A CROSS-CULTURAL STUDY OF THOUGHT PROCESSES AS MEASURED BY PIAGET'S TESTS OF CONSERVATION OF QUANTITY

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ABSTRACT OF THESIS

This study evaluated intelligence by measuring the level of thought processes of children aged approximately seven years, using tasks based on Piaget's developmental theory of intelligence. A comparison was based on knowledge of the conservation concept of quantity using Piaget type problems with continuous and discontinuous materials. This involved a Canadian Indian sample, a Jamaican sample, an Urban Canadian sample without kindergarten experience, and an Urban Canadian sample with kindergarten experience. In addition, the effects of teaching these concepts in two brief training sessions was assessed for all but the Jamaican sample.

It was suggested that a judgment based on level of thought was a more equitable test for cross-cultural purposes. These tests also provide information as to 'how' a child thinks, and therefore serve as a guide to education.

The prediction that subjects coming from an enriched environment would score higher on these tests was upheld, as the children with kindergarten experience or longer attendance at school had significantly more knowledge of the concept of conservation of quantity. However, the hypothesis that subjects from a less conceptually oriented culture would benefit more from the training sessions had to be rejected. The results showed that both city groups benefited significantly more than the Canadian Indian group. It was proposed that the type of training should be altered for the Canadian Indian sample.

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CHAPTER I

INTRODUCTION

The purpose of this study is to evaluate and compare the level of thought of children around the age of seven years who have been raised in different cultures. Intelligence will be evaluated herein by measuring the level of thought processes based on Piaget's developmental theory of intelligence.

Tests in current use are based on thought content. The Stanford-Binet Test and the Wechsler Scales are considered today to be synonymous with intelligence. In these tests, the subject is presented with a wide variety of tasks in the expectation that a sampling of all important intellectual functions will be represented (Anastasi, 1961). The Stanford-Binet is well-designed, standardized, and yields a single score derived from a battery of sub-tests. Each item correlates with the total score, thus indicating a common factor of general ability, which is, however, not defined. The Wechsler Scales are also efficiently designed and cover a wide range of tasks. This test produces a composite I.Q. score as well as separate scores for the verbal scale and performance scale. This test provides useful scores, but is based on no clear theory of intelligence. In addition to lack of theoretical justification, these tests are very vulnerable to cultural influence, type of environment, and experience of the subject (Eels & Davis, 1951). They have not shown themselves to be particularly useful when used in cultures differing from ours (MacArthur, 1964).

Piaget's work on intelligence is based on a theory of mental maturation. His concept of developmental stages of thought brings a fresh approach to this subject. He states that the sequence of stages is universal and that all children pass through these stages in the same order. The effect of culture is exhibited only by the chronological age at which these stages appear and therefore tests based on his theory are nearer the culture-free pole. Piaget tests indicate the present level of cognitive development of the child. Their value lies in revealing the type of learning for which the child is ready. It is in assessing this readiness, that the chief value of Piaget Tests have for cross-cultural testing.

Piaget was an original worker in this field, and used the clinical method by choice. The significance of his work rests in the detailed observations of children, from which he derived a wealth of hypotheses. He has perhaps been too sure of his hypotheses without first testing them more rigorously. In other, more recent, studies Piaget Tests have been used for psychometric purposes, and standardized procedures have been instituted. The child has been interrogated only to ascertain the reasons for his answer.

Piaget's study on intellectual processes has led him to conclude that at around seven years of age, the average child reaches a stage of development marked by the ability to use certain logical operations in his thinking. These logical operations have become independent of perception. One of the most outstanding features of this transition is the acquisition of the principle of conservation. This is the principle that a given amount of matter remains constant despite transformations. These stages range from no conservation, to on-and-off-conservation, to certain conservation.

Quantity is the first property to be conserved and appears earlier than weight or volume (Piaget & Inhelder, 1947; Inhelder, 1962). Conservation of weight and volume always implies conservation of quantity. Each typifies a level of genetic development in logical construction. The age at which a level of intellectual functioning appears is relative to the environment which can encourage or impede growth. The influence of the environment provides opportunities for learning, social interchange and motivation, all of which contribute to the level of development.

In this study comparison of thought level of the children will be assessed according to their understanding of the concept of conservation of quantity.

Developmental Approaches to Intelligence

The limitations of the meaning of the term intelligence, combined with the consequent difficulties of measurement and prediction, have caused some psychologists to explore a developmental approach to this problem. Their efforts to this point have been largely in the area of theoretical formulation. Research indicates that long term prediction depends not only on the child's present state, but on what environmental circumstances he will encounter in the future. Development of intelligence is dependent not only on heredity but on interaction of the organism with his environment. Longitudinal studies (Bayley, 1949; Honzik, 1948) show substantial gains and losses in test scores due to variation in experience. Studies of identical twins reared apart show variation in I.Q.'s which has to be attributed to environment (Newman et al., 1937). It seems evident from these studies that intellectual content will vary, depending on the life experiences of the individual.

Cattell (1965) in his theory of intellectual development has stated that the element of general ability contains two factors. He has named them fluid and crystallized general ability. He refers to fluid ability as "some sort of mental capacity or energy" (Cattell, 1965, p. 303), which correlates with many tasks. It reaches its highest growth when the brain achieves maturity, which is about fifteen years of age. This he conceives to be the innate intelligence of the individual. Crystallized ability is a collection of "skilled judgments a person has acquired by applying his fluid intelligence to his school opportunities" (Cattell, 1965, p. 304). These abilities represent knowledge based on learning. Crystallized ability can continue to grow in a stimulating environment, but fluid ability could be reduced by age or brain injury.

Hebb's (1949) theory synthesized neurophysiology with behavior knowledge to form the central processes. This presumably accounts for intelligence, and accentuates the role of environment. His developmental theory of intelligence stresses that the level of intelligence obtained by an individual is dependent on the interaction of heredity and environment. A nutritive environment which provides generalized experience is necessary to normal intellectual growth.

Hebb distinguishes two related ways in which intelligence is used at present. Intelligence (A) is the innate quality of brain function separate from any experience or knowledge gained by the individual. Intelligence (B) is the present level of proficiency in intellectual functioning. (A) and (B) are not two different things, because (A) is a necessary part of (B). Present intelligence tests can only measure the level of Intelligence (B), the individual's effective developed intelligence.

Hebb's theory has not been put to practical use, but Cattell has constructed a series of Culture Free Intelligence Scales to measure fluid ability. He has tried to eliminate all cultural influences by using culture-free items such as geometric figures. His tests have been successful in cultures similar to ours, but otherwise cultural effects are evident

(Anastasi, 1961).

Piaget and Inhelder (1947) criticize the current intelligence tests because although they measure efficiency, they give no clue as to the psychological operations involved. From the results of the present I.Q. scores it is impossible to determine the existing mental operation or level of cognitive development. They suggest that:

> "...instead of assigning levels and I.Q.'s with an astonishing mathematical precision to a psychological action (which is perhaps not irreducible to any quantitative measure) [could we not] attain that end in a more direct way by qualitative and genetic analysis of its operations"
>
> (Piaget & Inhelder, 1947, p. 402)

Piaget's conception of intelligence has much in common with Hebb as they are both fundamentally developmental and both stress organism-environment interaction. Hebb stresses perceptual experience, while Piaget claims it is motor behavior that structures the central processes. Piaget's work has been centered on discovering the invariant and basic properties in the functioning of cognition, as well as on the kinds of organization and their relations at different levels of development. His theory states that intellectual operations are acquired by active interplay between the organism and the environment. Variations in growth of intelligence are due to many factors, such as inborn structures, previous experience, and the prevailing culture.

Piaget claims that intelligence has its origin in infantile motor action, whereby the innate reflexes which are present at birth, such as sucking and grasping, give rise to more complex forms called reflex schemas by virtue of active contact with the environment. Schemas are tightly related action sequences, implying a specific cognitive structure. They are labelled by the behavior sequences to which they refer, as for example, the sucking schema. These schemas continue to be modified and coordinated by further interaction which accounts for alteration in perception in the course of learning. Berlyne (1965) equates coordination of schemas with habit family hierarchies. These hierarchies may be a sequence of responses forming a behavior chain to reach a goal that cannot be reached by a single response, or they may imply equivalence of a number of responses which can be used to attain the same goal.

The fundamental and invariant characteristics of intellectual functioning are organization and adaptation. Adaptation is further subdivided into assimilation, explained as a basic tendency of the organism to embody substances and stimulations; and accommodation, the process whereby the schema changes to better conform to the assimilated reality. These invariant characteristics of intelligence are the very same characteristics which hold for biological functioning. They supply the continuity between biology in general and intelligence in particular. Intellectual functioning is, therefore, seen by Piaget as a highly developed extension of more primitive activities.

> "...we can say that behavior becomes more 'intelligent' as the pathways between the subject and the objects on which it acts cease to be simple and become progressively more complex... . Thus from the point of view of the structural mechanism, elementary sensorimotor adaptations are both rigid and unidirectional, while intelligence tends towards reversible motility...which is the essential property."
> (Piaget, 1950, p. 10)

Inhelder (1962) regards the concept of reversibility as one of the most important properties of thought operations in the concrete and formal operational phases.

Growth and development of cognition is due to the process of building new structures on foundations provided by earlier ones. This is accomplished through assimilation and accommodation providing there is continuous interaction with the environment. The greater variety of situations to which the child must accommodate, the more differentiated become the schemas, and the more rapid is his rate of intellectual development.

Piaget divided intellectual development into four periods with each period divided into different stages. The first is the sensorimotor period which consists of six stages. This carries the child from reflexes to behavior patterns and lasts until the child is two years of age. From the sensorimotor period the child passes to the Preoperational Stage in which he remains until he is around seven years of age. The child has now developed the cognitive power to produce a mental image, and has also begun learning language. At the beginning of this period he is not able to classify objects, but this preconceptual stage is succeeded by an intuitive period where some kinds of thinking are involved. In problem solving the child can only account for one factor at a time. For example, when he observes water being poured from a thin, glass to a wide glass, he only notices one factor; either the changed level of the water, or the changed width of the glass. When the child learns to relate more than one factor at a time he enters the Concrete Operational Stage. This period lasts from seven to eleven years of age. The child is now able to reason, but only when the concrete objects are present. For instance, a child could correctly use the concept of relative length if the different sized sticks were placed before him. Formal Operations which begin at approximately eleven years of age characterize the fourth and final period, and deals with the individual's ability of solving problems symbolically. Cognitive processes have now been freed from perception. Problems can be solved that deal with several factors simultaneously. Thought is no longer confined to what is real and hypotheses can now be considered which may or may not be true.

Piaget's initial premise of the linking of intelligence to biology plus his consistent espousal of the necessity of organism-environment interaction gives continuity to his stage theory. He conceives of intelligence as a hierarchical organization. Each stage of intelligence becomes incorporated and integrated into the stage following. A first response of a child to a situation is a schemata that is already present from past assimilation. Variations in the environment force the child to grapple with this variation, thus modifying the schemata to form a different structure. Development consists of continuous transformations in the thought structures. For example, cognitive operations have to be performed on concrete objects before the concrete operations evolve into formal operational thought.

Hunt (1961) has derived five hypothetical principles from Piaget's scheme of organism-environment interaction. The first principle stresses the importance of exercising initial reflexes in the environment. By processes of assimilation and accommodation pronounced changes occur whereby the schemata become coordinated and enlarged. For example, the sucking schema not only enlarges to include more suckable objects but also becomes interrelated with other schemas involving visual and motor activities. Stimuli that evoke the schemata are referred to as "aliments" by Piaget.

> "In other words, the child does not only suck in order to eat but also to elude hunger, to prolong the excitation of the meal, etc., and lastly he sucks for the sake of sucking. It is in this sense that the object incorporated into the sucking schema is actually assimilated to the activity of this schema. The object sucked is to be conceived, not as nourishment for the organism in general, but, so to speak, as aliment for the very activity of sucking, according to its various forms."
>
> (Piaget, 1952, p. 35)

The above quotation also ties in with the second principle which states that new accommodations and assimilations to schemata provide pleasure, and the child therefore repeats actions in practice play.

The third principle declares that as the rate of development is due in substantial part to environmental circumstances, it follows that the greater the variety of situations, the more differentiated the behavioral circumstances become.

The fourth principle emphasizes the match between the schemata within the organism and the external circumstances of the environment. Discrepancies which are too large and beyond the limits of an organism's capacity evokes avoidance, but any discrepancy within the organism's capacity for accommodation arouses interest and curiosity (Berlyne, 1960).

The fifth and final principle concerns the internalization of actions. By a hierarchical process the organism finally achieves autonomous thought.

Equilibrium and disquilibrium constitute Piaget's theory of motivation. The organism will continue to react with an object until assimilation and accommodation are in equilibrium. Disequilibrium occurs when two schemata have not as yet been accommodated and assimilated. The organism will persist until integration has occurred, and a larger structure has been formed. This striving is considered to be an innate property comparable to the tendency toward equilibrium in the physical systems. He sees the whole of ontogenetic development as a series of differing equilibrium states.

The equilibrium model of learning advocated by Piaget (1952) specifically includes internal reorganizations, whereby the organism, by a process of assimilations and accommodations, relates the new content to previous acquisitions. Smedslund (1961a, 1961b) has furnished evidence that changes due to conceptual conflict are responsible for the acquisition of the conservation concept. He showed children two identical balls of plasticene.

One ball was then altered in shape and the child was asked whether the balls still weighed the same. He attempted to teach them the conservation concept by giving one group practice with additions and subtractions. With another group he used an external verification method by exposure to repeated weighings of the balls. Smedslund then introduced situations producing conflict. He elongated one ball causing the ball to look heavier. He then broke off a piece from it which made it look lighter because part of it had been removed. A conflict, he assumed, was thus set up between the tendency to judge the sausage-shape heavier because of its greater length, and the tendency to judge the sausage-shape lighter because a piece had been removed. Much greater success in learning conservation was achieved using this method than other treatments, and Smedslund concluded that acquisition of conservation was based on cognitive conflicts and internal equilibration.

Experiments based on Piaget's Formulations

Piaget refers to his experimental technique as 'the clinical method', which is not a standardized procedure but a kind of informal exploration where the experimenter uses all his skill to understand what the child says or does. This method best suited him, but it has been one of the main criticisms levelled at his work. Although he has made extremely important contributions and opened up new avenues of research, his work has not been reported in a scientifically acceptable manner. Inhelder (1962) admits that these procedures do not lend themselves to statistical treatment. Piaget had devised innumerable tests aimed at establishing the level of cognitive maturation. Inhelder has now undertaken some standardization research in collaboration with Bang, and has largely confirmed the succession of stages which had been established by the clinical method.

It has been established that the principle of constancy or conservation is applied to the quantity of matter earlier than weight or volume (Piaget & Inhelder, 1947; Inhelder, 1962). This sequence has also been validated by Lovell and Ogilvie (1960) as well as by others. Investigations on the validity of the stage sequence have been performed by Lunzer (1960) and Kofsky (1966) among others. These studies have generally confirmed the theoretical formulations of Piaget. Ferguson (1965) lists fifty investigations done from 1960 to 1964 that are either based on or related to ideas of Piaget. Results of the major premises were largely as Piaget had indicated, but certain small variations in pattern of development were noted in their samples.

Estes (1956) in investigating the conservation of number, however, appears to be the only one who reported failure to confirm Piaget's views. This study has also been criticized in turn by Flavell (1963). He felt that the report of the procedure and results was too brief; that the tasks used were not drawn from Piaget's original work on number, but from a short popular account of this work; that she even varied from this account in presentation of tasks.

Cross-Cultural Studies

The effect of culture in Piaget tests is exhibited by the chronological age at which the stages appear, but they are culturally fair in that the sequence of progressions is universal. This phenomena was demonstrated by Hyde (unpublished Ph.D. Thesis, 1959, in Lunzer, 1960) who administered a large battery of Piaget's number and quantity tasks to European, Arab, Indian, and Somali schoolchildren aged six to eight years. Developmental changes in responses were largely as Piaget had predicted, with the European subjects performing at a higher genetic level.

Goodnow (1962) in a replication study administered Piaget tasks of space, weight, and volume in Hong Kong to European and Chinese children aged eleven years, with varying amounts of schooling. Her results showed real similarity in performance among her groups. Schooling did not seem to affect the results measurably, with culture influence at a minimum. Her findings substantiate the universality of thought processes, although some tasks appear to display greater variation than others from culture to culture.

Vernon (1965, 1966) found results varied with different items in the Piaget battery which he administered to samples of ten year old English, Eskimo, Canadian Indian, and Jamaican children. On the average the English scored higher than the other groups, although performance varied widely on different tasks; depending on specific environmental experiences in each culture, not just on the "degree of acculturation." Vernon was also very concerned about the socio-economic conditions such as cultural level, type of homelife, encouragement of initiative, structural characteristics of the mother tongue, as well as opportunity of experience in the environment.

In this study an attempt will be made to control for the variable of active experience by instituting a transfer of training procedure. Schmidt (1960) compared the intelligence test performance of White, Indian, and Zulu children in Natal, and found that the Zulu children with an inferior education profited the most from a training procedure. Laroche (1959) noted similar gains were made by Katangese children when he used a test-retest method. In some cultures this training procedure may be the first opportunity for the children to acquaint themselves with the testing objects and participate in this type of situation, and it would be expected that they would benefit from this method.

A study by MacArthur (1962) on Metis pupils of low socio-economic status showed that tests exhibiting the least bias and the highest loading on general intellectual ability were the Standard and Colored Progressive Matrices, Cattell test of 'g' Scale 2, and the Safran Culture-Reduced Intelligence tests. He attributed these results to two factors. Firstly, these tests are "miniature learning situations, samples of learning-on-the-spot, using simple symbols not very dependent on particular previous learnings." Secondly, they employ simple concept formation learning with the ability to use this learning in new situations. He urged that further research should be focused on the developmental psychology of Piaget with its emphasis on concept formation, and on the transfer theory of Ferguson.

The Canadian Indian sample used in this experiment and MacArthur's Metis sample are comparable and, therefore, the present study was designed according to the above plan. A comparison will be based on knowledge of the conservation concept of quantity using Piaget type problems with continuous and discontinuous materials. A training period will also ensure that the tasks have been understood by each child as this variable is very important in cross-cultural testing.

Smedslund (1961c) points up the difficulty of teaching these concepts in a training situation. All of his subjects who had acquired the conservation concept of quantity in his training procedure extinguished very easily, whereas of the subjects who knew the concept initially, six out of thirteen subjects resisted extinction. However, it must be kept in mind that his subjects were all taken from the same environment where there was equal opportunity for learning these concepts. Children raised in other cultures may never have had access to this necessary experience, but when exposed to this information, it may be found that their maturation level may be sufficiently advanced for comprehension. Cryns' (1962) study bears out this premise.

It is, therefore, hypothesized that children coming from an enriched environment will score higher on the first test. It is also hypothesized that those children who come from a less conceptually oriented culture will profit more from a transfer of training procedure than will those children coming from our culture.

CHAPTER II

METHOD

Subjects

Subjects consisted of 67 Canadian Indian children attending school on the Peguis Indian Reserve, Manitoba; 41 children who were attending public school in Montego Bay, Jamaica, W.I.; 60 children attending Britannia School in St. James, Manitoba who did not have kindergarten experience; and 58 children from the same school who had attended kindergarten for some period of time before entering public school.

These children ranged in age from six to eight years. An effort was made to match the samples exactly according to age in months, but this proved to be unsuccessful, because of sample selection. However, a chi square performed on the results of testing according to ages was not significant.

The Blishen Index (1961) was used as a basis of comparing the samples socio-economically. This Canadian Index classifies occupations into seven classes mainly according to income and years of schooling. Blishen's figures indicate that approximately seventy percent of the Canadian Indian and Eskimo population are in the lowest category, Class Seven. The Peguis reserve appears to fall mainly into this class. The St. James' samples, as indicated by the father's occupation, are mostly in Class Five and Six of the Index. It appears that practically all the subjects, with very few exceptions, thus belong to the three lowest categories of the Canadian economy.

Due to the time factor and other exigencies it was not possible to complete the whole testing program on the sample of children from Jamaica. The only test that was completed with these children was the first test and, therefore, the only comparison that could be made with the other samples was on initial knowledge of conservation. In addition, a within sample comparison was computed as a function of the number of years of schooling. Fifteen of these children had attended school for two and a half years while the other twenty-six children had been in school for one and a half years. Socio-economic level of these children was estimated by the principal of the school to be low, but not in the lowest category of the town.

Materials

Three problems devised by Piaget and Inhelder (1941) for testing knowledge of conservation of quantity were used for Test I and Test II.

The first problem involved the placing of the same number of marbles or beads in two different sized and shaped jars, a long jar and a wide jar. The issue is whether the subject continued to believe that there were the same number of marbles or beads in each jar although the levels were now not the same.

In the second problem, two identical balls of plasticene were used. After the balls had been altered in shape the subject was required to judge whether the quantity of plasticene was still equal. Three variations were shown to the subject.

The third problem was initiated by using two glasses, exactly alike, and which contained the same amount of colored water. The levels of the water were varied three times by pouring this water into other containers of different shape and size. After each variation the subject was asked the question whether he believed that there was still the same quantity of water as in the unaltered glass.

These same problems were somewhat altered in Test II in order to prevent memorization. Details of both tests are provided in Appendix A.

Materials used for training consisted of real and familiar substances which were brought to the classroom for the children to actively manipulate and interact with in accordance with Piaget's assimilation-accommodation model. The assumption for this training procedure was that change cannot proceed without the proper stimulation from the milieu, provided, of course, the child is in some sense ready when something comes his way. Efforts were directed at understanding the terms more, less, the same, fewer, equal, and different. No direct answers to the problems were given at any time to prevent rote learning. Details of training periods are given in Appendix B.

Procedure

Each sample was treated separately with identical procedures administered to each by a single examiner.

All subjects were given Test I individually. All tasks were introduced to the subjects as games. Those children attaining a perfect score were named Initial Conservers and were eliminated from further participation. The remaining children were divided into two matched groups on the basis of their scores. Group 1 received two training periods. This training was conducted on a group basis with each group comprising approximately fifteen members. Group II did not receive training and controlled for any improvement from test to retest as this in itself could be a training experience.

All subjects, with the exception of the Initial Conservers, were then individually administered Test II.

Scoring

One point was given for a correct answer to each subtest. A perfect score totalled seven points.

Experimental Design

TABLE 1

Experimental Design Administered to Each Sample

Test 1 administered to all subjects - Initial Conservers identified		
Group I	Training Period	Test II
Group II	- - -	Test II

A four group design employing the Canadian Indian sample, the Jamaican sample, the Urban Canadian sample without kindergarten experience was used to compare scores on the first test as a measure of initial conservation knowledge.

The results of training were assessed by comparing the difference scores between Test I and Test II of the Canadian Indian sample and the two Urban Canadian groups. The training period for the Jamaican sample was unfortunately not completed and, therefore, could not be included in this comparison.

The third analysis was a comparison within the Jamaican sample based on the results of the first test as a function of the number of years of school attendance.

CHAPTER III

RESULTS

Before analyzing the data testing the hypotheses, it was necessary to ascertain whether the variations in age, due to sampling difficulties, affected the findings. The data are illustrated in Table 2 and Figure 1.

TABLE 2

Frequency of Initial Conservers as a Function of Age

Age of Subjects	Initial Conservers	Non Conservers	Total
Over 7 years: 3 months	10	48	58
From 6 years: 8 months to 7 years: 2 months	10	94	104
From 6 years to 6 years: 7 months	6	58	64
	26	200	226

Chi-square = 1.845; $p > .05$.

A chi-square, was computed which compared Initial Conservers as a function of age. In addition, an analysis of variance (Table 3) of the difference scores resulting from the training program was performed in order to investigate the effect of the differences among the subjects on learning. Both results were not significant.

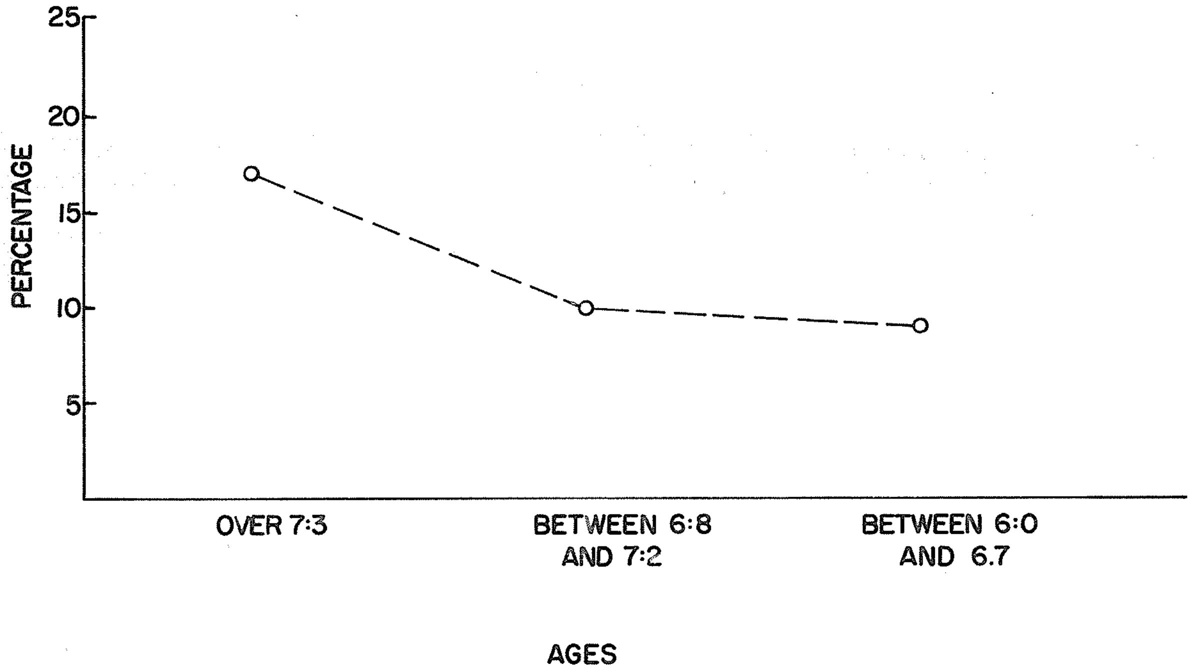

FIGURE I. Percentage of Initial Conservers as a Function of Age

TABLE 3

Summary of Analysis of Variance on Difference Scores

Due to Training as a Function of Age

Source	df	ms	F
Between	2	4.15	.95 N.S.
Within	76	4.34	

Figure 2 which illustrates the results of learning as a function of age shows even a converse trend, indicating that the older children were not as advanced as the younger children. This could be attributed to the fact that the older group contained proportionately more Indian children.

Two analyses were performed to test the hypothesis that children from an enriched environment would score higher on a test of conservation knowledge. The chi-square analysis in Table 4, illustrated in Figure 3, indicated no difference between the cultures in regard to the initial conservers in each sample. Not many subjects knew this concept. Only 11.9% of the total sample were positive that no matter how the quantity of substance was manipulated, there was still the same amount. However, when total conservation scores from Test I for each subject in each sample was compared by an analysis of variance (Table 5) significant differences appeared. The results are illustrated in Figure 4. Application of Duncan's Range Test (Table 6) revealed that the Urban Canadian sample with kindergarten experience and the Jamaican sample were the highest groups, and had significantly more conservation knowledge than the Canadian Indian group. The

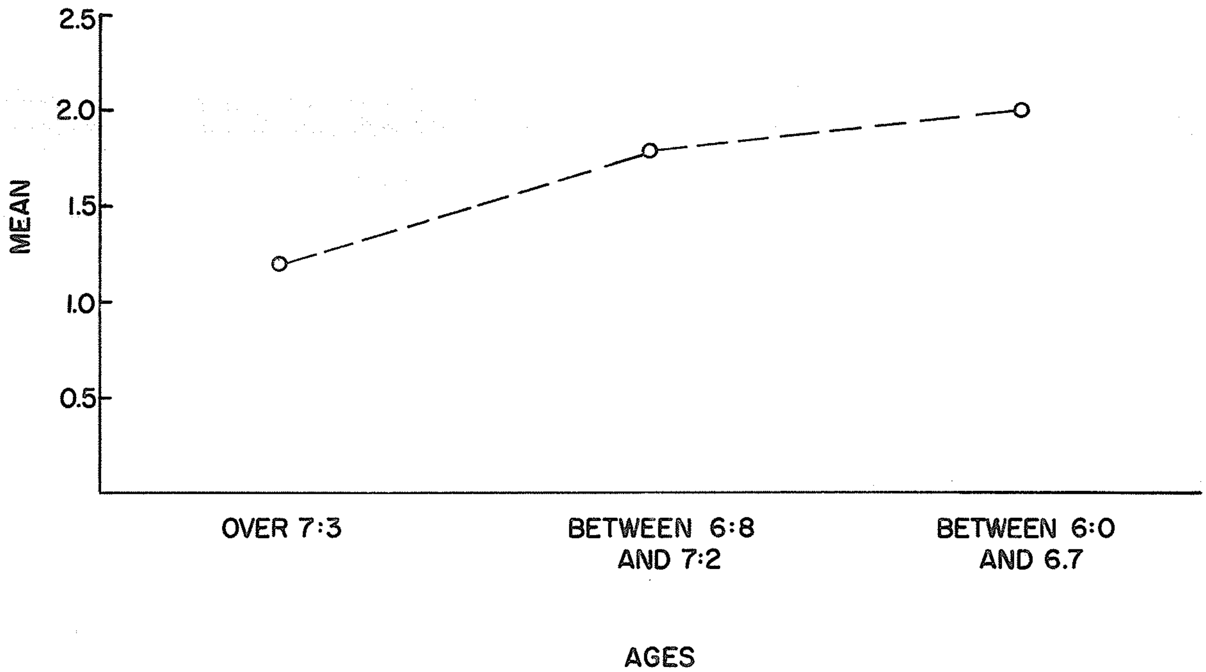

FIGURE 2. Mean of Difference Scores Due to Training as a Function of Age

TABLE 4

Frequency of Initial Conservers from Each Sample

Group	Initial Conservers	Non Conservers	Total
Canadian Indian	4	63	67
Urban Canadian	10	50	60
Urban Canadian with kindergarten experience	9	49	58
Jamaican	3	38	41
	26	200	226

Chi-square = 4.67; $p > .05$.

Urban Canadian sample without kindergarten experience was not significantly different from the Canadian Indian group or the two high groups. The kindergarten experience was the significant factor in differentiating between the Indian culture and Urban Canadian. The superiority of the Jamaican sample can also be attributed to the schooling factor as 15 of these children had attended school for two and a half years, while the other 26 children had attended school for one and a half years. The sample of Urban Canadian children without kindergarten experience had only been

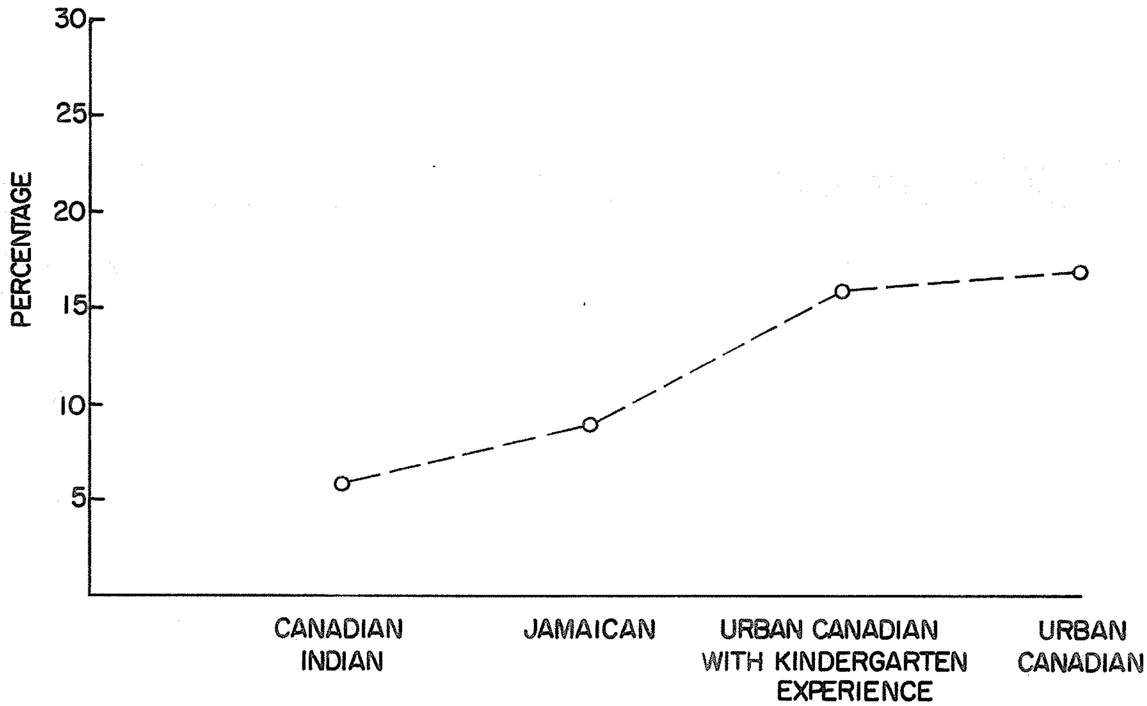

FIGURE 3. Percentage of Initial Conservers in each Sample

TABLE 5

Summary of Analysis of Variance on Total Conservation Scores Between Canadian Indian, Urban Canadian, Urban Canadian With Kindergarten Experience and Jamaican Sample

Source	df	ms	F
Between Groups	3	19.63	3.21*
Within Groups	222	6.09	

* $p < .05$.

TABLE 6

Duncan's Range Test on Total Conservation Scores

Mean	Can. Indian	Urban Can.	Urban Can. with Kindergarten Experience	Jamaican
	1.3	1.9	2.5	2.5

at school for about six months. Therefore, the first hypothesis which stated that children coming from an enriched environment will score higher on a first test of conservation was confirmed.

The following analyses were concerned with the second hypothesis which stated that children from a less conceptually oriented culture would profit more from a transfer of training procedure than will children from

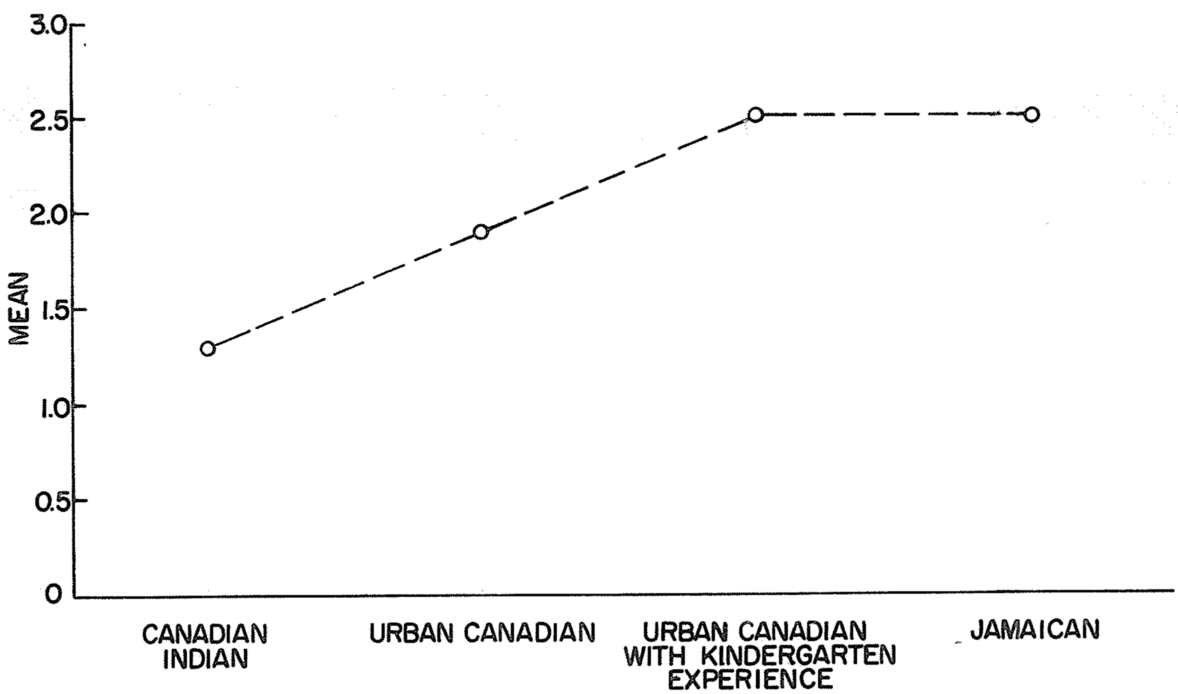

FIGURE 4. Mean Conservation Scores of Canadian Indian, Urban Canadian, Urban Canadian with Kindergarten Experience and Jamaican Samples

our culture. Initially, it was necessary to determine whether the training program had a significant effect when compared to the groups that did not have training. Accordingly a 2 x 3 analysis of variance was performed on the difference scores between Test I and Test II of all the groups. However, as there were not the same number of subjects in each group, a harmonic mean correction for the mean squares was applied and an estimate of the error due to this approximation method was computed according to Snedecor (1956, par. 12.16). This analysis was performed by the IBM/360 Computer and the results are shown in Table 7. The findings revealed that training significantly increased the amount of conservation knowledge as compared to the control groups.

TABLE 7

Summary of Analysis of Variance on Difference Scores between the Canadian Indian Groups, the Urban Canadian Groups Without Kindergarten Experience and the Urban Canadian Groups with Kindergarten Experience

Source	df	ms	F
Experimental Groups and Control Groups	1	12.2154	7.66*
Canadian Indian Sample Urban Can. Without Kindergarten Exp. Urban Can. With Kindergarten Exp.	2	6.3791	4.00
Group X Sample Interaction	2	3.3626	2.11
Error Within Cells	7	1.5952	
Total	12		

* $p < .05$.

SS adjusted for unequal subclass numbers by the use of the harmonic means of N (Snedecor).

Examination of the mean difference scores (Table 8) indicated that although the control groups did not vary greatly, there was considerable variation among the means of the experimental groups. Accordingly a simple randomized analysis of variance (Table 9) followed by a Duncan's Range Test (Table 10) was then performed on the scores of the experimental groups to ascertain which group profited the most from the training. The findings demonstrated that the two Urban groups profited significantly more than the Canadian Indian group. This difference is illustrated in Figure 5.

TABLE 8

Mean Score Differences of the Experimental and Control Groups

	Canadian Indian	Urban Canadian without Kindergarten Experience	Urban Canadian with Kindergarten Experience
Experimental groups	.68	2.19	2.42
Control groups	.31	1.30	.20

Consequently this hypothesis had to be rejected as the data indicated the opposite result had occurred. It is suggested that the training offered was not suitable for the Canadian Indian children.

A comparison within the Jamaican sample on the effect of length of schooling was made between the children who had approximately two and a half years of attendance at school, with those children who had attended school for one and a half years. The median ages between the groups differed by three months, but it is unlikely that this difference affected the results. The "t" (one-tailed) for this analysis was 2.05 which indicated significance beyond the .025 level. Therefore, the children who had attended school longer had more conservation conception, and consequently were operating at a higher level of thought.

TABLE 9

Summary of Analysis of Variance on Difference Scores Due to Effect of Training Program Between Canadian Indian, Urban Canadian and Urban Canadian with Kindergarten Experience

Source	df	ms	F
Between Scores	2	23.95	6.65*
Within Groups	76	3.6	

* $p < .05$.

TABLE 10

Duncan's Range Test on Difference Scores as a Function of Training Between Canadian Indian, Urban Canadian and Urban Canadian with Kindergarten Experience

Canadian Indian	Urban Canadian	Urban Canadian with Kindergarten Experience
.68	2.2	2.4

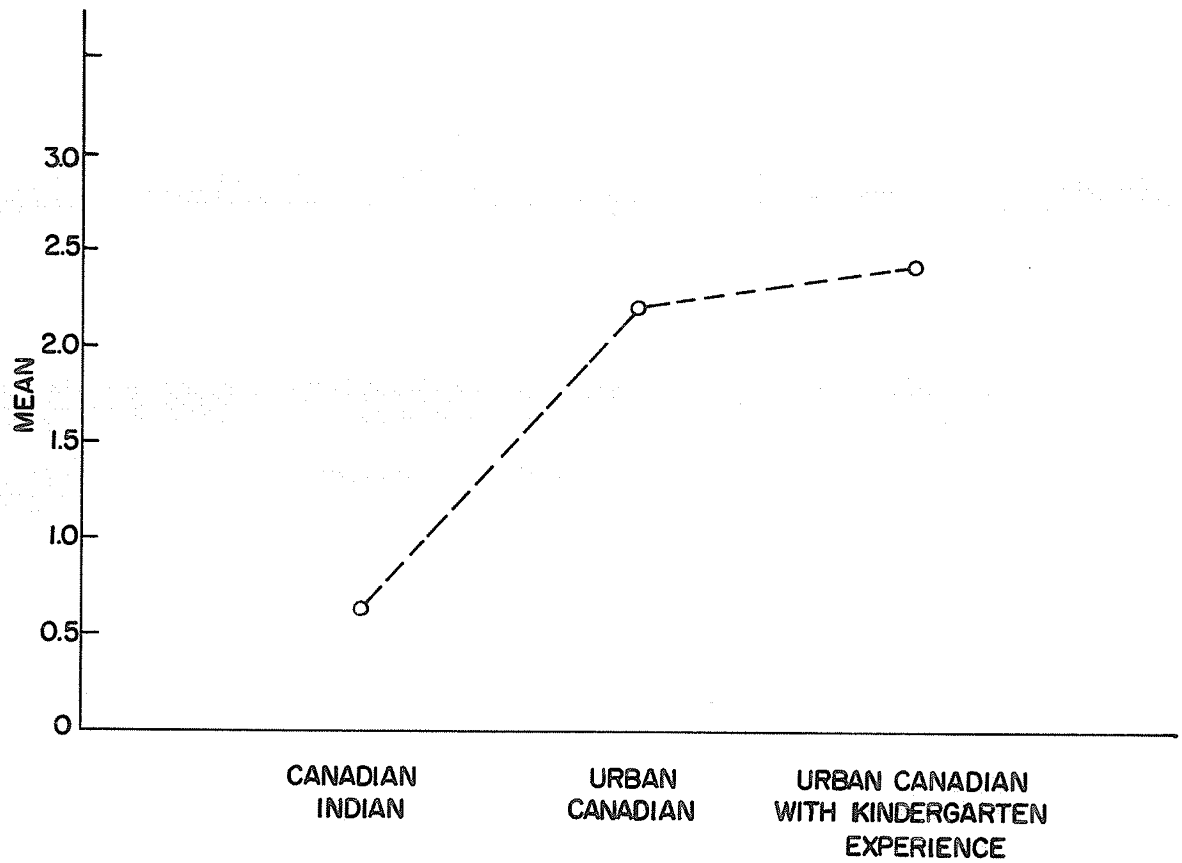

FIGURE 5. Mean Difference Scores as a Function of Training on Canadian Indian, Urban Canadian and Urban Canadian with Kindergarten Experience

CHAPTER IV

DISCUSSION

Results based on the Piaget tests have provided relevant information and suggest four main issues for discussion. The first point revolves around the use of Piaget tests as a tool for cross-cultural testing. The second topic is the manner in which experience affects the formation of thought processes. Thirdly, the knowledge gained from the results of the training period has to be evaluated. Finally, the overall significance of the findings as an aid to education will be assessed.

These tests would appear to be free from cultural influence since the number of initial conservers in each sample was not significantly different. Also comparison of the results of the first test between the Canadian Indian sample and the Urban Canadian sample without kindergarten experience did not differ significantly. This indicated that the thought processes of the children within the two samples were approximately the same level. It can, therefore, be surmised that these tests show less bias than the conventional intelligence tests when administered to children from cultures less conceptually oriented than our culture. The explanation could be that these tests provide a more fair basis for judgment. They do not depend on verbal facility but on cognitive maturation.

They also provide more information about the essential aspects of cognition than the usual concept-formation tasks. Berlyne (1965) has explained why the quantitative-invariant experiment is more valuable in assessing the thinking process. The usual concept-formation tasks are a form of discrimination learning. Here the subject chooses the properties which are relevant to the concept such as shape, size, or color. All information necessary to understand the concept is perceptually available. However, in the Piaget tasks, the perceptual information has to be supplemented by information retained by the subject from previous experiences in order to arrive at the correct answer. For example, in the water pouring experiment, he has to remember, that is, have internal symbolic information, that the contents of the two small glasses is the same water that was once in one of the big glasses. Although they are not now perceptually alike there is still the same quantity of water. The right answer depends on the subject's memory and stored information resulting from past experiences. The quantitative-invariant experiments on directed thinking depend jointly on external stimuli of the moment and on stored information embodied in self-stimulation from symbolic responses. The stored information contains the information of the transformations that the objects of our thinking have undergone. Berlyne equates quantitative-invariant identification with secondary stimulus generalization. The generalization is between the column of water in one big glass with the columns of the water in the two smaller glasses, plus the memory trace, plus the process of pouring. To understand quantity means to understand the changes or transformations it can undergo and yet remain the same amount, and also to understand the changes it can undergo to alter the quantity. These tests involve far more than external perceptual recognition.

Results from this experiment have also demonstrated the beneficial effect of enriched experience on the development of thought processes. The effect of culture was not significant when the Canadian Indian sample was compared to the Urban Canadian sample without kindergarten experience. However, when the Canadian Indian sample was compared to an Urban Canadian sample with kindergarten experience a significant increase in scores was noted for the latter group. They clearly revealed that meaningful experience, such as kindergarten attendance, was instrumental in hastening the formation of thought processes.

Piaget (1952) emphasizes that the role of variation in circumstances affects the rate of infantile development. The more the child has seen and heard, the more new things he is interested in, the greater is his capacity for coping with his environment. This is because changes in circumstances forces new accommodations and assimilations, which constitute the development of intelligence. As the schemata become accommodated to a wider range of circumstances, more aspects of the environment acquire the capacity to evoke the child's interest and curiosity. Animal studies (Hebb & Williams, 1946) support this hypothesis. They found that pet-reared rats did much better on their test, due to more variations in their environment, than cage-reared rats which experienced only the limited circumstances of the cages. At the human level, Dennis (1960), found this to be the case when he compared home reared children to maternally deprived children in an orphanage at Teheran. He claimed that due to lack of attention and stimulation only forty-two percent of the orphanage children could sit alone, at two years of age, whereas most home reared children sit by the age of nine months. Physiological evidence showing the effects of early learning has also been presented (Krech et al., 1962). Significant changes in the chemistry and neuroanatomy of the cortex of rats raised in enriched environments were recorded.

Evidence is inconclusive whether effects of early experience are permanent in deciding the final level of intelligence. Also, the extent to which adverse environmental effects are reversible has not as yet been decided. Yet following the reasoning of Piaget's developmental theory, in that new levels of thought are built on the existing structures, early rich experience appears to be essential.

Berlyne (1965) translated the development of internalized thought into learning terms. When explained in this manner, the role that experience plays in this process becomes readily understandable. Piaget refers to operations as internalized actions. Berlyne has equated Piaget operations with what other psychologists call implicit responses. He states:

> "An operation is thus a transformation. It symbolizes a process that changes one stimulus situation into another, and by representing to himself a transformation applied to a real or imagined stimulus situation, a subject can arrive at a representation of the stimulus situation that a transformation would bring about."
>
> (Berlyne, 1965; p. 114)

Ability to recognize quantitative invariants lies in the ability to distinguish transformations that leave quantitative properties invariant. A subject recognizing a quantitative invariant will be in possession of a number of habit family hierarchies where all chains will end up with the same final outcome, but where the beginnings of the chains will include all types of transformations. For example, in the water pouring experiment, the same amount of liquid will be poured into many different shaped containers. The invariant-preserving transformation would be one that produces changes in two or more variables that offset one another. An increase in height would be accompanied by an appropriate decrease in width and, therefore, leave the quantity of liquid unchanged. A great many habit family hierarchies would be required to attain the concept of conservation. The above explanation accounts for the role of experience, and also explains why it is so difficult to teach this concept in a short time.

These hierarchies play a relevant part in development. Understanding of conservation is eventually universal. Enriched experience can hasten the process or conversely lack of experience can retard maturation. However, it is conceivable that an older, more mature, child would not require the same number of habit family hierarchies for understanding the concept as a younger child. But it is reasonable to assume that the earlier the child attains this concept, the better is he able to match his abilities to his environment. This leads to a fuller understanding of his surroundings.

In this respect note has to be taken of the large gain made by the Control group in the Urban Canadian sample without kindergarten experience as compared with the Canadian Indian sample. Here Piaget's fourth principle applies, in which he intimates the necessity of the match between the individual and his environment as a prerequisite for learning. The Urban group was evidently mature enough to accept the beginning notions of conservation . The testing encounter alone was a learning experience for them, as to this time, they had not been exposed to these situations. On the other hand, the Control group with kindergarten experience evidently had some familiarity with this concept which indicated that they were already operating at this level. They scored higher on both the first test and the second test than did the group without kindergarten experience. They did not acquire new learning by virtue of test administrations.

Examination of Table 7 showed the results of the difference scores as a function of training. The Table indicated that the training periods significantly increased the scores of the experimental groups as a whole. This showed that if the child is exposed to an environment which stimulates the learning of new habit family hierarchies, he can develop intellectually. These training periods were very brief, but they did indicate that it is possible for educators to stimulate children to master new concepts. Thus, they raise their cognitive level of thought.

A further breakdown of the results in the experimental groups as shown in Tables 9 and 10 indicated that both Urban Canadian samples benefited significantly from the training. However, gain for the Canadian Indian sample was not significant. Three possibilities suggest themselves for this occurrence. Firstly, one has to consider whether the Indian children really understood the experimenter. Language was no barrier, since English is the only language spoken on the reserve. In addition, this particular reserve is not that isolated or much lower socio-economically than other non-Indian groups. There may have been difficulties in communication, however, about which the experimenter was unaware.

Secondly, pilot testing for the training period involved only city children. This raises an important question as to whether the training periods were suitable for the Indian children. The right match between the child and his learning environment also depends upon the content of his past learning. The situations and material used may not have matched the content of the Indian child's experiences. Another approach may have yielded more indicative results. The third possibility is concerned with the match and the child's stage of development. The results of the first test indicated that the Canadian Indian children scored lower on initial knowledge of conservation.

Here the difference did not approach significance in comparison with the Urban Canadian sample without kindergarten experience. However, it may still have been this difference that prevented this group from profiting, to the same extent, from the brief training periods. In Berlyne's terms they did not as yet possess as many habit family hierarchies as the other groups which could be used as a base for enlarging their schemas.

Therefore, the second hypothesis which stated that subjects from a less conceptually oriented culture would benefit more from training than children coming from other cultures had to be rejected. The results have indicated that the subjects have to be at a certain cognitive level before they can take significant advantage of instruction. Secondly, the teaching has to be geared to the particular sample.

The comparison within the Jamaican sample on the basis of the amount of schooling corroborates the significance of meaningful experience on thought processes.

Data collected in this experiment have clearly shown the dependence of the growth of thought processes on the type of environment. Effect of this interaction with the environment has been clearly displayed in the comparison of the Canadian Indian sample and the Urban Canadian samples. The Urban Canadian sample without kindergarten experience was not significantly superior to the rural Canadian Indian group. The decisive factor was the kindergarten experience that made this sample significantly more developed cognitively. No study was made of the kindergarten program, and no records were kept of the amount of time each subject attended. It varied between two months to ten months, and yet attendance proved to be a positive experience. One can suggest that early education develops the schemata, causing maturation of the thought processes. Planned controlled experience should be even more helpful in backward cultures in order to ensure optimum development.

One method of guaging this instruction would be by periodic administration of Piaget tasks, choosing those suitable to the level of thought development. Failure to pass the tests would reveal that the teaching program should be instituted at a lower level. Conversely, if the child succeeds in the tests, the teaching program could be speeded or advanced. Education should be geared to a child's understanding.

In this experiment the Canadian Indian children did not profit as much from the training as did the other two samples. This illustrates that these children required a method different from that for the city children. Use of more familiar materials might have been helpful. Instruction could either be instituted at a lower level or perhaps a method embodying more suitable content was required.

It is necessary to understand the cognitive processes underlying the comprehension of a given subject. This involves the knowledge of the anticipatory schemas governing this topic. Learning mainly consists in the modifications of the anticipatory schemas and formation of the habit family hierarchies that make it possible to respond correctly to a question. Development of the structure mediating the solution should be the goal of the educator.

Finally, the tasks used in this study have shown themselves to be educational. By confronting a child with the unexpected and giving him the opportunity to personally manipulate the materials into different variations, he is forced to enlarge and modify his existing schemata. They should form part of the curriculum.

CHAPTER V

SUMMARY AND CONCLUSIONS

This study evaluated intelligence by measuring the level of thought processes of children approximately seven years of age, using tasks based on Piaget's developmental theory of intelligence. The comparison was based on knowledge of the conservation concept of quantity using Piaget type problems with continuous and discontinuous materials. This involved a Canadian Indian sample, a Jamaican sample, an Urban Canadian sample without kindergarten experience, and an Urban Canadian sample with kindergarten experience. Tests were administered to two hundred and twenty-six children. In addition, the effects of teaching these concepts in two brief training sessions was assessed for all but the Jamaican sample.

The first analysis was based on the results of the first test. This indicated that the number of Initial Conservers in each sample was not significantly different. It was, therefore, suggested that a judgment based on level of thought was a more equitable test for cross-cultural purposes.

Total conservation scores from Test I for each subject in each sample was also compared. Findings revealed that the Urban Canadian sample with kindergarten experience and the Jamaican sample scored significantly higher than the other two groups. Therefore, the prediction that subjects from an enriched environment would score higher on the test was upheld. The children with kindergarten experience, and the Jamaican children who attended school for a longer period of time had significantly more knowledge of the concept of the conservation of quantity.

The second analysis was concerned with the effect of the training program on the different samples. Results showed a significant increase in the difference scores between Test I and Test II for the groups that received training. It was also indicated that the two urban groups profited significantly more from the training period than did the Canadian Indian sample. These reasons were suggested for this finding. Firstly, there may have been difficulties in communication. Secondly, the training program may not have matched the content of the Indian child's experience. Thirdly, the Canadian sample scored a little lower on the initial test of conservation, which may have affected subsequent learning. Therefore, the hypothesis that subjects from a less conceptually oriented culture would benefit more from the training sessions was rejected.

The comparison within the Jamaican sample on the basis of the amount of schooling indicated that the children that had attended school longer had more knowledge of the concept of conservation of quantity.

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APPENDICES

APPENDIX A

Test I, Test II

TEST I

Judgment of discontinuous quantity - Marbles

60 marbles, a tall jar, and a wide jar are used. The subject counts marbles into the wide jar and the Experimenter counts marbles into the tall jar. Together they each drop the marbles, one at a time and also count out loud as the marbles go into the jar.

Judgment of continuous quantity - Plasticene

Two equal balls of plasticene are used. The first deformation consists of the subject keeping his ball round while the Experimenter forms her ball into a sausage shape. The second variation consists of the Experimenter further elongating the sausage shape. In the third variation the Experimenter cuts up the sausage into many pieces.

Judgment of continuous quantity - Water

Two twelve ounce glasses exactly alike are filled with colored water to the same level. The first variation consists of pouring the water from one of these glasses into two smaller six ounce glasses. The second variation is performed by beginning with two identical six ounce glasses that are filled with equal amounts of water. Water is then poured from one of these glasses into two long thin glass containers. The third deformation begins with the same six ounce glasses that have been filled with equal amounts of water. Water from one of these glasses is poured into four small glass containers.

After each variation the children were asked whether there was more or less or the same amount in each, and why they thought so. The questions were asked in a different order each time.

TEST II

Judgment of discontinuous quantity - Wooden beads

In this second test beads are used instead of marbles. The subject uses the tall jar and the Experimenter uses the wide jar. The procedure followed is the same as in Test I.

Judgment of continuous quantity - Plasticene

Two equal balls of plasticene are used. The child forms his ball into a pancake shape, while the Experimenter turns her ball into a hot dog shape. The second variation consists of the child continuing to flatten his pancake while the Experimenter further elongates the hot dog shape and then forms it into a doughnut shape. The third variation involves tearing up the doughnut shaped plasticene into little pieces.

Judgment of continuous quantity - Water

The three variations each begin with two six ounce glasses filled with equal amounts of water. Water from one glass is poured into a twelve ounce glass. Water from one glass is poured into two smaller jars. Water from one glass is poured into five smaller glass containers.

The children were queried in the same manner as in Test I.

APPENDIX B

Training Period I, Training Period II

TRAINING PERIOD I

Children stand around a large table and are queried about the meaning of equal, more, less, different, and same. After each presentation of material, discussion is encouraged regarding the equality of the substances after transformation.

Each child is given twenty lima beans and told to make any pattern they wish. The children are asked if they still have the same amounts even though the patterns are different.

In turn, two equal lengths of raw spaghetti, two perforated papers, and two equal slices of bread are passed to each child with instructions to break up one but leave the other whole. Some children are told to eat a small piece of bread, while other children are told to eat two small pieces of bread. Discussion of equality after each presentation is actively encouraged by the Experimenter.

Two twelve ounce Cokes are opened in front of the children. Each Coke is poured into a different size and shape jar. The children are asked if they think there is still the same amount in each container, and if they could drink it, which jar would they choose?

Materials are removed immediately after use to prevent distraction during the following task.

TRAINING PERIOD II

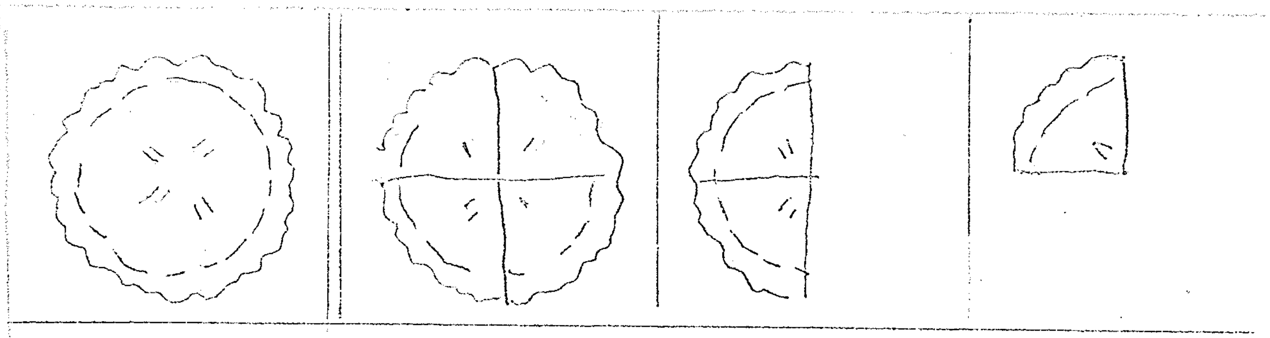
The children are again grouped around a large table and the same discussions are continued as in the first training period.

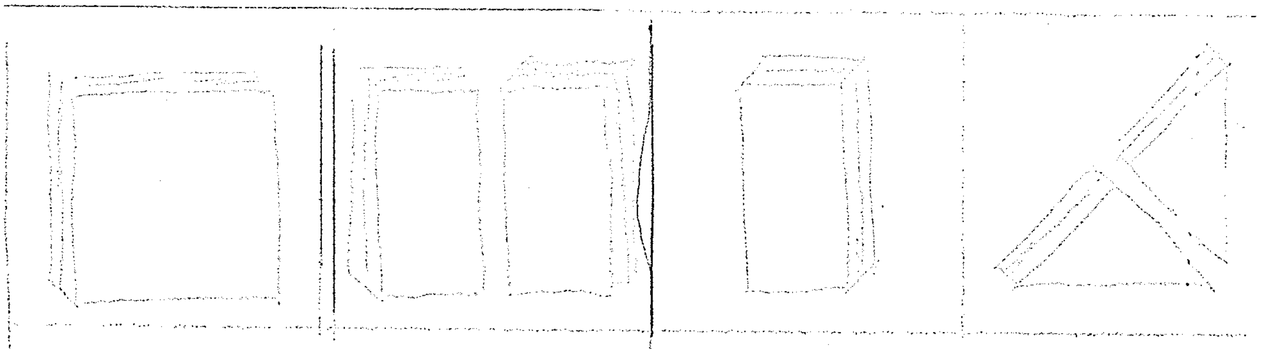
Each child is given twenty shreddies. The boys are told to make a circle pattern and the girls are told to make a square pattern. Subsequently some children are told to eat one or two shreddies.

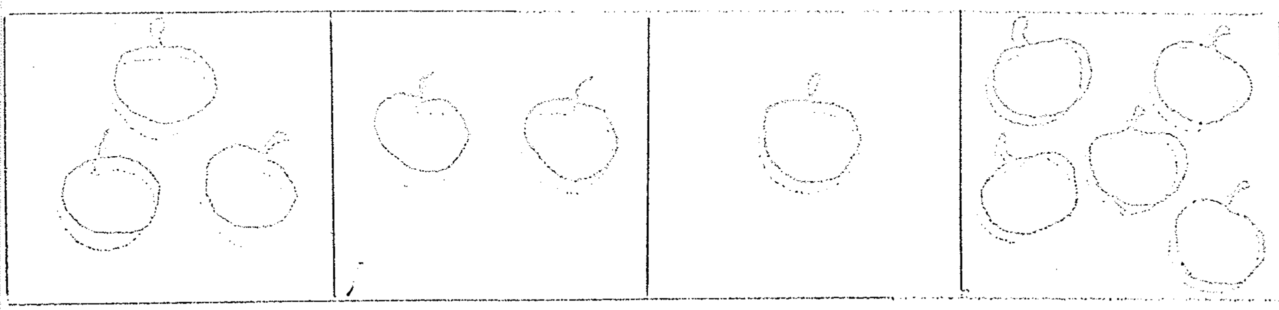
Three apples are shown to the children. One is left whole, the second one is cut in half, and the third apple is cut into round slices. This same presentation is performed with three hard-boiled eggs with the exception being that the third egg is cut into quarters lengthwise. Discussion is encouraged.

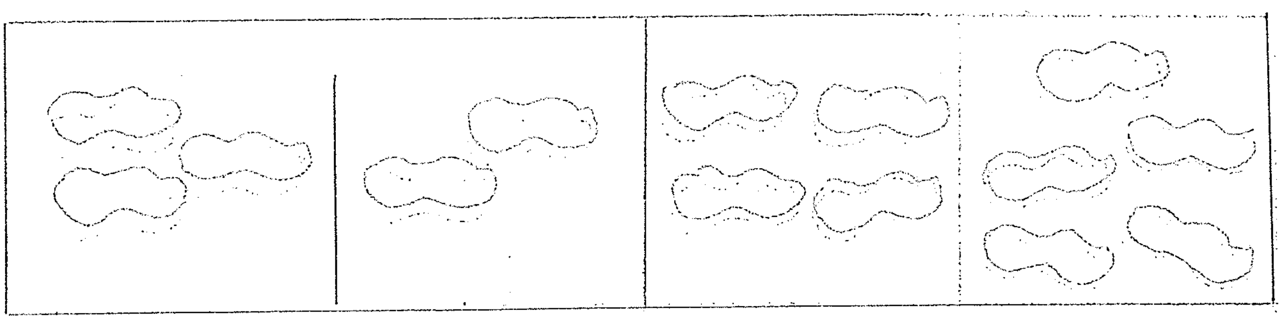
Children are shown two unopened eight ounce cartons of milk. They are opened and poured into jars of different shape and size. The same discussion is encouraged and the same questions are asked as with the Coke problem. The milk is then poured back into the original containers and again poured into jars, but this time the jars are reversed. This presumably sets up a conflict situation. Discussion is encouraged.

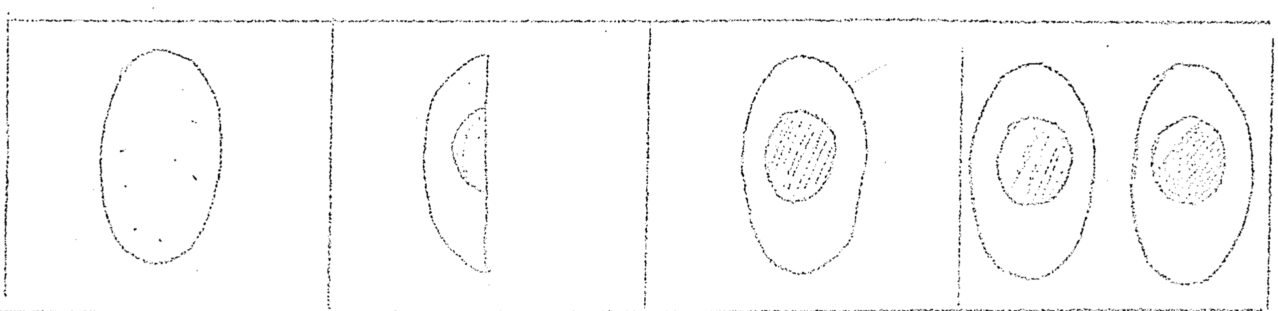
Worksheet (as appended) is filled out by the children as Experimenter explains what is required.











APPENDIX C

JAMAICAN SAMPLE

Attended School Two and a half years		Attended School One and a half years	
Subject	Test I	Subject	Test I
1	7	1	1
2	5	2	3
3	1	3	4
4	5	4	1
5	5	5	2
6	3	6	0
7	1	7	2
8	4	8	1
9	2	9	0
10	4	10	4
11	0	11	0
12	5	12	2
13	7	13	1
14	7	14	1
15	0	15	3
		16	4
		17	1
		18	2
		19	5
		20	0
		21	1
		22	0
		23	4
		24	1
		25	0
		26	2

URBAN CANADIAN SAMPLE

WITH KINDERGARTEN EXPERIENCE

No Intervening Training			Training		
Subject	Test I	Test II	Subject	Test I	Test II
1	0	0	1	1	5
2	0	0	2	3	7
3	1	0	3	6	7
4	1	1	4	0	2
5	2	4	5	6	5
6	0	0	6	0	0
7	0	0	7	1	7
8	0	1	8	0	5
9	2	2	9	1	7
10	0	0	10	2	7
11	3	4	11	0	4
12	2	3	12	4	7
13	0	3	13	5	7
14	0	0	14	4	7
15	0	0	15	0	0
16	5	6	16	1	7
17	1	0	17	0	3
18	2	2	18	1	0
19	0	0	19	2	7
20	4	1	20	2	3
21	6	7	21	3	2
22	6	7	22	4	5
23	1	1	23	0	0
24	1	0	24	0	0
25	6	7			

URBAN CANADIAN SAMPLE

WITHOUT KINDERGARTEN EXPERIENCE

No Intervening Training			Training		
Subject	Test I	Test II	Subject	Test I	Test II
1	0	2	1	1	6
2	2	6	2	0	3
3	0	0	3	0	3
4	0	0	4	0	3
5	0	1	5	0	0
6	0	0	6	0	0
7	0	0	7	0	0
8	0	2	8	0	2
9	0	0	9	0	1
10	0	0	10	6	7
11	0	0	11	0	1
12	1	4	12	0	3
13	1	7	13	2	2
14	0	4	14	2	6
15	1	0	15	1	6
16	4	7	16	0	2
17	0	1	17	1	0
18	0	0	18	0	2
19	0	0	19	0	5
20	2	7	20	0	2
21	1	0	21	0	1
22	5	6	22	0	3
23	0	0	23	1	1
			24	5	7
			25	0	3
			26	3	7
			27	1	7

CANADIAN INDIAN SAMPLE

No Intervening Training			Training		
Subject	Test I	Test II	Subject	Test I	Test II
1	0	0	1	0	3
2	1	3	2	0	0
3	0	0	3	0	1
4	0	0	4	0	0
5	0	0	5	0	0
6	0	0	6	0	0
7	0	0	7	0	0
8	0	0	8	0	0
9	0	1	9	0	1
10	0	0	10	0	0
11	0	0	11	0	0
12	0	0	12	0	0
13	0	0	13	0	0
14	0	0	14	0	0
15	0	0	15	0	2
16	0	0	16	1	1
17	0	0	17	3	4
18	0	1	18	1	1
19	0	1	19	1	1
20	1	2	20	1	1
21	1	0	21	1	1
22	1	0	22	1	7
23	1	0	23	0	0
24	0	1	24	2	0
25	1	2	25	3	3
26	2	3	26	4	7
27	2	3	27	4	6
28	3	2	28	5	7
29	3	6			
30	4	3			
31	5	7			
32	1	1			