these responses in an attempt to discover the nature of the difficulties posed by the different types of test. In this way it should then be possible to interpret more effectively what thinking processes are being assessed by these tests.

6.11. Remarks

The level of successful performance by Westernized Korean children (sample-4) is very similar to the privileged British children (sample-5 and -6) in terms of number of conservers in each age group. These are the most successful performers among all of the sample groups. This implies that regardles of cultural differences between British and Korean children, they can be trained to have similar cognitive ability by providing them with similar contexts to exercise their knowledge.

However, some differences are observed in their attitudes in responding to the tests. For example, Korean children often pause (which is seen as a moment of projecting their thinking) before answering the questions. This tendency was seen to

be more obvious in the rural children. On the contrary, most British children responded spontaneously regardless of the correctness of their answer. Such differences may be attributed to the habit of thinking which has been practiced in the two difference cultural traditions (Details of such differences are found in chapter 2). This observation of the habit of responses, however, has not been theorized or generalized in this study due to the lack of systematic enquiry on the issue but it remains as a speculative suggestion which require further study.

CHAPTER 7

Qualitative Analysis of children's Explanations

7.1 Introduction

In this chapter, the details of each child's reasons given for their answers whilst experimenting with three conservation tests are analysed. In examining their reasoning processes, the children's own explanations are utilized and these are used as indicators of their likely mental processes. This analysis is referred to as the "qualitative analysis" hereafter.

The importance of process, rather than result,in evaluating the ability of the learners has been discussed by many educational theorists.

However, very few Piagetian researchers have analysed the process of performance by taking full account of children's own explanations in the way that is adopted here.

Six types of reason have been observed during interaction between the experimenter and the children subsequent to the administration of the conservation tests. These are:

Category-1:correct answers for expected reasons,
Category-2:correct answers with no reasons, or silence,
Category-3:correct answers for wrong reasons,
Category-4:wrong answers for logical reasons,
Category-5:wrong answers with no reasons,or silence
Category-6:wrong answers for wrong reasons.

In judging the category to which the children belong, each response was placed in one of the above six categories, and then each child was placed in one of the categories according to its most frequent type of explanation.

The characteristics of each category together with examples of children's responses are described in the following section.

7.2

Characteristics of the reason given by the children.

7.2.1 Category-1:correct answer for expected reasons

The children in this category answered correctly and gave reasons such as adults would expect. In giving their reasons the children referred to the original quantity and explained that the amount had not been changed although the shape of the containers had.

Four different reasons could be distinguished in their answers to the question:

(1) these children were able to express their opinion on the unchanged amount of the liquid in relation to the shapes of the glasses, which could be called "compensatory reasoning". For example, they said, "It looks more, but it's the same because the glass is thinner",

(2) these children stated the reason for the unchanged amount of liquid by pouring back the liquid into the glasses at the starting point,

which is referred to as "reversibility".

(3) these children expressed their view on the unchanged amount of liquid by "identifying" the original configuration. For example, they said, "You did not add any more juice to them" or "There was the same amount of juice as at the beginning",

(4) Since there was the same amount of liquid, these children do not give any further explanation but point out the fact that there was the same amount of liquid. For example, they said, "They are the same because they are the same", which is referred to as "tautology".

An example of responses belonging to category-1 is given below; responses by a 5-year-old Korean boy in sample-1.

Piagetian Test

Question 1: Which glass has more juice in it?
Answer: They are the same.
Question: Why?
Answer: (Because) the same to begin with.
Question 2: Which glass has more juice in it?
Answer: They are all the same.
Question: Why?
Answer: (Because) the same to begin with.
Question 3: Which one, this or those two has more juice?
Answer: They are both the same.
Why: Because there was the same before.
Question 4: Which one has more plasticine, the ball or the sausage?
Answer: All the same.
Question: Why do you think so?
Answer: (Because) it was the same to begin with.
Question 5: Which one,the blanket or the two balls has more plasticine?
Answer: Both the same.
Question: Why do you think so?
Answer: (Because) there was the same plasticine to

begin with.
Question 6: Which glass has more sweets in it, glass A1 or glass A2 ?
Answer: All of them are the same.
Question: Why?
Answer: (Because) there are the same to begin with.
Question 7: Which one, glass A2 or glass C1 and C2 combined has more sweets in it?
Answer: Both the same.
Question: Why?
Answer: (Because) they are the same.(fact)

Revised Test

Teddy bear said, "I have more juice than rabbit". The rabbit said, "I have more juice than teddy bear".The dog said,"you both have the same amount of juice to drink".

*The animal who answered correctly varied.

Question 1: Which animal's answer is correct?
Answer: The dog.(correctly answered)
Question: Why?
Answer: (Because) They have the same to drink.
Question 2: Who is right?
Answer: The dog.(correctly answered)
Question: Why?
Answer: (Because) the dog says correctly.
Question 3: Whose answer is correct?
Answer: The teddy bear.(correcty answered)
Question: Why?
Answer: The teddy bear says correctly.
Question 4: Which animal's answer is correct?
Answer: The rabbit.(correctly answered)
Question: Why do you think so?
Answer: (Because) the rabbit is right.
Question 5: Who answered correctly?
Answer: The dog.(correctly answered)
Question: Why do you think so?
Answer: (Because) the dog is right.
Question 6: Which animal's answer is correct?
Answer: The dog.(correctly answered)
Question: Why?
Answer: (Because) the rabbit and the teddy bear have the same smarties.
Question 7: Which animal answered correctly?
Answer: The dog.(correctly answered)
Question: Why?
Answer: (Because) the dog and the teddy bear have the same plasticine.

It was noted that children tend to follow the same form of answering the questions within a test; here, for example, in the Piagetian test, the reason was identity oriented while in the Revised test, it was tautology oriented. Tautology used by children seems not just a meaningles repetition,but equivalent to factual statment. This point will be discussed further in a later section.

In the following table, the number of both British and Korean children belonging to category-1 in the course of the administration of the Piagetian and the Revised tests is shown.

It can be seen from the results that there were more British children (57%) giving explanations for their answer than their Korean counterparts (38%).

Another important result is that the younger children are not inferior to older children within the age range of 5-9 in their logical explanation, once they got the answer right and had language fluency.

Table 7-1A shows the results of the children explanations while being tested with the Revised test. These results are similar to those with the Piagetian test.

Table 7-1: Number and percentage of the children who gave expected reasons for their correct answers in the Piagetian Tests

Korean																				
Sample	5yrs			6yrs			7yrs			8yrs			9yrs			Total		Aver.
	N		%	N		%	N		%	N		%	N		%	N		%
S1	1	(1)	100	1	(2)	50	2	(8)	25							4	(11)	36
S2	1	(2)	50	2	(2)	100	1	(3)	33							4	(7)	57
S3	0	(0)	0	0	(1)	0	0	(1)	0	0	(1)	0	0	(4)	0	0	(7)	0
S4	1	(1)	100	1	(2)	50	3	(8)	38	3	(9)	33	5	(10)	50	13	(35)	43
Total	3	(4)		4	(7)		6	(20)		3	(10)		5	(14)		21	(55)	
%	75			57			30			30			36			38		
British																		
S5	1	(2)	50	4	(5)	80	4	(8)	50	5	(10)	50	8	(10)	80	22	(35)	63
S6	1	(2)	50	0	(0)	0	3	(7)	42	5	(10)	50	7	(10)	70	16	(29)	55
S7	1	(1)	100	1	(1)	100	1	(1)	100	1	(4)	25	5	(7)	71	9	(14)	64
S8	0	(0)	0	1	(1)	100	1	(2)	50	2	(6)	33	4	(9)	44	8	(18)	44
Total	3	(5)		6	(7)		9	(18)		13	(30)		24	(36)		55	(96)	
%	60			86			50			43			67			57		

* The numbers in the brackets indicate all conservers at the corresponding group.

Table7-1A: Number and percentage of the children who gave expected reasons for their correct answers in the Revised Test

Korean

Sample	5yrs N	%	6yrs N	%	7yrs N	%	8yrs N	%	9yrs N	%	Total N	Aver. %
S1	1 (8)	13	5 (9)	56	4 (9)	44					10 (26)	38
S2	1 (5)	20	2 (7)	27	1 (9)	11					4 (21)	19
S3	0 (0)	0	0 (2)	0	0 (3)	0	1 (5)	20	1 (7)	14	2 (17)	12
S4	3 (7)	43	5 (8)	63	4 (10)	40	5 (10)	50	5 (10)	50	22 (45)	49
Total	5 (20)		12 (26)		9 (31)		6 (15)		6 (17)		39 (109)	
%	25		46		29		40		35		35	

British

S5	3 (7)	43	5 (9)	56	5 (9)	56	4 (10)	40	8 (10)	80	25 (45)	56
S6	4 (8)	50	3 (8)	38	6 (10)	60	7 (10)	70	7 (10)	70	24 (46)	59
S7	1 (5)	20	1 (3)	33	3 (7)	43	3 (8)	38	6 (8)	75	14 (31)	45
S8	2 (2)	100	4 (5)	80	4 (5)	80	6 (9)	67	6 (9)	67	22 (30)	73
Total	10 (22)		13 (25)		18 (31)		20 (37)		27 (37)		88 (152)	
%	46		52		58		54		73		58	

* The numbers in the brackets indicate all conservers at the corresponding group.

7.2.2. Category-2: correct answers with no reasons or silence.

The children in this category answered the conservation question correctly but when they were asked the reasons for their answers they did not give any reasons. There were two kinds of responses: 1) just being silent, 2) saying, "I don't know."

What may be the possible explanation for such responses? Several questions could be posed here: were these children too shy to say anything? One might think that they were too shy to give their reason but that cannot be entirely true as they had already answered the first question (although for some Korean children shyness might affect their answers due to the influence of child-bringing tradition described in Chapter2). Did they really not know the reason. When they say, "I do not know the reason" what is it that actually they do not know? Does this mean that they do not fully

understand the language and intention of the questioner, or that they do not have the ability to explain their "inner reasoning"? Does the reason for such silence lie with the children or the questioner?

Let us examine the original question forms in the Piagetian tests. In the Piagetian conservation test, there was the same amount of juice in glasses A1 and A2. The juice in glass A1 was poured into the narrower glass-B (or smaller glasses C1 and C2) so that the level of the juice became higher than that of glass A2. The child was right in saying,"They both have the same amount". Then the children were challenged as to the reason for their correct answer by being asked,"Why is there the same amount of juice?" This approach possibly creates the alternative answers and is also ambiguous in that the responders might not understand the questioner's intention. This means that their response, "I don't know" could be caused either by their inability to explain or by the ambiguity of the question. Concerning the children who did not give any reason, an alternative explanation could be made to the extent that the "silence" response might be engendered by culture and upbringing, especially for Korean children (see Chapter 2). This explanation is feasible because there are more children in this category amongst

the Korean children than their British counterparts.

The children belonging to this category could neither be judged as correct responders nor as wrong responders. The reasoning process of these children, therefore, could not be assessed adequately by the Piagetian tests.

The numbers and proportions of children who gave no reason for their correct answer amongst those who responded correctly in the Piagetian and the Revised tests, are tabulated in the table 7-2 and 7-2A respectively. All correct responders at each age level and in each sample are also shown in brackets.

It is noticeable here that the Korean children (5%) offered fewer explanations than the British children (12.5%) when they were asked for verbal explanations for their answers.

It is once again shown that a higher proportion (16%) of the Korean children than the British children (3%) offered no explanation in a situation demanding verbal explanation.

Table 7-2: Number and percentage of the children who gave no reason for their correct answers in the Piagetian Test.

Korean Sample	5yrs N	%	6yrs N	%	7yrs N	%	8yrs N	%	9yrs N	%	Total N	Aver. %
S1	Ø(1)	Ø	1(2)	5Ø	1(8)	13					2(11)	18
S2	Ø(2)	Ø	Ø(3)	Ø	1(3)	33					1 (8)	13
S3	Ø(Ø)	Ø	Ø(1)	Ø	Ø(1)	Ø	1(1)	1ØØ	1(4)	25	2 (7)	29
S4	Ø(1)	Ø	Ø(2)	Ø	1(8)	13	1(9)	11	Ø(1Ø)	Ø	2(3Ø)	7
Total	Ø(4)		1(8)		3(2Ø)		2(1Ø)		1(14)		7(56)	
%	Ø		13		15		15		7		13	
British												
S5	Ø(2)	Ø	Ø(5)	Ø	Ø (8)	Ø	1(1Ø)	1Ø	Ø(1Ø)	Ø	1(35)	3
S6	Ø(2)	Ø	Ø(Ø)	Ø	1 (7	14	1(1Ø)	1Ø	Ø(1Ø)	Ø	2(29)	7
S7	Ø(1)	Ø	Ø(1)	Ø	Ø (1)	Ø	Ø (4)	Ø	Ø (7)	Ø	Ø(14)	Ø
S8	Ø(Ø)	Ø	Ø(1)	Ø	Ø (2)	Ø	1 (6)	17	1 (9)	11	1(18)	11
Total	Ø(5)		Ø(7)		1(18)		3(3Ø)		1(36)		5(96)	
%	Ø		Ø		6		1Ø		3		5	

* The numbers in the brackets indicate all conservers at the corresponding group.

Table 7-2A: Number and percentage of the children who gave no reason for their correct answers in the Revised Test.

Korean Sample	5yrs N	%	6yrs N	%	7yrs N	%	8yrs N	%	9yrs N	%	Total N	Aver. %
S1	1 (8)	13	2 (9)	11	1 (9)	11					4 (26)	15
S2	1 (5)	20	1 (7)	14	1 (9)	11					3 (21)	14
S3	0 (0)	0	1 (2)	50	1 (3)	33	1 (5)	20	2 (7)	29	5 (17)	29
S4	1 (7)	14	1 (8)	13	1(10)	10	1(10)	10	1(10)	10	5 (45)	11
Total	3(20)		5(26)		4(31)		2(15)		3(17)		17(109)	
%	15		19		13		13		18		16	
British												
S5	0 (7)	0	0 (9)	0	0 (0)	0	1(10)	10	0(10)	1	1 (45)	2
S6	0 (8)	0	0 (8)	0	1(10)	10	0(10)	0	0(10)	0	2 (46)	4
S7	0 (5)	0	0 (3)	0	0 (7)	0	0 (8)	0	0 (8)	0	0 (31)	0
S8	0 (2)	0	0 (5)	0	0 (5)	0	1 (9)	11	1 (9)	11	2 (30)	7
Total	2(22)		0(25)		1(31)		3(37)		1(37)		5(152)	
%	0		0		0		8		3		3	

* The numbers in the brackets indicate all conservers at the corresponding group.

7.2.3. Category-3: Correct answers for wrong reasons

The children in this category answered correctly but gave "wrong" reasons for their answers. For example, in the conservation of liquid tests they were able to discriminate the quantity correctly although the liquid was transferred into different shaped glasses. However, when they were asked to explain their answers, they gave illogical reasons, thereby contradicting their own answers. For example, when the glasses A2 and B, tall and wide respectively, were presented with the same amount of orange juice in each of them, the following were typical of responses given;

Question: Which glass has more juice, A2 or B?....1
Answer: They are both the same..... 2
Question: Why? 3
Answer: Because glass B is taller and thinner and glass A2 is wider (or glass A2 is fatter and glass B is thinner)..... 4

Rewriting of the above answers 2 and 4 together in logical symbols, we have : A=B and A=W B=T .. T=W, that is, "tall" and "wide" are equated. But certainly these children do not mean that "tall" equals "wide". Before proceeding any further, a question arises: What were the children's thought processes during their answers?. When we single out answer 2 and 4 it appears that they are illogical, but when we interpret the children's answers in an

ordinary life sense (or semantics only) they are comprehensible. From the answers, 2 and 4, we can seek to investigate what interpretation of 3 was made by the children when they formulated their answers. It seems that they re-organized the question 3 as if it meant 'Why does the tall glass look as if it has more although they have the same amount of juice? And then we could interpret their answer-4 to mean something like: **although both glasses have the same amount of juice, glass B looks as if it has more juice in it than does glass A (or the level of the juice in glass B is higher and that in glass A is lower)**"because glass B is taller and thinner and glass A is wider".

It could also be true that they are just confused. It is seen from such responses that these children did not fully express verbally what they think in a verbal form. Examples of such responses follow.

An example of the explanation by a 8-year-old British girl in sample-6 (Questions will not be repeated here).

Piagetian Test

Answer for question 1: This glass (taller) and that glass (wider) have the same amount of juice. Because this is taller and that is wider.

Answer for question 2: They are the same. Because this is long and that one is much wider.

Answer for question 3: They are the same amount of juice. Because there are two glasses.

Answer for question 4: The sausage and the ball have the same amount of plasticine. Because sausage is longer and the ball is round.

Answer for question 5: They both the same. Because this is flat and big (indicating the blanket).

Answer for question 6: Both glasses have the same smarties. Because this is tall and that is bit wide.

Answer for question 7: They are the same. Because that one is wide and this one is taller and thinner.

Revised Test

Answer for question 1: Dog is right. Because teddy bear and the rabbit have the same amount to drink.

Answer for question 2: Dog. Because rabbit has tall and thinner glass.

Answer for question 3: Dog. Because rabbit drinks in two glasses, teddy bear and rabbit have the same amount to drink.

Answer for question 4: Dog. Because rabbit has longer plasticine,teddy bear has big one, they have the same.

Answer for question 5: Dog. Because this is big piece (indicating) and there are two balls.

Answer for question 6: Dog is right. Because teddy bear and rabbit have the same amount of smarties.

Answer for question 7: Dog is right. Because teddy bear and rabbit has the same amount of smarties.

From the response given by this child it is noticed that they do not pay much attention to the syntax of the language but more rely on the semantics in the situation demanding explanations for their answer.

The number of children belonging to this category amongst correct responders in the Piagetian and the

Revised tests is shown in table 7-3 and 7-3A.

The results both from the Piagetian and the Revised tests, clearly demonstrate that although they were able to solve conservation problems, a substantial number of children could not or did not offer logical reasons for their answers. This means that a significant number of children regardless of their age(5-9),social, and cultural backgrounds, appear to be unable to offer logical explanations for their correct judgement on matters relating to the conservation of quantity of Piagetian type.

Table 7-3: Number and percentage of the children who gave wrong reasons for their correct answers in the Piagetian Test.

Korean																
Sample	5yrs		6yrs		7yrs		8yrs		9yrs		Total		Aver.			
	N	%	N	%	N	%	N	%	N	%	N		%			
S1	Ø(1)	Ø	Ø(2)	Ø	5(8)	63					5(11)		45			
S2	1(2)	5Ø	1(3)	33	1(3)	33					3 (8)		38			
S3	Ø(Ø)	Ø	1(1)	1ØØ	1(1)	1ØØ	Ø (1)	Ø	3(4)	75	5 (7)		71			
S4	Ø(1)	Ø	1(2)	5Ø	4(8)	5Ø	5 (9)	56	5(1Ø)	5Ø	15(3Ø)		5Ø			
Total	1(4)		3(8)		11(2Ø)		5(1Ø)		8(14)		28(56)					
%	25		38		55		5Ø		56		5Ø					
Brirish																
S5	1(2)	5Ø	1(5)	2Ø	4 (8)	5Ø	4(1Ø)	4Ø	2(1Ø)	2Ø	12(34)		34			
S6	1(2)	5Ø	Ø(Ø)	Ø	3 (7)	43	4(1Ø)	4Ø	3(1Ø)	3Ø	11(29)		39			
S7	Ø(1)	Ø	Ø(1)	Ø	Ø (1)	Ø	3 (4)	75	2 (7)	29	5(14)		36			
S8	Ø(Ø)	Ø	Ø(1)	Ø	1 (2)	5Ø	3 (6)	5Ø	4 (9)	44	8(18)		44			
Total	2(5)	4Ø	1(7)		8(18)		14(3Ø)		11(36)		36(96)					
%	4Ø		14		44		47		31		38					

*The numbers in the brackets indicate all conservers at the corresponding group.

Table 7-3A: Number and percentage of the children who gave wrong reasons for their correct answers in the Revised Test

Korean												
Sample	5yrs		6yrs		7yrs		8yrs		9yrs		Total	Aver.
	N	%	N	%	N	%	N	%	N	%	N	%
S1	6 (8)	75	2 (9)	22	4 (9)	44					12(26)	46
S2	3 (5)	60	4 (7)	57	7 (9)	78					14(21)	67
S3	0 (0)	0	1 (2)	50	2 (3)	67	3 (5)	60	4 (7)	57	10(17)	59
S4	3 (7)	43	2 (8)	25	5(10)	50	4(10)	40	4(10)	40	18(45)	40
Total	12(20)		9(26)		18(31)		7(15)		8(17)		54(109)	
%	60		35		58		47		47		50	
British												
S5	4(7)	57	4 (9)	44	4(9)	44	5(10)	50	2(10)	20	19(45)	42
S6	4(8)	50	5 (8)	63	3(10)	30	2(10)	20	3(10)	30	17(46)	37
S7	4(5)	80	2 (3)	67	4(7)	57	5(8)	63	2(8)	25	17(31)	55
S8	0(2)	0	1 (5)	20	1(5)	20	2(9)	22	2(9)	22	6(30)	20
Total	12(22)		12(25)		12(31)		14(37)		9(37)		59(152)	
%	55		48		39		38		24		39	

*The numbers in the brackets indicate all conservers at the corresponding group.

7.2.4 Category-4: Wrong answers for logical reasons.

The children in this category explained logically about the relationship between the level of the juice in different glasses but their initial answers appeared to be wrong.

There were two types of reasoning in this category:

Question: Which glass has more juice? (There was the same amount of juice in a tall glass and a wider glass.)
Answer: There is more juice in taller glass.
Question: Why?
Answer 1: Because it is skinny so it looks more....Type 1.
Answer 2: Because this is tall so it goes up, that is wide so that does down.....Type 2.

In the case of type-1 answers, it is obvious that the child interpreted the question as if it were, "Which one looks as if it has more? and "Why does it look as if it has more?" This suggests that they interpreted the question as best they could regardless of the logic of the question itself. Only certain information has been selected by the child and he seeks to make the best use of it. What the child regards as the correct answer does not depend on the logical structure of the question but tne meaning of the question. An example of such responses by a 7-year- old British boy from a rural school is as follows (Questions are ommitted here).

Piagetian test

Answer 1: This taller glass got more juice in it. Because it's thin and narrow it looks more.
Answer 2: This tall glass. Because it's thin and it goes higher up (indicating taller glass),

this one is flat and it goes down (indicating wider glass).

Answer 3: The wider glass. Because none of them are the same but there two glasses look a lot of juice because there are two.
Answer 4: The sausage. Because it is long and it looks more than that ball.
Answer 5: This big plasticine (indicating the blanket). Because this is wide and it looks much more.
Answer 6: This tall glass. Because it is thin and it looks more and this wider glass goes down.
Answer 7: This taller glass. This goes up, that goes down because the glasses are different.

Revised Test

Answer 1: Dog is correct. Because rabbit has thin and narrow glass and it looks a lot.
Answer 2: Dog is correct. Because rabbit has thin shallow glass, it goes high up.

New Test B

This child answered correctly and gave correct reasons in every task in the New Test B.

Question 1: Which glass, this or that (indicating glass A2 and glass B2) has as much milk as this (indicting B1).
Answer: That one (indicating glass A2,which is correct one).
Question: Why?
Answer: Because this is wider glass, it goes down, but they got the same milk.
Question 2: Which glass has more barley in it?
Answer: This one (indicating wider glass which containes more barley than the taller glass, and is correct one.)
Question: Why?
Answer: There was more barley in there (correct answer) before pouring into this glass.
Question 3: Is there the same amount of plasticine in lids C and D or not?
Answer: Both lids got the same plasticine.
Question: Why?
Answer: Because the dustbin is smaller.

The number of children belonging to this category in the Piagetian Test is shown in Table 7-4 and in the Revised Test in Table 7-4A.

It is noticed from the results that many more British children (17%) gave this type of explanation compared to their Korean (8%) counterparts (8%).

It is seen from the results in both the Piagetian and the Revised tests that the proportion of children belonging to this category varies arbitrarily in terms of age and sample groups.

Table 7-4: Number and percentage of the children who gave logical reasons for their wrong answers in the Piagetian Test.

Korean												
Sample	5yrs		6yrs		7yrs		8yrs		9yrs		Total	Aver.
	N	%	N	%	N	%	N	%	N	%	N	%
S1	Ø (9)	Ø	Ø(8)	Ø	Ø(2)	Ø					Ø (19)	Ø
S2	Ø (8)	Ø	Ø(7)	Ø	5(7)	71					5 (22)	23
S3	Ø(10)	Ø	Ø(9)	Ø	Ø(9)	Ø	Ø(9)	Ø	Ø(6)	Ø	Ø (43)	Ø
S4	Ø (9)	Ø	1(8)	13	Ø(2)	Ø	Ø(1)	Ø	Ø(Ø)	Ø	1 (2Ø)	5
Total	Ø(36)		1(32)		5(2Ø)		Ø(1Ø)	Ø	Ø(6)		6(1Ø4)	
%	Ø		3		25		Ø		Ø		6	
British												
S5	Ø (8)	Ø	Ø (5)	Ø	Ø(2)	Ø	Ø (Ø)	Ø	Ø(Ø)	Ø	Ø (15)	Ø
S6	1 (8)	13	2(1Ø)	2Ø	Ø(3)	Ø	Ø (Ø)	Ø	Ø(Ø)	Ø	3 (21)	14
S7	1 (9)	11	2 (9)	22	2(9)	22	Ø (6)	Ø	Ø(3)	Ø	5 (36)	14
S8	2(1Ø)	2Ø	2 (9)	22	1(8)	13	1 (4)	25	Ø(1)	Ø	6 (32)	19
Total	4(35)		3(33)		3(22)		1(1Ø)		Ø(4)	Ø	14(1Ø4)	14
%	11		18		14		1Ø		Ø		14	

* Number of all non-conservers in each group is shown in the brackets.

Table 7-4A: Number and percentage of the children who gave logical reasons for their wrong answers in the Revised Test.

Korean														
Sample	5yrs		6yrs		7yrs		8yrs		9yrs		Total		Aver.	
	N	%	N	%	N	%	N	%	N	%	N		%	
S1	Ø(2)	Ø	Ø(1)	Ø	Ø(1)	Ø					Ø	(4)	Ø	
S2	Ø(5)	Ø	Ø(3)	Ø	Ø(1)	Ø					Ø	(9)	Ø	
S3	Ø(1Ø)	Ø	Ø(8)	Ø	Ø(7)	Ø	Ø(5)	Ø	3(3)	1ØØ	3	(33)	9	
S4	1(3)	33	Ø(2)	Ø	Ø(Ø)	Ø	Ø(Ø)	Ø	Ø(Ø)	Ø	1	(5)	2Ø	
Total	1(3)		1(14)		Ø(9)		Ø(5)		3(3)		4	(51)		
%	5		Ø		Ø		Ø		1ØØ		8			
British														
S5	Ø(3)	Ø	Ø(1)	Ø	Ø(1)	Ø	Ø(Ø)	Ø	Ø(Ø)	Ø	Ø	(5)	Ø	
S6	Ø(2)	Ø	Ø(2)	Ø	Ø(Ø)	Ø	Ø(Ø)	Ø	Ø(Ø)	Ø	Ø	(4)	Ø	
S7	1(5)	2Ø	2(7)	29	Ø(3)	Ø	Ø(2)	Ø	Ø(2)	Ø	3	(19)	16	
S8	1(8)	13	1(5)	2Ø	Ø(5)	Ø	1(1)	1ØØ	1(1)	1ØØ	5	(2Ø)	25	
Total	2(18)		3(15)		1(9)		1(3)		1(3)		8	(48)		
%	11		2Ø		11		3		33		17			

*Number of all non-conservers in each group is shown in the brackets.

7.2.5.Category-5: Wrong answers with no reasons or silence

Children in this category did not give any reasons for their answers and it appears that they did not have anything to say or could not decide what to say. Children in this category also failed to solve given tasks, therefore, their silence was treated as lack of response unlike the children belonging to category-2 who were successful in solving tasks but silent about their reasons.

Table 7-5 shows the number of children belonging in this category in the Piagetian Test and Table 7-5A of those in the Revised test.

The Korean children (33%) were significantly less expressive in comparison with their British counterparts (10%) in responding to the Piagetian tests.

Similarly larger proportion of the Korean children (39%) were silent compared with their British (19%) counterparts in giving their reasons for the Revised test. However, the percentage of children belonging to this category varies in terms of age and sample groups.

Table 7-5: Number and percentage of children who gave no reason for their wrong answers in the Piagetian Test.

Korean												
Sample	5yrs		6yrs		7yrs		8yrs		9yrs		Total	Aver.
	N	%	N	%	N	%	N	%	N	%	N	%
S1	2 (9)	22	2 (8)	25	Ø (2)	Ø					4 (19)	21
S2	2 (8)	25	2 (7)	29	2 (7)	29					6 (22)	27
S3	7(10)	70	4 (9)	44	4 (9)	44	5 (9)	56	2(6)	33	22 (43)	51
S4	1 (9)	11	1 (8)	13	Ø (2)	Ø	Ø (1)	Ø	Ø(Ø)	Ø	2 (20)	10
Total	12(36)		9(32)		6(20)		5(10)		2(6)		34(104)	
%	33		28		30		50		33		33	
British												
S5	2 (8)	25	Ø (5)	Ø	Ø (2)	Ø	Ø(Ø)	Ø	Ø(Ø)	Ø	Ø(15)	13
S6	Ø (8)	Ø	1(10)	10	Ø (3)	Ø	Ø(Ø)	Ø	Ø(Ø)	Ø	1(21)	5
S7	2 (9)	22	2 (9)	22	Ø (9)	Ø	Ø(6)	Ø	Ø(3)	Ø	4(36)	11
S8	1(10)	10	1 (9)	11	1 (8)	13	Ø(4)	Ø	Ø(1)	Ø	3(32)	9
Total	5(35)		4(33)		1(22)		Ø(10)		Ø(4)		10(104)	
%	14		12		5		Ø		Ø		10	

*Number of all non-conservers in each group is shown in the brackets.

Table 7-5A: Number and percentage of the children who gave no reason for their wrong answers in the Revised Test

Korean												
Sample	5yrs		6yrs		7yrs		8yrs		9yrs		Total	Aver.
	N	%	N	%	N	%	N	%	N	%	N	%
S1	1 (2)	50	0 (1)	0	0(1)	0					1 (4)	25
S2	2 (5)	40	1 (3)	33	1(1)	100					4 (9)	44
S3	5(10)	50	2 (8)	25	3(7)	43	3(5)	60	0(3)	0	13(33)	39
S4	1(3)	33	1 (2)	50	0(0)	0	0(0)	0	0(0)	0	2 (5)	40
Total	9(20)		4(14)		4(9)		3(5)		0(3)		20(51)	
%	45		29		44		60		0		39	
British												
S5	1(3)	33	0(1)	0	0(1)	0	0(0)	0	0(0)	0	1 (5)	20
S6	0(2)	0	0(2)	0	0(0)	0	0(0)	0	0(0)	0	0 (4)	0
S7	2(5)	20	2(7)	29	0(3)	0	0(2)	0	0(2)	0	4(19)	21
S8	1(8)	13	1(5)	20	2(5)	40	0(1)	0	0(1)	0	4(20)	20
Total	4(18)		3(15)		2(9)		0(3)	0	0(3)		9(48)	
%	22		20		22		0		0		19	

*Number of all non-conservers in each group is shown in the brackets.

7.2.6. Category 6: Wrong answers for wrong reasons

The children in this category replied as if they believed that the quantity of liquid changed when it was transferred into the container with a different shape. This means that they do not have the ability to answer these problems correctly. But one interesting feature was that the reason given was always related to the actual shapes. For example, the container which had a higher level was believed to contain more. In some cases wider containers were believed to hold more liquid. The words, "more" in these cases corresponds with "high" level but not "lower" level, and with "wider" glass but not "narrow" glass. In other words, these children judged the amount of liquid in their own system (i.e. high=more, wider=more). Let us consider a typical example:

Question: Which glass has more juice in it, A2 or B.
Question: Why?
Answer: Because that one is taller (or bigger, wider, fatter).

Can one not claim that the child is able to think according to his own logical system? If the answer is "Yes", the real problem involved seems to be the ability to memorize premises and to relate them in different situations. It is also seen that to a certain extent these children were able to relate two concepts - the taller glass to more juice.

It is also observed that both the answers and reasons given were wrong. One may wish to raise a question, " What is the reasoning process involved in two wrongs"?

Further discussion will be given on such "illogical" responses in a later later section.

Tables 7-6 and 7-6A show the number of children belonging to this category whilst testing them with the Piagetian and the Revised tests.

In both the Piagetian and the Revised tests the proportion of the children belonging to this category varies and seems not be related to age or sample groups. It is noticed that slightly more of the British children (65%)than the Korean children (53%) belong to this category.

The next section deals with an analysis of reasons given by the Korean rural children (sample-3), British rural children (sample-8) and British city children from non-professional families (sample-9) to the New tests.

Table 7-6: Number and percentage of the children who gave wrong reasons for their wrong answers in the Piagetian Test.

Korean												
Sample	5yrs		6yrs		7yrs		8yrs		9yrs		Total	Aver.
	N	%	N	%	N	%	N	%	N	%	N	%
S1	7 (9)	78	6 (8)	75	2 (2)	100					15 (19)	79
S2	6 (8)	75	5 (7)	71	0 (7)	0					11 (22)	50
S3	3(10)	30	5 (9)	56	5 (9)	56	4 (9)	44	4(6)	67	21 (43)	49
S4	8 (9)	89	6 (8)	75	2 (2)	100	1 (1)	100	0(0)	0	17 (20)	85
Total	24(36)		22(32)		9(20)		5(10)		4(6)		64(104)	
%	66		69		45		50		67		62	
British												
S5	6 (8)	75	5 (5)	100	2(2)	100	0 (0)	0	0(0)	0	13 (15)	87
S6	7 (8)	88	7(10)	70	3(3)	100	0 (0)	0	0(0)	0	17 (21)	81
S7	6 (9)	67	5 (9)	56	7(9)	78	6 (6)	100	3(3)	100	27 (36	75
S8	7(10)	70	6 (9)	67	6(8)	75	3 (4)	75	1(1)	100	23 (32)	72
Total	26(35)		23(33)		18(22)		9(10)		4(4)		80(104)	
%	74		67		81		90		100		77	

*Number of all non-conservers in each group is shown in the brackets.

Table 7-6A: Number and percentage of the children who gave wrong reasons for their wrong answers in the Revised Test.

Korean											
Sample	5yrs		6yrs		7yrs		8yrs		9yrs		Total	Aver.
	N	%	N	%	N	%	N	%	N	%	N	%
S1	1 (2)	50	1 (1)	100	1 (1)	100					3 (4)	75
S2	3 (5)	60	2 (3)	67	0 (1)	0					5 (9)	56
S3	5 (10)	50	6 (8)	75	4 (4)	100	2 (5)	40	0 (3)	0	17 (30)	57
S4	1 (3)	33	1 (2)	50	0 (0)	0	0 (0)	0	0 (0)	0	2 (5)	40
Total	10 (20)		10 (14)		5 (6)		2 (5)		0 (3)		27 (48)	6
%	50		71		83		40		0		53	
British												
S5	2 (3)		1 (1)		1 (1)		0 (0)		0 (0)		4 (5)	80
S6	2 (3)		2 (2)		0 (0)		0 (0)		0 (0)		4 (4)	100
S7	2 (5)		3 (7)		3 (3)		2 (2)		2 (2)		12 (17)	63
S8	6 (8)		3 (5)		3 (5)		0 (1)		0 (1)		11 (21)	55
Total	12 (28)		9 (15)		7 (9)		2 (3)		2 (3)		31 (47)	
%	67		60		78		67		67		70	

* Number of all non-conservers in each group is shown in the brackets.

7.3 New Test-A

This test was given only to the Korean rural children (N=5Ø, 5-9 years, Sample-3). The result is tabulated in Table 7-7.

Table 7-7: Number of chidlren belong to each category for the Korean children from a rural area in the New Test-A.

	5yrs	6yrs	7yrs	8yrs	9yrs	Total	Aver.%
Category-1	3	3	4	6	5	21	58
Category-2	3	2	3	2	3	13	36
Category-3		1	1			2	6
Total Conservers	6	6	8	8	8	36	
Category-4							
Category-5	3		1			4	29
Category-6	1	4	1	2	2	1Ø	71
Total Non-conservers	4	4	2	2	2	14	

In this test, 21 out of 36 children (58%) gave right reasons for their correct answer (belonging to category-1), 13 children (36%) offered no explanation for their correct answer (category-2) and 2 children (5.6%) gave wrong reasons for their correct answer (category-3).

It is very clear here that the proportion of children belonging to category-3 is significantly smaller in the New Test-A (5.6%) than in the Piagetian (71%) or Revised (59%) test.

Amongst the 14 children who failed to solve the New Test-A, 4 of these children (29%) offered no explanation for their wrong answer (category-5) and

None contradicted their wrong answers (category-4).

An example of such responses by a 7-year-old Korean girl from a rural area in sample-3 is be given below.

Piagetian Test

Answer 1: This one (indicating tall glass). No explanation was offered.
Answer 2: This one (indicating taller glass). No reason was given but silent.
Answer 3: That one (indicating two glasses). No reason was given.
Answer 4: Sausage.Silence for reason.
Answer 5: Two balls. Silence for reasons.
Answer 6: Here (indicating tall glass of sweets). No reason was given.
Answer 7: Here (indicating two glass of sweets).No response for reasons.

New Test A

This child answered correctly in all items of the New Test A.

Question 1: Do both calves have the same amount of water to drink or not?.
Answer : Both calves were given the same amount of water.
Question : Why the bowl (indicating smaller bowl) looks fuller then?
Answer: That bowl is very small, isn't it?
Question 2: Whose necklace will be longer?
Answer: Yours will be longer (correctly answered question).
Question: Why mine will be longer than yours?
Answer: You have more shells,haven't you.
Question 3: Do both house have ths same amount of clay or does the bigger house have more clay?
Answer: This is big house and that is small house but they were built with the same lumps of clay.

7.4 New Test-B

This test was given to the British children in sample-8 and sample-9 only. The following Table summarises the results.

Table 7-8: Number of children belonging to each category at each age level for the British chidlren in the New Test-B

	Sample-7						
	5yrs	6yrs	7yrs	8yrs	9yrs	Total N	Average %
Category-1	6	10	10	9	10	45	98
Category-2	1					1	2
Category-3						0	0
Total Conservers	7	10	10	9	10	46	
Category-4	2					2	50
Category-5	1					1	25
Category-6				1		1	25
Total Non-conservers	3	0	0	1	0	4	

	Sample-8						
	5yrs	6yrs	7yrs	8yrs	9yrs	Total N	Average %
Category-1	7	8	8	8	9	40	91
Category-2	1				1	2	4.5
Category-3		1		1		2	4.5
Total Conservers	8	9	8	9	10	44	
Category-4	2					2	33
Category-5						0	0
Category-6		1	2	1		4	67
Total Non-conservers	2	1	2	1	0	6	

In sample-7, 45 out of 46 correct responders (98%) gave right reasons (category-1) and 4 children (2%) offered no reason (category-2) for their answer. None of them gave contradictory reasons (category-3).

Amongst the 4 children who failed to solve the New Test B, two of them (50%) gave logical

explanations (category-4), one child (25%) offered no reasons (category-5) and one child (25%) gave wrong reasons (category-6). The most distinctive feature of the results was that there were only a few (Ø-5%) children who gave illogical reasons whereas a substantial proportion of children belong to this category in the Piagetian (36%) and the Revised (55%) tests.

In sample-8, 4Ø out of 44 correct responders (91%) gave correct reasons, 2 children (4.5%) offered no reasons, and 2 children (4.5%) gave wrong reasons for their correct answer.

Amongst the 6 children who failed to solve the tasks,2 of these children (33%) gave logical explanations (category-4) and 4 children (67%) gave wrong reasons (category-6). None of them were silent.

Almost all children (91-98%) gave logical explanations for their correct answers (belonging to category-1) in the New Test-B and this is clearly different from the pattern of responses observed in the Piagetian (44-64%) and the Revised(45-73%) tests.

An example of responses by an 8-year-old British boy attending a rural state school is as follows. Question forms in the Piagetian and the Revised tests are omitted in the following example.

Piagetian Test

This child answered correctly but gave wrong reasons.

Answer 1: This taller glass and the wider glass have got the same amount of juice. Because this is taller and that is wider.
Answer 2: They both are the same. Because this is long and that one is much wider.
Answer 3: They are the same amount of juice. Because there are two glasses.
Answer 4: Sausage and the ball have the same plasticine. Because sausage is longer and the ball is round.
Answer 5: They both are the same. Because this is flat and big.
Answer 6: Both have the same smarties. Because this is tall and that is a bit wide.
Answer 7: They are the same. Because that one is wide and this one is taller and thinner.

Revised Test

This child answered correctly but gave illogical explanations.

Question: Which animal answered correctly? Why?
Answer 1: Dog (correct).
Because Teddy bear has longer glass (wrong).
Answer 2: Teddy Bear.(correct)
Because Teddy Bear said so (wrong).
Answer 3: Rabbit (correct).
Because Dog has two glasses (wrong).
Answer 4: Dog (correct).
Because Teddy bear has longer one.
Answer 5: Rabbit (correct).
Because this is big piece (wrong).
Answer 6: Teddy Bear (correct).
Because Dog has smarties in taller glass (wrong).
Answer 7: Dog (correct).
Because Teddy Bear has flat glass and Rabbit has longer glass (wrong).

New Test-B

This child answered correctly and gave logical explanations in all items in this test.

Question 1: Which glass, this (A') and that (B') has as much milk as Susie has in this glass (A)?
Answer:That one (indicating glass B- answered correctly).
Question: Why?
Answer: Because this glass has one cup and that glass has one cup.
Question 2: Which glass has more barley in it?
Answer: This glass (answered correctly).
Question: Why?

Answer: Because it was more there (indicating the original amount -answered correctly)

Question 3: Is there the same amount of plasticine in lid C and D or not?
Answer: The same (answered correctly).
Question: Why?
Answer: Because we made them with the same plasticine.

The following section gives a summary of the explanations by the children in the three tests.

7.5. Summary

The foregoing qualitative analysis of the children's explanations can be summarised as follows:

7.5.1

Among children who solved the Piagetian and the Revised tests of conservation successfully, by no means all of them were able to give correct explanations: for those answers only 50% of the British children and 38% of the Korean children gave wrong reasons in the Piagetian Test.
In the New tests, however, only a small number of children, 6% in the case of the Korean children and 3% in the case of the British children, gave wrong reasons for their correct answers (category-3). This result is significantly different from that in the Piagetian and the Revised tests.

It is evident, therefore, that the children who contradicted themselves in their judgement and explanation in the Piagetian and the Revised tests are in fact able to make correct judgements, as

well as logical explanations, whilst solving the New test tasks.

7.5.2.

The proportion of both British and Korean children who can explain logically their correct answers (belonging to category-1) varies arbitrarily in terms of their age and sample groups.

It is not clear therefore whether the quality of logical thinking is related to the age level or not, apart from the very obvious fact that the older children have more knowledge, experience, and fluency in language to cope with more difficult tasks in a more sophisticated manner.

7.5.3.

Some of those who failed to solve the Piagetian and the Revised tests nevertheless gave answers which imply that they actually understood the relationships involved. The percentage of children belonging to this category-4 was 6%-8% in the case of the Korean children and 14%-17% in the case of the British children. These children's explanations appeared to contradict their wrong answers,but the explanation alone correctly described the principle of conservation. Such contradiction shows that these children can explain the principle of conservation, but they were perhaps unable to grasp the meaning of the question

initially.

7.5.4.

There were much more Korean children than British children who gave no reasons or silence for their answers. These results demonstrate that Korean children do not verbally express themselves as easily as their British counterparts. The reason for this difference could be that the Korean children's way of life requires more inner thinking whereas the British children are used to express their thinking in a verbal form from their early childhood (See chapter 2).

7.5.5.

Those who gave wrong reasons for their wrong answers were approximately 62% in the Piagetian test and 53% in the Revised test in the case of the Korean children, and 77% in the Piagetian test and 65% in the Revised test in the case of the British children. It is reasonable to classify these children as apparent "failures" in solving the Piagetian and the Revised tests.

We have seen the differences of performance amongst children in various tasks and the results have first been analysed statistically, and then qualitative analyses were used to understand more clearly the nature of the failures. In this way, children's cognitive ability regarding

conservation tasks has been observed as objectively as possible.

The next chapter will discuss these findings in relation to previous research work and to Piagetian theory.

CHAPTER 8

Discussion and Conclusions

The cognitive ability of children of five to nine years of age was examined in the British and the Korean cultural contexts. For this, the children were given three different tests, i.e. the Piagetian test, a revised test and a new test. The results were reported in the previous two chapters.

It is now appropriate to discuss the findings of the present study and to compare them with the questions posed earlier.

8.1. Relevance and irrelevance of "context" in cognition

The role of educational social and cultural contexts in the development of thinking has long been one of the most important issues in educational psychology and in other related fields of study. This is particularly the case when studying Piagetian theory of cognitive development, because Piaget's emphasis on the universality of structure of cognition posed several questions. For example, does his view of cognitive structure include an explanation of the diverse modes of logical thinking influenced by the cultural contexts of the thinker. Some theorists such as

Bruner, Cole, Donaldson, etc. criticise Piaget and suggest that social and cultural contexts fundamentally influence the development of thinking. This issue of the effect of "context" is complicated by the differing definitions and emphases presented by various researchers . It is unclear whether the influence is a quantitative or qualitative one.

In this study, the term "context" covers the whole range of conceptual experience and physical environment of a child. In this sense, the "context" proposed here may carry a similar sense to the term "cognitive ambience" suggested by Heron & Simonsson (1969). They suggested,

> "Ambience was there defined as, the total pattern of implicit cognitive-relevant cultural values, communicated through linguistic and other behaviour by adults and older children. The vital feature of this communication is unintentionality, the day-to-day usualness, the taken-for-granted assumptions about what is and what is not important in life"(p.291).

Here the different points of view on this issue will be discussed, comparing Piaget to the others, and to furnish evidence for differences between them based on the present study. This will then lead to several suggestions by the present investigator.

First of all, Piaget's stance on this issue will be presented: Piaget said,

> "The stages... are accelerated or retarded in their average chronological ages according to the

child's cultural and educational environment. But the very fact that the stages follow the same sequential order in any environment is enough to show that the social environment cannot account for everything. This constant order of succession cannot be ascribed to the environment" .... "In fact, both social or educational influences and physical experience are on the same footing in this respect, they can have some effect on the subject only if he is capable of assimilating them, and he can do this only if he already possesses the adequate instruments or structures (or their primitive forms). In fact, what is taught, for instance, is effectively assimilated only when it gives rise to an active reconstruction or even reinvention by the child" (Piaget 1970c p.721).

Here Piaget is saying that wherever children live in the world, their stage of mental development is sequential and is successive in a systematic way, because all logical thinking must be constructive and the methods of the construction are analogues of the process of biological adaptation.

It is also clearly stated that construction of such thinking is not necessarily influenced by the surroundings and life experience of the thinker; but tne level of thinking can be retarded or accelerated by the educational and cultural environment. It is then that Piaget proposes a particular mode of thinking which has a direction i.e. objective thinking or objective knowledge.

Before proceeding any further, it is necessary to clarify whether Piaget's position includes the natural course of development of children or not. He stated,

"Mental growth is inseparable from physical growth:

the maturation of the nervous and endocrine systems, in particular, continues until the age of sixteen" (Piaget and Inhelder 1969, p.vii).

It is very obvious that Piaget includes in his theory the natural course of children's development, yet plays down contextual influences. His theory tried to be a full explanation of the process of children's mental development, starting from birth to sixteen years of age.

In Piagetian theory, there are dual ways of describing the influence of social context. It is, on the one hand, a trivial matter in the development of quality of cognition because in the construction of logical thinking, all that is needed is the process of adaptation, but not environment. On the other hand, it is a significant matter in the quantity of development because a certain level of logical thinking will be reached at different ages, depending on the social and cultural backgrounds of the children.

Piaget's view of the development of thinking is perfectly logical and consistent within its own set of assumptions. But when the theory is examined in relation to real life, the following curious omission is seen: Although Piaget's theory covers the natural course of the development, it does not mention intellectual performance in the daily activities of children. Piaget did not pay any attention to the possibility of "free" capacity of

development, which might not be systematically constructive but could be freely creative.

Having examined Piaget's theory, one can say that, theoretically, there is every reason for Piaget to maintain this constructivism of the development of objective thinking, since this particular view gives a logical explanation of the development ,at least, of objective knowledge or thinking. Piaget argues that this process is analogous to the common biological mechanism of assimilation and accommodation which can be found in non-human growth. This biological analogy of the organization of schemata has remained unchallenged due to the impossibility of testing the theory. The problem of testability of his theory is well described in the work of Brown and Desforges (1979) who argues that:

"Piaget is claiming that it is necessary to adopt a constructivist theory. But the presence of the processes and regulations at the core of this account has to be inferred from the behaviour they are used to explain. Hence, once again the account is untestable"(p90).

Others, also, criticize Piaget and they consider that Piaget's argument is inadequate in the explanation of the natural course of mental development. Cole and Bruner (1974) in their study of Culture and thought suggested cultural factors influence the way basic processes become organized into "functional systems" and showed how these are

applied in any given situation. Donaldson (1978) discussed the significance of "context" in the process of children's understanding of the object matter and she commented:

"Piaget insists that the course of intellectual development is independent of "human sense". When we test intellectual functioning with non-sense words or phrases both children and adults show great difficulty in their intellectual achievement. Therefore indeed intellectual operation can not be determined without human sense" (p.76).

Werner (1973) argued that cognitive development is more diverse than suggested by Piaget. He suggested that the logic of thinking in Western countries is only one of many possible varieties of the mental processes.

Matthew's (1980) criticism of Piaget's position in the field of child philosophy is well stated in the following words:

"There is another worry. Piaget proposes to validate his claims about developmental stages by finding the same patterns of response in all children. Such a finding is to be considered a guarantee that the thinking of children really does develop in this fashion. The unusual response is discounted as an unreliable indicator of the ways in which children think. But it is the deviant response that is most likely to be philosophically interesting. The standard response is, in general, an unthinking and un-thought-out product of socialization, whereas the nonconforming response is much more likely to be the fruit of honest reflection. Yet Piaget would have the nonconforming response discounted and eliminated on methodological grounds" (p38).

In a natural life situation, it is an obvious fact that children will not be engaged only in

objective thinking. Children cannot always be told what to think or what to know; they manifest their creative and exploratory action in their natural course of development. Children are often seen as questioners, and they are constantly searching for strategies to adjust to different situations.

Let us look at examples which demonstrate various modes of thinking found in task-solving situations.

Example-1

Suppose a child is learning to solve a mathematical multiplication task in a mathematics class: What is 15x5? The child first has to remember the rule that 5 times 5 equals 25. Then he has to remember the rule of carrying 2 to the 10's column, and finally he will come to the right answer. He has now acquired the knowledge to solve this mathematical calculation.

Indeed, as Piaget suggested, unless the child had a previous thinking system (schema), which contains knowledge of the multiplication rule and a memory of the five times tables, this problem cannot be solved. Having learned how to solve the above problem, the child will be gradually able to solve more complicated tasks such as, "What is 5125 x 51?"

The knowledge to be dealt with by the child was mathematical calculation and the strategy

needed was his memory which can be described as a previously constructed scheme. It appears that the child does not need to be in a particular social environment to remember mathematical rules. All that is required is perhaps his will to remember and his concentration on the task. In this case, therefore, environmental influence may be trivial. But the problem is whether this is generalizable to all learning situations. To proceed further in this enquiry , other examples will be taken from the results of the present investigation.

Example-2

A six-year-old girl is given a conservation of liquid task. There were equal amounts of orange juice in identical glasses , A and A-1. The orange juice from glass A was poured into a narrower glass B. The child was asked to decide if there was the same amount of orange juice in glassesB and A-1.

The child took the "pour back action" to get the answer (This was the usual response, either physical or mental, during the experiments.)

After taking such action, she compared the level of the juice in the two glasses. Having demonstrated agreement with her own perceptual judgement, she showed her knowledge that there was the same amount of juice in both glasses. In this case, the

knowledge involved was invariance of quantity, and the strategy utilized was "pouring back action" which was followed by "agreement".

In order for the child to solve this task, her idea of "pouring-back" action was needed. If the child cannot create that action, she may not solve the problem. Suppose the child knows the fact that she will get the answer if the juice is poured back, then she would already possess the idea of reversibility, which is the most important notion for the conservation answer. We then have to conclude that all the children who carried out the pouring action must be designated as conservers. But this action was taken by the child as a means of discovering the answer.

What was the existing schema which lead the child to think of a "pour-back" action? Unlike the previous case it is very difficult to determine which existing system she used. No specific scheme can be designated in describing her action besides the general knowledge and experience during the past five years of the child's life.

One way of interpreting this action is that the child just created the idea and put it to the test. The "pouring back action" is itself a

situation-specific action and can be ascribed to a positive influence of the situation as a whole.

There were two types of learning in the above cases: one is that which requires a formal procedure taught in school, and the other one is that which derived either from previous interactions with the environment or from this particular interaction. Such examples are readily observable in everday activities by children. Arguably, in order to create ideas one needs an environment, whether it is physical or intellectual environment.

Let us examine another example from our cross-cultural data. When conservation performance was assessed in a group of children in whose way of life an application of mathematical knowledge was entirely different from the Piagetian sample, context was found to have an even greater influence.

Example-3

Korean children (N=10) of five years of age, who come from a remote rural area, were given a standard Piagetian conservation task of substance. None of them solved the task successfully. The same children were taken to a beach where they usually play with sand, trees, shells and clay. These children were given conservation tests of substance which were equivalent to the Piagetian tests, but the method

of presentation was different (i.e., building clay houses of different size). In this new test, six out of ten of 5-year-olds were classified as conservers. Three out of these six conservers gave correct explanations either of reversibility or of identity; the others gave no reason. Thus six of the children who were unable to solve Piagetian tests were able to solve the same kind of problem when it was presented in a way which was familiar to them. The only changes in the task were the manner of presentation and the use of local material. Now the real problem arises in judging whether these six children are to be designated as conservers or non-conservers. It is reasonable to say that they were able to think logically when they were presented with tasks appropriate to them in terms of language and contextual familiarity, but they were unable to think logically when the tasks were presented in an unfamiliar form.

The contextual influence in thinking is not only shown by the rural children in the situation solving practical tasks but also by Westernized children in dealing with abstract tasks: The Korean children who were educated and lived in a Westernized city are equivalent to privileged British children in the success of their performance in the Piagetian and the Revised tests.

It seems reasonable to infer from these results that children's intellectual experiences in natural life substantially affect their performance in solving logical and mathematical problems. A similar line of argument is found in the work of Cole and Bruner (1971) who commented,

"Cultural differences in cognition reside more in the situations to which particular cognitive processes are applied than in the existence of a process in one cultural group and its absence in another" (p233).

On the basis of the evidence collected in the present investigation it seems crucial to include 'context' in any discussion of cognitive development. Context and construction seem to be complimentary ; each is necessary, but the degree of the influence will depend on the nature of the knowledge to be dealt with.

It is very clear from the cross-cultural evidence that the ability to demonstrate conservation could be strongly influenced by the children's physical and intellectual environment during, at least, five to nine years of their age. Therefore it casts doubt on the Piagetian assumption that the environment influences the rate of development only.

8.2. Cognitive level -vs- Cognitive modes

According to Piaget's developmental theory, children's mental development has to go through

stages. Each stage is very closely related to physical maturity and is characterised by a set of rules governing the stages. He firmly believed that mental capacity developes in accordance with the biological maturity of the body, which reaches its highest state at around sixteen years of age. He also believed that the developmental pattern is uniform. For Piaget, children have at birth nothing but motor functions without reasoning ability, and as they grow physically they gradually acquire reasoning capacity. He stated,

"The following theory of development, which is particularly concerned with the development of cognitive functions, is impossible to understand if one does not begin by analysing in detail the biological presuppositions from which it stems and the epistemological consequences in which it ends"(Piaget, 1970,p.703).

Certainly nobody will deny the sequence of the development of children's capability in dealing with logical or mathematical problems necessary for their existence. Let us examine this issue more closely. In Piaget's developmental theory, he indicated that 5-year-olds cannot think as logically as 9-year-olds can because they are supposed to belong to different stages of mental development, pre-operational and concrete-operational stages respectively.

For Piaget, reversibility is not possible for 5-year-olds, who belong to the pre-operational

stage, and he says,

"The most universal manner in which the initial logic of the child differs from our own (but with a lag between its manifestations in action and its manifestations in language) is undoubtedly its irreversibility due to the initial absence of decentration, hence its lack of conservation" (Piaget 1968 p.79).

In brief, Piaget suggested in his stage theory that each stage is characterised by a set of logico-mathematical rules which represent the qualitative aspect of growth. Movement from one stage to the next is gradual, according to age,which is the quantitative aspect.

Evidence from this study ,however, demonstrates that the children's ways of manipulating the conservation principle are diverse and complex and not altogether in accordance with Piaget's ideas.

Some children aged 5 and 6 achieved maximum scores (conservers) and gave logical explanations in solving the Piagetian tasks, whereas some children aged 8 and 9 years were non-conservers (in the same sample group). Such phenomena are found in several sample groups. Could this mean that some 5-year-olds were more capable than some 8-year-olds in dealing with this particular problem? The answer is 'Yes'. Indeed, although these children had been educated in the same school and grown up in a similar society, their ability to deal with certain conservation tasks varied from one individual to the other. Therefore in the findings

of the present study, the "individual differences" are marked and taken to explain the superior performance by some 5-year-olds in comparison with the inferior performance by some 8-year-olds in the same sample group. The possibility that some 5-year-olds have a better quality of cognition than some 8-year-olds has been omitted entirely by Piaget in his theory, since he ignored individual differences in the course of developing his theory. He said that he was concerned with "Mechanisms common to all subjects at a certain level, those of the 'average' subject" (Piaget 1971a. p69.). He also said that I have no interest whatsoever in the individual, I am very interested in general mechanism" (Dasen & Heron 1980).

Of course the children tested in the present study were not the same children, when compared at 5 and 8 years of age. Therefore the Piagetian assumption of sequential development ,to a certain extent, remains unchallenged. Individual differences, however, may not be very important in finding out the common mechanism of human thinking. However, individual differences are very important if the common mechanism is to be tested and to be utilized in educational practice. In a modern society where human activities are increasingly diverse, a general theory which allows a great deal of

exceptions may not be useful for practical purposes. It is emphasized here that individual difference in the performance level were salient and therefore must not be disregarded in the quantitative aspect of cognitive development.

According to Piaget, such differences are referred to as a "lag" which indicates the lagging level of children's understanding of the conservation principle, which is representative of scientific knowledge. Therefore, Piagetian methods of evaluating children's ability are such that the level of performance on standard tasks is equivalent to their quality of knowledge. In other words, children can fully manipulate their knowledge in a testing situation, and therefore the quality of knowledge can be correctly measured by testing them with representative tasks, such as conservation, seriation, etc. The same tasks can be used in any society or culture since the social and cultural environment affects only the quantitative or age-related aspects discussed earlier.

In brief, the quality of children's knowledge can be assessed by examining the level of performance on certain logico-mathematical tasks, and the quantitative differences between individuals are ascribed to "developmental lag".

Here a question arises,"What is the logic of

such Piagetian arguments that the level of performance in conservation tasks is equivalent to the quality of knowledge possessed by the subject?"

For Piaget, logico-mathmematical knowledge is the only valid form of knowledge. The nature of this knowledge is evolutionary. Therefore the process of knowledge is the same as is found in the evolution of a child's growth from birth to adulthood. In this way, the level of knowledge and the level of children's maturity are inseparable. It is also clear that Piaget's idea of qualitative differences between each stage is inseparable from his description of the quantitative aspects of growth because he believed that both mental and physical development could be maximized at the age of sixteen. Piaget's idea of evolutionary knowledge leads him to use tests representing only one form of knowledge, and so in nature Piagetian tests are all of the same kind. This uniformity accounts for the fact that the developmental sequence produced by those tests is even and gradual, and that Piaget came to describe such simple and straightforward sequentially progressive patterns for the quantity and quality of human cognition.

In the present enquiry, this Piagetian idea is challenged, particularly as regards the aspect of the method of evaluation, on the grounds outlined

in the following section.

8.3.1. Fairness of the "tests" in evaluating children's ability in thinking and learning.

The results of our experiments demonstrated that children's ability to comprehend the principle of conservation is so complex that the level of performance in one form of conservation test is not equivalent to the level obtained from another form of conservation test. The following results demonstrated it more clearly.

The British and Korean children in almost all samples and in each age group performed better in the Revised Test than in the Piagetian Test. These differences do, however, vary in terms of statistical significance, the general trend being that the younger age groups (5-7 years) performed much better in the Revised Test than in the Piagetian Test, whereas most older age groups (8 and 9 years) performed well in both tests. However, this general pattern is no longer valid for the Korean rural children since the trend is reversed. For some British children (in sample-7 and sample-8) the pattern is again slightly different from those two extremes.

It is also seen that for British 5-year-olds, in Sample-5 taking the Piagetian test, only two children were conservers, while nine children

became conservers in the Revised test. This means that seven children, who could not manipulate their understanding of the conservation principle in Piagetian terms, could in fact do so in the Revised test. How should we interpret the cause of the performance difference between the Piagetian and the Revised Test?

The tasks in the Revised tests were exactly the same as those in the Piagetian test, but the way of asking questions was different. The tasks were presented as a form of play, and the language used was very clear, so as to leave no alternatives.

Does this mean then that for any standard test, if language and methods of presentation are altered, the level of performance will be changed? The answer is by no means straightforward. But the important notion here is that if the outcome of the tests is to be clearly interpretable, the tasks should be designed to minimize any ambiguity in them, so that children can carry out the tasks without being confused by the wording.

There should be other ways to judge the appropriateness of the tasks. In the revision of the test , in this case, aspects of child language and contextual significance are specially considered because, in the Piagetian methods of asking questions, there is an obvious misleading element and also such ambiguity of the use of

language - as was pointed out by the children, while the Piagetian test was being administered. We could not, therefore, determine whether the outcome of the test was attributable to the children's level of cognitive development or to confusion over the task's requirements. Therefore an effort has been made to minimize linguistic ambiguity in the questions by employing the children's own ways of expressing and manipulating the tasks. As a result, almost all the children, both British and Korean, performed better in the Revised test than the Piagetian test.

It is clear from the results for the Westernized children, that the successful performance was affected, at least, by the more appropriate usage of child language and by the methods of presentation. Therefore, the actual problem for these children seems to be the matter of comprehending the question itself, rather then their having a lack of knowledge of conservation principles. It is then wrong to designate those who failed in the Piagetian tasks but succeeded in the Revised test as non-conservers. Accordingly it is unfair on the basis of the original test to decide whether they belong to the pre-operational stage or the concrete-operational stage. The performance of the Korean rural children in the Piagetian and the

Revised tests was significantly poorer in comparison to their city counterparts, and the effects of the Revised test were minimal especially for the younger age groups, which is the opposite to the other groups. In other words, the change of language and methods of presentation adapted in the Revised test were meaningful only for Westernized Koreans, but not for these rural children in a remote area. But was even the Revised test a fair test of conservation for these children? They understood the language of the questions, but were they familiar with the context within which they were expected to demonstrate conservation? There was sufficient doubt about this to justify the development of a new form of test in which conservation was presented in a more familiar context. In the New Test-A, the methods of presentation and the tasks were practical and a familar part of their daily experience. Consequently, their performance improved significantly in every age group. For example, 60% of 5-year-olds were conservers in the New Test-A while none of them was so in the Piagetian tests.

It may be worth noting the fact that standard textbooks published by the Korean Ministry of Education are used in every school in the country, so that theoretically the level of knowledge taught is expected to be similar whether children live in

the city or not. However, they have greatly different experiences in applying their learned knowledge in practice. Such differences seem to lead children to have a different knowledge content and modes of thinking in dealing with the same task.

Surely then their initial inability to solve Piagetian tasks is attributed not to a level of cognitive development, but to experience which is a product of their social and cultural environments.

This implies that the children were better able to manipulate their ability to think logically in relation to their daily activities.

It was also seen from the results of the performance in the Piagetian, Revised, and the New Test-A that the children's ability to solve conservation tasks varied greatly depending on the suitability of the test. This is greatly dependent on the contexts within which their knowledge are practiced.

Further evidence of such variation can be found in the performance by the British rural children. Among British groups, the least successful performers in the Piagetian test were those from a rural state-run school. Are they really inferior in logical thinking? Do we compare performances on the sandard Piagetian test, or an a

test designed to fit the children's previous experience?

Unlike the Korean situation, the British rural children are not remote from normal British life in terms of the provision of state education. It is therefore unnecessary to have practical tasks as it was in the Korean rural society. Instead it was decided to devise tasks which showed the principle of conservation in tasks of progressvely greater difficulty. Therefore, among three items in the New Test-B, the full notion of the conservation principle was introduced gradually in three stages. The performance of the British rural children was significantly improved and they can also explain the reasons for their answers logically.

It is ,therefore, wrong to interpret the results of young children around 5 years of age on the Piagetian tests to indicate that such children are not able to solve logical problems involving reversible operations. Under appropriate conditions, some 5 year-olds are capable of carrying out these type of thinking. A question can be raised here, "Did Piaget use "easier" tasks for younger children? The answer is 'No'. Piaget used the same tasks for different age groups because he believed that the level of successful performance is the yardstick to judge these children's knowledge of the conservation principle.

This means that Piaget measured the level of one form of knowledge (one mode of thinking), for example, conservation principle expressed in a mathematical form, among other forms of knowledge of conservation, and used this as the one indicator by which to judge children's conservation ability as a whole.

Surprisingly, many Piagetian researchers (Dasen, Seagrim and Lendon, de Lacey) used the same method: the same Piagetian tests were administered to the children in different age groups and even in vastly different cultures. Our evidence indicates that it is impossible to make comparisons on the basis of identical materials and methods of presentation between children of differing ages and cultural backgrounds and then aim to assess their ability to think logically. This is because the prerequisites to solve Piagetian conservation tasks involve both the ability to understand the lingustic form of questions, and the possession of a relevant knowledge of tasks given.

It is argued on the basis of the evidence obtained in this investigation that the ability to solve "abstract tasks" does not necessarily correspond to the ability to understand the knowledge concerned. This is the fundamental issue of difference between the present investigator and Piaget in judging children's

cognitive ability.

8.4. Children's Language

An aspect of the use of child language is also an issue emerging from this enquiry. The main subject is not the theory itself, but the fallacy found in Piaget's way of evaluating children's ability to reason in relation to verbal explanations.

Piaget's consideration of the relationship between language and thought is seen in the following quotation:

> "As language is only a particular form of the symbolic function and as the individual symbol is certainly simpler than the collective sign, it is permissible to conclude that thought precedes language and that language confines itself to profoundly transforming thought by helping it to attain its forms of equilibrium by means of a more advanced schematization and a more mobile abstraction."(Piaget, 1968,pp91-92)

The problem here is that Piaget, although having the view that "thought precedes language" did not put his belief into practice. When Piaget carried out experiments with children he did not provide the children with tasks with which he could have discerned their language proficiency and reasoning ability. He used only the "clinical method"(using spoken language in a formal manner). As a result Piaget came to under-estimate young children's ability to think logically.

Donaldson (1978) observed children's usage of language in the course of solving cognitive tasks and found that children do not always answer the question which is asked; thus she suggests,

"...in any event the question the children were answering were frequently not the questions the experimenter had asked. The children's interpretation did not correspond to the experimenter's intention; nor could they be regarded as normal, given the rules of the language. The children did not know what the experimenter meant;and one is tempted to say they did not strictly appear to know what the language meant"(p49).

The findings of the present experimenter support the above argument more conclusively; a sustantial number of children (approximately 37%-50%) of five to nine years of age do not or cannot express their logical thinking in a logical form of speaking when asked for explanations of their answers (See Chapter 7 for the details). It is also seen that the performance of almost all children in the experiment is affected by different verbal presentation i.e., the children tested performed significantly better in the Revised test than the Piagetian test.

It is therefore wrong to say that young children could not or do not have the ability to reason when they produce illogical answers and explanations, since the children's ability to think logically is expressed in several ways including illogical forms of language. Such diverse forms of

children's logical thinking were not adequately taken into account by Piaget. While he recognized that children's thinking is different from that of adults, he did not realize the difficulty children had in understanding and using acceptable linguistic expressions.

It is suggested here that that the actual ways in which children express their judgement in relation to conservation problems are often not congruent with those of adults and therefore liable to be misinterpreted.

8.5. An implication of the findings in educational practice and suggestions for further research.

Piaget generalized not only the modes and process of cognitive growth, but also the nature of valid knowledge itself. His conservation test is a typical example. In order to discern whether a child has reached a certain mental state, that child must be able to solve certain problems. The problems are not taken from the child's activities or from situation specific contexts, but are constructed with respect to certain logical and mathematical laws. Because of this origin Piaget suggested that the procedures and material for assessing children's intellectual ability can be universal and accordingly similar test tasks can be valid to assess children's cognitive ability

whether they are Eskimos, Aboriginals, Koreans or British.

On the contrary, the findings of the present investigation demonstrate that young children's reasoning ability cannot be measured fairly by means of a standard test and the "clinical method" used by Piaget. Firstly, due to the fact that there is an apparent mismatch between language and thought, and secondly due to the influence of the educational, social and cultural backgrounds in which children have had different conceptual experience. This means that children's performance in "strange" logical and mathematical tasks is not a reliable yardstick of their ability to carry out logical thinking. This was most clearly seen in the results of the rural Korean children who performed very poorly in the Piagetian test, but whose scoring dramatically improved when tests more familiar them. These results bear a close resemblance to the findings of Cole et. al.,(1971) in that the successful performance on tasks requiring logical thinking is closely related to the subject's familiarity with the subject matter.

It is also noted here that it is not easy to construct tasks embodying logical properties which are appropriate for young children who have a limited knowledge and language. The New Test is no

exception to this. It is affected by such difficulties which limit its use. However, the importance is the methodology suggested in the present investigation and the New Test is an example of it.

It is suggested that the role of context is very important in evaluating children's ability to think logically in any society. In the case of remote rural areas in Korea, children were inferior in logical thinking only when that thinking was demanded on tasks which were entirely unfamiliar to them. Therefore when assessing children's cognitive ability in any cross-cultural study, it is desirable to have tasks which assess thinking as part of their daily application of the knowledge as well as abstract tasks.

Further research is required to look into such problems in depth and to construct appropriate tasks for young children from various cultural groups in the hope of assessing their cognitive ability more fairly.

8. 6. Concluding remarks.

The following conclusions have been drawn from the evidence discussed earlier.

Firstly, in expressing their thoughts and reasoning, the way in which children use language in differing ethnic or age groups is not seriously

taken into account in Piaget's theory of human cognition.

The second main conclusion is that the level of cognitive performance on a certain tasks seems to mean very little when there are extremes of difference in the social and educational backgrounds of the children being tested. It may thus be impossible to make valid judgements concerning the children's cognitive ability by administering the Piagetian tasks if the children in one group are familiar with that kind of task and the others are much less familiar with them. In the Piagetian interpretation, the latter children have to be considered as having failed the conservation tasks. But they were required to coordinate concepts strange to them. The results of the present study indicate that the failure to coordinate strange concepts is not necessarily the result of cognitive inability, since most of the children tested can think logically in solving conservation tasks appropriate to their own social and intellectual contexts. These failures in Piagetian tests must thus be ascribed to differences in experience, rather than to lower level of cognitive development.

This thesis has demonstrated how the levels of cognitive development attributed to children is a

function of the content and the presentation of the tasks. It thus throws doubt on cross-cultural studies which have used only the standard Piagetian tasks in determining levels of cognitive development. The interpretation of non-standard tasks is, of course, more difficult, as a judgement of the appropriateness of a task cannot be objective. But to a back on a common task which does not have a common meaning is no answer. A more sophisticated approach which acknowledges contextual influences is essential.

Piaget failed to provide an fully adequate description of young children's ability to think logically by not taking full account of the nature of child language, by generalizing children's cognitive ability without even carrying out experiments with children from vastly different social and cultural backgrounds, and by using similar tasks and procedures regardless of the difference in children's ages.

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