A CROSS-CULTURAL COMPARISON OF WEIGHT AND NUMBER CONSERVATION

by

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ABSTRACT

This study was designed to explore, cross-culturally, the generality of developmental sequences and to provide, in a tentative way, some information about the determinants of cognitive development.

Indian and white children of British Columbia were compared on two related Piagetian tasks, namely, conservation of number and conservation of weight. An initial matched sample of 34 Indians and 34 whites was tested. Matching was on the basis of age, grade, sex and years of schooling. All Ss ranged from 6 to 10 years of age. They were in grades one to four. A second sample, including the matched sample, consisted of 67 Indians and 76 whites, selected from grades one to four and ranging in age from five to eleven. The results from the two samples were consistent. Conservation of weight and number increased with age, but not to the point of significance. Conservation on both tasks also increased at higher grade levels. The relationship between conservation of number and grade was significant in the total sample when both Indians and whites were combined (nonsignificant for each cultural group taken separately). In terms of sequential development, conservation of number was attained, in all but a very few cases, before conservation of weight.

Most importantly, the overall results demonstrated (with one exception) no significant differences between Indians and whites. The exception was on conservation of

weight in the total sample where significantly more Indian than white Ss conserved.

Next, extinction procedures were carried out on 12 Indians and 12 whites who had previously demonstrated conservation of number and weight. Extinction occurred rapidly (within three trials) for most Ss in both cultural groups. These results are in disagreement with those obtained by Smedslund (1961c) and with the theoretical considerations of Piaget.

An attempt was made to train for conservation of weight using Smedslund's (1961b) method of direct external reinforcement and a method called reverse external reinforcement. Reinforcement in both training methods involved allowing S to return the objects to the scales after he had made a judgment conserning their relative equality. Direct external reinforcement consisted in the presentation of two similar objects and the subsequent deformation of one of the objects. Reverse external reinforcement consisted in the presentation of two dissimilar objects and the subsequent deformation of one of the objects to resemble the other object. N was 10 in each ethnic group for direct external reinforcement; 4 in each group for reverse external reinforcement. A control group of 23 Ss was used to control for spontaneous acquisition of conservation between original testing and posttest following two training sessions. Neither training method was successful in comparison with the control group. There was an increase

in number of Ss conserving from pre- to posttest in all groups. There were no differences between Indians and whites.

These results were discussed, in the first place, in terms of their relationship to Piaget's studies and other studies on the attainment of conservation of weight and number. Secondly, the implications for the area of cross-cultural testing for Piaget's developmental stages were discussed.

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CHAPTER I

INTRODUCTION

Cross-cultural studies of cognitive development can serve two purposes: they extend the generality of developmental sequences previously established with a single cultural group; and they provide, in a tentative way, some information about the determinants of cognitive development. If two groups, the same chronological age, but differing in many aspects of home and cultural environment, differ in performance on a cognitive task, the suggestion is that one or more of the environmental variables on which they differ is relevant to the cognitive performance. More significantly, perhaps, if two such groups do not differ, the suggestion is strong that performance on the cognitive task does not depend importantly on the environmental variables on which they differ.

The purpose of this study was to compare Indian and white children in British Columbia on two related tasks, the conservation of number and conservation of weight. Both tasks originate in the work of Jean Piaget and his collaberators and are relevant to his theory of intellectual development (Piaget, 1952). A second purpose was to determine the effects of extinction procedures on conservation responses, and to compare, by this method, the stability of conservation in the Indian and white Ss. A subsidiary purpose was

to explore and compare the effectiveness of two methods of training in producing conservation responses in Ss who did not initially conserve.

A review of Piaget's theory of intellectual development will be presented, with particular emphasis on the period when conservation is attained. Next, studies concerned with the age of attainment of number and weight conservation will be reviewed. Finally, cross-cultural studies of performance on Piagetian tasks, and studies of the effects of training on conservation will be reviewed.

1) Piagets Theory of Intellectual Development

According to Piaget (1952) there are two principles governing intellectual development throughout its course. The first is the principle of adaptation, the second the principle of organization. Adaptation occurs "when the organism is transformed by the environment and when this variation results in an increase in the interchanges between the environment and itself which are favourable to its preservation." (Piaget, 1952, p. 5). There are two processes involved in adaptation - assimilation and accommodation. Assimilation refers to the ability of the organism to change or adjust the object in its environment so that it becomes incorporated into the structure of the organism. Accommodation is the converse process whereby the organism adjusts itself to the specific nature of the object it is trying to assimilate. Every assimilation of an object to an organism requires an accommodation of the organism to the object. An

adaptive act always presupposes an underlying organization, Piaget's second principle of intellectual functioning. The specific nature of this organization differs from period to period in development.

Piaget's theory makes the development of intelligence dependent on environmental experiences of a very general nature. Cognitive development does not depend exclusively, or even primarily, on formal educational experiences and deliberate instruction, but on many varied interactions with the environment. It appears also that intelligence does not depend on the development or mediation of language, but that the use of language depends on the same development of cognitive organization that manifests itself in the particular tasks that Piaget considers are diagnostic of specific periods of development.

According to Piaget (1952), there are three periods involved in the development of intelligence. Each period involves a stage of formation and one of attainment. The periods succeed each other in an invariant sequence, allowing for individual differences in the ages of attainment. The period which is relevant to this study is Piaget's second period - the period of concrete operational thinking.

The development of concrete operational thinking begins around the sixth or seventh year and extends to the eleventh or twelfth year. It is preceded by an introductory subperiod characterized by pre-operational thinking. Concrete operational thinking depends, according to Piaget (1950),

upon the application to concrete situations of stable cognitive structures, known as "schemata" on which various mental transformations can be performed. Concrete thinking

> is characterized by a long process of elaboration of mental operations. The process is completed by about the age of seven and is then followed by an equally long period of structuration. During their elaboration, concrete thought processes are irreversible. We observe how they gradually become reversible. With reversibility, they form a system of concrete operations. (Inhelder, 1962, p. 25).

Central to the development of concrete thinking is the child's understanding of the principle of conservation. Conservation implies the ability to recognize that a particular dimension of an object may remain invariant in the face of irrelevant changes in other dimensions of the object. A typical Piaget-type conservation task would involve giving a child two balls of plasticine of equal weight, rolling one of the balls into a sausage in front of the child, and then asking if the weight of the plasticine in the sausage has decreased, increased, or remained the same in comparison to the ball. At a certain age the child learns to free himself from reliance on immediate perceptual stimuli which would lead him to state that the plasticine objects, now differing in shape, also differ in weight. At this age, the child infers from the former equality of the balls, the lack of addition or subtraction of plasticine, and the fact that changes in one dimension (e.g. width), may compensate for

changes in another dimension (e.g. length), that even though the objects may differ in shape, they remain the same in weight.

In seeking to assess the intellectual development of a given child, Piaget's method is essentially one of clinical examination.

> For Piaget the goal is to diagnose the intellectual processes available to the subject. Flexibility in the experimental procedures facilitates the diagnosis by permitting an inquiry into the reasons for a response, an inquiry taboo in a standardized procedure. Similarly, a diagnosis is more easily and more vividly supported with detailed illustrations than with statistical data and norms. (Braine, 1962, p. 42).

Recently, there have been a number of reports of experiments similar to those of Piaget, but using more rigorous controls and subjecting the data to more thorough statistical analysis. Good summaries of these studies are presented by Wallach (1963) and Flavell (1963). Conservation of properties across irrelevant changes has been demonstrated for a number of dimensions, e.g. amount, weight, volume, horizontality, length, area, number and duration. Most studies have demonstrated the sequential invariance in conservation on different dimensions postulated by Piaget (Wallach, 1963), e.g. amount is conserved before weight, and weight before volume. In addition, some studies have attempted to examine factors which may affect the absolute ages at which different types of conservation are first exhibited, e.g. intelligence, linguistic factors, sex, task complexity, etc.

2) Age of Attainment of Conservation of Number and Weight

Conservation of number refers to the ability to recognize that number remains invariant in the face of certain transformation. Conservation of weight refers to the ability to recognize that weight remains invariant in the face of certain transformations. Piaget states that conservation of number occurs in the majority of children around seven years of age, and conservation of weight around nine to ten years. (Oléron, Piaget, Inhelder and Greco, 1963).

A typical experiment by Piaget on conservation of number involves putting pearls into two identical glasses. The child picks up one pearl in each hand and drops them simultaneously into the two glasses (one hand putting the pearl in one glass and the other hand putting the pearl in the other glass). This is continued until all the pearls are used up. Then a glass of a different shape is introduced (either longer and thinner, or shorter and wider) and the pearls from one of the glasses are transferred into the new glass. The S is then questioned as to whether there is the same number of pearls in both glasses (comparing the pearls in the new glass with the pearls which have not been transferred from one of the former glasses). Conservation is demonstrated, of course, by the assertion that the number of the collection remains invariant despite changes in the spatial arrangements of its elements. Piaget (Oléron et al., 1963) found with a sample of 90 Swiss children, that at

five years, 85% of the Ss were non-conservers, while at seven years, 74% of the Ss conserved. Therefore, the majority of children conserve number by seven years of age. These results indicate, in addition, that the ability to enumerate collections by counting, which all Ss were capable of doing, does not necessarily give evidence of an understanding of the concept of a number or of number conservation. Additional studies support this finding (e.g. Wohlwill and Lowe, 1962; Wohlwill, 1960; Dodwell, 1960).

Piaget postulates a three-stage development to explain conservation of number.

> In stage I "Absence of Conservation" the quantity of an aggregate tends to be estimated on the basis of aspects of the perceptual situation that are irrelevant to the number of items. The number of items is judged to change as their spatial distribution changes. According to Piaget, the child in the first stage of reasoning is egocentric and judges on the basis of global properties or centers upon one aspect of a problem at a time. In stage II "Beginning of Construction of Permanent Set," there is a vacillating belief that alteration of the spatial arrangement of the items does not alter their number or quantity. The child begins to show awareness of the principles of reversibility, identity, and compensated relations, principles which are necessary for the understanding of conservation. In stage III, "Conservation and Quantifying Coordination," the child understands the concept of conservation. His cognitive field has become a coherent organized whole from which he can abstract. (Feigenbaum, 1963, pp. 423-424.)

A number of studies have supported Piaget's theory of the development of conservation of number. Smedslund (1964), although he does not present details in his study concerning

the ages of acquisition of number conservation, states that "The 75 percent level is reached between the ages of 5 to 8 years" (p. 23). Feigenbaum (1963) using a technique almost the same as Piaget's experiment with beads in glasses, found that no children conserved between 45 - 54 months, 47% conserved between 55 - 64 months, 56% conserved between 65 - 74 months and 91% conserved between 75 - 87 months. Feigenbaum's sample consisted of 90 U.S. children drawn from nursery and elementary schools. Hood (1962) tested for conservation of number with 126 English children. He employed two sets of objects for which a one-to-one correspondence had been established before one of the sets of objects was spatially re-arranged. Results were analyzed in terms of Piaget's three-stage theory. At the four to five year old age level, 28% of the Ss were at stage I (non-conservation), 64% at stage II (transition) and 8% at stage III (conservation). Ss between 7.1 - 8.0 years were all conservers (stage III). Between five and seven there is a steady growth in number of children conserving.

A previous statement indicated that Piaget believes conservation of weight develops around nine to ten years. This has been demonstrated by a number of Geneva studies. For example, Oleron et al.(1963), using 175 Swiss children, to test for conservation of weight, found that no children showed conservation with plasticine balls at five years of age. Twenty-four percent of seven year old Ss conserved, 72% of nine year olds and 96% of eleven year olds.

The same type of plasticine ball experiment was used by Lovell (1961) and Lovell and Ogilvie (1961) on 364 British school children. Ss were shown two balls of plasticine and had to judge which was the heavier using their hands or scales as they wished. The stages proposed by Piaget (non-conservation, transition, conservation) were again confirmed. They found that 91% of first year Ss (7-8 years) did not conserve, 5% were in the transition stage and 4% conserved. By the third year (9-10 years) 32% were non-conservers, 20% were in transition and 48% conserved. At the fourth grade level (10-11 years) 13% did not conserve, 13% were in transition and 74% showed conservation. Lovell's data seems to indicate that conservation of weight, assessed by his method of measurement - essentially a standardized questionnaire technique - occurs slightly later for the British children than for the Geneva children.

Elkind (1961b) again using procedures more standardized than those of Piaget's, tested 175 children in Newton, Mass. on conservation of weight. Each S received three trials. For each trial S was asked to predict, then judge, then explain his conservation or non-conservation responses. Two clay balls were presented on each trial and S had to determine to his satisfaction that both balls weighed the same. E then asked S to predict the relative weights of the balls if one ball was rolled into a sausage. Then E transformed the ball into a sausage and asked "Do they both weigh the same, do they both have the same amount of weight?"

Finally, S was asked to explain his answer to the latter question. The results were in agreement with Piaget's formulation, that is, conservation responses increased with age. Twenty-one percent of five year olds versus 73% of nine year olds and 84% of ten year olds conserved (N = 25 at each age level). Elkind (1961b) found, in agreement with Piaget, that the children's predictions, judgments and explanations could be used interchangeably as equivalent signs of conservation. He distinguished four types of explanations. Two were non-conservation explanations - romancing and perceptual. (An example of romancing would be - "its more because my uncle said so". An example of perceptual would be - "it's more because it's longer".) Two were conservation explanations - specific (e.g. "you didn't add or take any away") and general (e.g. "no matter what shape you make it into it won't change the weight"). Romancing and perceptual explanations decreased with age while specific explanations increased (to nine years) and then leveled off with age. These results are in basic agreement with Piaget's theory of the three-stage growth in the development of concepts of quantity.

A major problem in comparing studies involving the ages of attainment on Piagetian tasks is noted by Goodnow (1962, p.20).

> It makes little sense to compare ages of attainment unless the criteria are the same, but the criterion in the Geneva studies is often difficult to determine. What distribution of results should there be, for example, before we talk about mastery at an eight-year level: some eight year olds, half of them, most of them,

> or all of them? More important, what are we to mean by mastery - a correct but easily shaken grasp, or a full and sturdy understanding? There could easily be a gap of years between these two achievements, or the second stage might never be achieved.

Goodnow's (1962) position is perhaps a little overstated. It seems fairly clear from Piaget's studies that when he talks about mastery at a particular age level, he means that 75% of that age group show conservation, assessed by means of his particular procedures and criteria. It also seems clear that what Piaget means by mastery is that the child cannot be easily shaken out of a conserving response and that Piaget's particular "clinical method" is designed to identify and eliminate those children who have an easily shaken grasp of conservation.

Braine and Shanks (in press) argue that Piaget, his colleagues and other investigators replicating or extending the Geneva results have used an ambiguous technique to assess conservation. According to Braine and Shanks (in press), this technique does not make ti clear to the child whether he is supposed to respond to the real properties of the objects (that is, which one <u>is</u> heavier) or the phenomenal properties (that is, which one <u>looks</u> heavier). To Braine and Shanks (1965) conservation is defined as the ability to distinguish between real and phenomenal properties of the objects. If conservation questions are phrased in a less ambiguous manner, it is only necessary that the child can make a judgment "they weigh the same" to be considered a conserver. Using this criterion to assess conservation,

Braine (1959, 1964) and Braine and Shanks (in press) have shown that they can produce conservation in Ss at least two years earlier than the age reported by Piaget (Oleron et al. 1963).

Gruen (1966) has recently suggested that the disagreement between Piaget (1950) and his supporters (e.g. Smedslund, 1961b) and Braine (1959, 1964) and his supporters (e.g. Bruner, 1964) is "basically a disagreement about the very nature of the processes which underlie the concepts with which Piaget's theory deals". (Gruen, 1966, p. 978). To Smedslund (1961b), a child is only a conserver when he can assert not only that the two objects weigh the same, but can give an adequate explanation for this assertion (in terms of reversibility, compensation or logical necessity). "The operational structure (as defined by Piaget) underlying the conservation concepts appears to us to be a complex, coordinated system that cannot be properly evaluated by rather summary investigation of answers to preselected questions with no exploration of the child's justification of those answers." (Inhelder, Bovet, Sinclair and Smock, 1966, p. 162).

Gruen (1966) considers that the use of these different criteria to assess conservation reflects different theoretical notions concerning the underlying psychological processes in conservation and, therefore, different definitions of conservation. Regardless of Gruen's (1966) suggested interpretation of the differences in criteria, it seems necessary that care should be taken in any study to specify

clearly what criterion is being used to assess conservation, and, if possible, what theoretical notions underlie the use of this criterion so that comparisons can be drawn between different studies.

It seems fairly clear that conservation of weight is attained later than conservation of number. This still leaves open the possibility that although weight is conserved at a later age for most children, the sequences is not always invariant for the individual child. No direct test is known to have been done on the relationship between conservation of number and weight. However, Smedslund (1961f), in tests on the conservation of substance with discontinuous and continuous materials found that Ss very infrequently acquire conservation on continuous materials before they have acquired conservation on discontinuous materials. He found, for example, that only five out of 154 Ss showed conservation of substance on continuous materials before discontinuous materials. The fact that any Ss at all conserved on continuous materials before discontinuous materials, still raises some problems for Piaget's theory, which postulates an invariant sequence.

Almy, Chittenden, and Miller (1965), in one of the few longitudinal studies to date, followed kindergarten children through to the middle of the second grade. They examined sequential development, through semi-annual interviews, on two tasks involving the conservation of number, and one involving conservation of an amount of liquid. They found

that most children who changed at all showed the expected developmental sequence, that is, no conservation of quantity or liquid, without conservation of number. Sigel and Mermelstein (1965) tested for conservation of substance, weight and volume. The Ss were 24 six-year olds and 24 nine-year olds. Although individual differences were found in ages of attainment of conservation on the three tasks, they report that in no instance did they find "that any child could solve conservation tasks out of order, i.e. those children solving weight, could also solve substance, those solving volume, could also solve substance and weight." (Sigel and Mermelstein, 1965, p. 11).

Three studies have indicated that the age at which conservation can be demonstrated is affected by the complexity of the conservation task and the use of different types of materials to test for conservation. (Feigenbaum, 1963; Elkind, 1961a; Uzgiris, 1964).

Feigenbaum (1963) tested for conservation of number, using the typical beads into glasses experiment, Conservation was assessed in three groups of Ss, matched for age, I.Q. and social class. The number of beads in the conservation test and the size differential of the glasses was varied. The difference between the glasses into which the beads were originally placed and the glass used to assess conservation was smaller in one group, so that less perceptual distortion was produced. Conservation was not affected by the use of different glasses, but was affected by the number of beads.

> The evidence gives tentative support to a view that the complexity of the stimuli presented affected Ss'frequency of success in case of incomplete assimilation of the principle of one-to-one correspondence and to a view that the crucial discrimination for young children regarding enumeration or logical derivatives of a number sort occurs in the first few numbers of the system. (Feigenbaum, 1963, p. 431).

Both Elkind (1961a) and Uzgiris (1964) have reported differential results on conservation according to the type of material used. Uzgiris (1964) examined the effects of using four different types of materials (plasticine balls, metal nuts, wire coils and plastic wire) on the attainment of conservation of weight. She reported "considerable variation in the percentage of Ss who conserve'weight' across materials, especially at certain grade levels" (Uzgiris, 1964, p. 836-837) e.g. no children conserved weight at the first grade level on plastic wire whereas 20% of Ss in the first grade conserved on plasticine balls. Elkind (1961a) reports similar findings on conservation of number using sticks and beads. Beads into glasses was an easier conservation task than sticks laid out in rows on the table, with one row extended beyond the other.

These results indicate that care must be taken, for comparison purposes, in specifying the exact nature of the task, the type of materials used, and, in testing for conservation of number, the number of beads, sticks, etc. employed. The fact that conservation does not necessarily generalize across all situations supports Piaget's conclu-

sion that "success in comparing a given type of quantity of a certain type of material did not necessarily generalize to all materials" (Elkind, 1961a, p. 42).

In general, the validation studies support Piaget in indicating that most children conserve number around seven years of age and weight around nine to ten years. In addition, they indicate that the complexity of the task, the type of material used to assess conservation, and the criteria used to determine conservation can affect the ages at which children appear to conserve. However, these studies have all been conducted on Western subjects. The next section is concerned with an application of Piaget's theory to other cultural groups.

3) Cross-cultural Comparisons

It seems worthwhile to examine cultural differences in the attainment of conservation, in order in the first place, to extend the range of population to which generalizations about Piaget's developmental periods can be applied, and, in the second place, to see whether the environmental variables on which cultural groups differ may affect the ages of attainment of periods of development.

A. Application of Piagetian tests to different cultural groups.

Goodnow (1962) tested approximately 500 European and Chinese boys between the ages of 10 and 13 on four Piaget tasks (combinatorial reasoning, conservation of space, weight, and volume). Among the Chinese boys education varied from little or no schooling to full schooling. In

the conservation tasks, the most striking result was that variations in nationality, social status and schooling made no essential difference to success. There was a very real and very close similarity in performance among boys of different nationality and education. The three groups who showed the best overall performance on the three tasks were the Europeans, the Chinese from a low socio-economic status with little or no schooling, and the special group of Chinese boys who had received no science course in primary school. On all three tasks, the group of Chinese from middle-class backgrounds and the group from low socio-economic backgrounds (both groups having received full schooling) were slightly inferior to the above three groups. On the combinatorial task, Goodnow (1962) found that the European and middle-class Chinese boys were superior to the low-income, full schooling and low income, semi-schooling Chinese groups.

A comparison of Goodnow's (1962) results with the Geneva results indicates a fair replication, with some exceptions.

> On the combinatorial task, there is a close replication of the tie between age and success. On the perceptual tasks (conservation tasks), the order of difficulty for weight and volume is an predicted, but both the space and volume task appear as more difficult than the Geneva results imply. (Goodnow, 1962, p. 19).

Except for the volume task, the quality of reasoning compared favorably with the Genevan studies.

Price-Williams (1961) tested illiterate bush West African children of the Tiv tribe on conservation of both

continuous and discontinuous quantities. Earth was used as an example of continuous quantity and nuts as an example of discontinuous quantity. The results indicated the same progression in the idea of conservation as that found in European and other Western children, although some doubt is raised about the actual age of attainment of conservation on account of the difficulty of obtaining the ages of the children.

Other studies have indicated a generally inferior performance of Piagetian tasks in cultural minority or non-Western cultural groups. Hyde (1959) gave a large battery of Piaget's number and quantity tasks to groups of Europeans (mostly British), Arabs, Indian and Somali school children, 6-8 years of age, living in Aden. The subjects showed the same general types of responses and developmental changes as Piaget's subjects. However, the European subjects generally performed on a higher level than the non-European subjects.

Almy et al. (1965) compared 24 Negro and Puerto Rican children from a low income neighborhood in New York with 41 middle class white children. In contrast to most previous studies, this study was a longitudinal one, following kindergarten children through to the middle of the second grade with semi-annual interviews. Two tasks involved the conservation of number and one the conservation of an amount of liquid. The results indicated that by the middle of the second grade, 76% of the middle class children conserved on all three tasks, whereas, only 29% of the lower class children conserved.

Vernon (1965a, 1965b, 1965c) gave an extensive test battery to 100 ten-and-a-half to eleven year old boys in England and to 50 boys of the same age in Jamaica. The West Indian boys were drawn in groups of ten from five contrasted primary schools, chosen to represent the following sub-cultures: better-class urban, poorer-class urban, country, town, sugar-cane plantation and isolated rural small holding. It was considered that the selected Jamaicans would be superior to the average Jamaican boy who often only irregularly attends school from ten years upwards. A large number of Piaget tasks were included in the test battery, including several conservation tasks - conservation of volume of liquid, of amount of plasticine, of length of rods and of area. Combining all the test scores on the Piaget battery, the median West Indian performance indicated a moderate degree of retardation. The greatest deficiencies in comparison with the English boys occurred on five tasks, three of which were conservation tasks - conservation of volume, rod lengths and area. There were negligible differences between the two groups on conservation of amount of plasticine. There were no significant differences between Jamaican sub-cultures in performance on the Piaget tasks.

The results of these cross-cultural comparisons are not entirely consistent. The studies have, in general, supported Piaget's theory of the sequence of cognitive development. However, while a number of studies have indicated that minority and non-Western groups may conserve later than

European and white American children tested, other studies have found no cross-cultural differences. The use of different tasks to assess conservation, and the problems involved in attempting to apply the same criteria of achievement, have made comparisons difficult. It is desirable, therefore, to look at specific environmental variables which may produce differences between groups in ages of attainment of conservation.

B. Environmental variables on which cultural groups differ.

Non-western children and cultural minorities may often differ from the Western white child in terms of handicaps imposed on them as a result of poor socio-economic, cultural and linguistic environment, defective education and family instability. It is relevant to look at any studies which have taken these environmental factors into account.

Amount of schooling is an obvious environmental variable which might affect performance on Piagetian tasks. Most studies, however, have concluded that amount of schooling and any specific classroom training relevant to the solution of Piagetian problems do not appreciably affect performance on Piaget's tasks. Sigel and Mermelstein (1965) compared six and nine year old Negro children in Prince Edward County, Virginia with six and nine year old Negro children in Chicago. In addition to the rural-urban difference, the former group had had virtually no formal education, since the public schools had been closed to prevent school integration. Several tasks were used involving conservation of discon-

tinuous and continuous quantities. One of the tasks was non-verbal in character. In addition a class inclusion task was given. The results indicate that there were no significant differences between the non-schooled and schooled groups. Differences that were found were between age groups. Goodnow (1962), Hyde (1959) and Vernon (1965a, 1965b, 1965c) did not find any significant relationships between formal school experience and the development of conservation.

Wohlwill (1960), does not consider that any specific training which the subjects were exposed to in school could have been directly transferred to his task on conservation of number. He noted that grades in school were very imperfectly related to performance. He concludes, in agreement with Piaget:

> "In other words, very general experience, assimilated and transformed in the course of development, can to a large extent, replace more specific practice as a condition of learning. Applied to our study, this interpretation would attribute the change underlying a child's progress from the first to the second, or from the second to the third phase, not in terms of practice in counting, or experience with conservation of number, but rather in terms of immediate experience in the discrimination and identification of number, and in the abstraction of invariant properties from changing stimulus complexes." (Wohlwill, 1960, p. 372).

Most studies have indicated a positive relationship between intelligence test performance and conservation (Almy et al., 1965; Dodwell, 1960; Elkind, 1961; Feigenbaum, 1963; Hood, 1962 and Smedslund, 1964). Feigenbaum, for example, found a positive relation between I.Q. (as measured

by the Stanford-Binet) and success in conservation of number. Each of these studies used different tests and methods to assess intelligence, ranging from administrations of standard intelligence tests to rank ordering, by the teachers, of Ss' intellectual abilities. Children from cultural minorities, e.g. Indian, Maori, generally receive a lower score on standard intelligence tests than their European counterpart (Ausubel, 1960; Cameron and Storm, 1965). Therefore, on the basis of this variable alone, one would expect subcultural groups to perform more poorly than the dominant cultural group. The only study to date failing to find any relationship between intelligence (measured by the Raven's Progressive Matrices) and ability to conserve is Goodnow's (1962) study.

> Performance.....appears to be quite unaffected by wide differences in matrices scores, and to be sensitive instead to a combination of age and some sort of personal maturity. Matrices scores appear to be a more-than-fair index of general intelligence (Goodnow, 1962, p. 8).

It is this personal maturity that Goodnow (1962) hypothesizes brought up the performance of semi-schooled, low income Chinese boys. As a protection against spurious matrices scores, E eliminated boys in this group who copied or obviously leaned on someone else for help (this kind of behavior was more prevelant in this group). "In eliminating these 'advice seekers' we may have ended up with the subjects who had the most assurance and independence of judgment." (Goodnow, 1962, p. 11). This enabled these boys to do well on the conservation tasks. Goodnow (1962) did find, however,

that performance on the Piaget combinatorial task was closely related to matrices scores of intelligence.

The fact that Goodnow's (1962) more mature Ss succeeded better on the conservation tasks suggests that some kind of temperamental variable may be involved in conservation performance.

It is surprising in view of the number of environmental variables in which cultural minority groups appear to be at a disadvantage, that greater differences have not been found in cross-cultural comparisons.

4) Training

Attention has recently been centered on the specific question of how children acquire conservation.

> Although Piaget has described some of the precursors of this notion of conservation in children who have not yet attained this level, little is known thus far about the specific ways in which the transition from lack of conservation to the presence of conservation takes place. It is apparent, however, that an adequate explanation of this problem ultimately requires a clearer understanding of the psychological processes at work in this transition phase (Wohlwill and Lowe, 1962, p. 153).

According to Smedslund (1961a) there are two possible and plausible explanations to account for the development of conservation. The first explanation, which Smedslund (1961a) calls a "learning theory" explanation, would state that conservation is the result of fairly specific learning, as a result of either direct external reinforcement, or the direct demonstration of conservation or reversibility. The

second explanation, labelled "equilibration theory", would state that conservation depends on the conceptual attainments already at the child's disposal together with activity and experience of a very general nature which serve to bring out the gaps and inconsistencies in the child's mental structures and lead to a complete inner reorganization. The first explanation is a continuous theory of the growth of intelligence, whereas the second explanation is a discontinuous theory.

Smedslund's (1961c) work on the effects of extinction on children conserving weight in a pretest seems to suggest that the effects of practice depend on initial developmental level. Smedslund (1961c) compared the effects of extinction on two groups of children ranging from five to seven years of age. Thirteen children had acquired conservation through normal life experience (demonstrated by a pretest) whereas eleven children had not shown conservation in a pretest, but conserved after two training sessions on external reinforcement of conservation of weight. External reinforcement consisted in allowing the child to return the balls to the scales after he had made a judgment about their relative weights, and note that, in fact, the two balls, in two different shapes, still weighed the same. Extinction procedures consisted of surreptitiously removing some of the plasticine from the deformed object. After three extinction trials, all of the children who had acquired conservation through training extinguished, whereas six out of thirteen children who had acquired conservation normally resisted extinction.

These results give tentative support to the equilibration theory as opposed to the learning theory interpretation.

> "On the basis of learning theory one may expect the notion of conservation can always be extinguished, regardless of whether it has been established in the laboratory or in normal life. This follows from the assumption that notions of conservation are dependent on external reinforcement. On the other hand, it follows from equilibration theory that a genuine principle of conservation should be practically impossible to extinguish, since it reflects an inner 'logical' necessity." (Smedslund, 1961c, pp. 85-86.)

Smedslund's interpretation of his results as providing a direct test of the merits of a "learning theory" as opposed to a non-learning theory approach is open to serious question. In the first place, it is not clear which of the many learning theories extent is being tested. It seems naive to suppose that there is a single prediction about the most effective method of producing conservation or a single interpretation of the way conservation comes about naturally that all learning theorists would agree upon, or that any single variety of learning theory would venture an explanation of conservation without a much more thorough analysis of the situation and the criteria in theoretically relevant terms than Smedslund has provided. The task is not the sort to which learning theories have characteristically been applied and does not lend itself readily to analysis in terms of the operations employed in learning studies. As such, it is clearly a challenge to learning theories, but it shows a lack of awareness of the subtleties of prediction

and interpretation of which learning theories are capable, particularly those that employ the concepts of mediating and cue-producing responses, to suppose, as Smedslund appears to suppose, that the failure of his direct external reinforcement to produce conservation resistant to extinction, is particularly damaging to some learning theory approach. For example, the external reinforcement method seems to assume and require that the child recognize a discrepancy between his verbal prediction and the stimuli presented by the demonstration and that this discrepancy be punishing to him, its absence positively reinforcing. Given these assumptions, the number and pattern of such negative and positive reinforcements, there is no reason to suppose that the tendency to make conserving responses would not be readily reversed when the reinforcement contingencies are reversed. This turns out to be the case.

This is not to imply that the conservation phenomena, or Piaget's findings generally, do not pose any problem for learning theory approaches, or that the conventional learning theory approaches may not, in the long run, turn out to be inadequate for these phenomena. In Smedslund's defense, it does seem, to the writer, that a general learning theory orientation does lead to the expectation that conservation could be extinguished and that Piaget's position strongly suggests, at least, very great difficulties in extinction, once the cognitive operations are firmly established. For this reason, procedures like Smedslund's extinction are very important in establishing the characteristics of conservation

and other Piagetian phenomena that require explanation, whatever the theoretical approach.

A well-designed study on the development of number was conducted by Wohlwill and Lowe (1962). Seventy-two kindergarten children (mean age five years, ten months) were assigned to four subgroups of 18 children each. All children received an individual pretest on both a nonverbal (a matching-from-sample technique) and conventional Piaget-type verbal test of conservation of number. Each subgroup received a different training experience followed by a verbal and nonverbal posttest. The verbal posttest involved answering the question "Who has more chips, you or I?" following distortions produced on one of two rows of chips. No further inquiry was made concerning the child's response to this question. The nonverbal posttest was, again, matching-from-sample as in the pretest. One subgroup was given reinforced practice in conservation by counting sets of elements before and after their spatial rearrangement. This method was intended to facilitate acceptance of the idea that number remains invariant in the face of irrelevant perceptual changes. The second group received similar reinforced practice along with the additional experience of seeing that addition and subtraction of elements did, in fact, change the numerical value of the set. This technique was intended as a means of helping the child to make the inference that if no elements were added or subtracted, then there could not be any change in numerical value. The third group was given practice in learning to dissociate the irrelevant dimension (length)

from the dimension of number. The S was allowed to see that a given number of units could be made to form rows varying in length. In the final group which served as a control condition, children were given practice in counting the row of varying numbers of objects always presented in the same spatial arrangement.

The results indicated that all groups (including the control group) improved significantly from pre-test to non-verbal post-test. Slightly more improvement was demonstrated in the group that had had experience in addition and subtraction but this did not reach significance. In terms of the verbal post-test, there were very few changes in any group.

The main body of work on the effects of training has been carried out by Smedslund (1961b, 1961d, 1961e, 1961f, 1962). One of Smedslund's (1961b) studies was similar to that of Wohlwill and Lowe (1962). In Smedslund's (1961b) study, 48 five to seven year old children participated. There were three groups, each group receiving pre and post-tests for conservation of weight. One group acted as a no training control group. The other two groups each received 32 training trials. One group was given reinforced trials on conservation of weight: after one plasticine ball had been deformed, the child could test his prediction by placing the two objects back on the scale. The second group also received reinforced practice on the scale, but in terms of noticing the effects on the relative weights of the objects produced by the operations of addition and subtraction

of small pieces of plasticine to one of the objects. Both Smedslund (1961b) and Wohlwill and Lowe (1962) were interested in whether exercise of a related schema (addition-subtraction) would aid in acquiring conservation. Smedslund's (1961b) results parallel those of Wohlwill and Lowe - significant improvement by all three groups from pre- to posttest, with no statistically significant between-group differences.

A further experiment by Smedslund (1961d) involved a training group similar to Wohlwill and Lowe's (1962) dissociation group. Eleven six-year old children were given experience in noticing the unreliability of perceptual size cues.

> It was attempted to extinguish the visual cues to weight by making them artificially unreliable. This procedure was expected to make the subjects search for more reliable cues to the level of symbolic representation of past events, and thereby lead to conservation. (Smedslund, 1961d, p.153).

In three 12-trial sessions, children had the opportunity to notice that larger objects were not necessarily heavier in weight than smaller objects. None of the Ss changed from no traces of conservation in the pretest to a stable notion of conservation in the posttest.

Feigenbaum and Sulken (1964) have also attempted to train children in conservation of number using methods similar to Wohlwill and Lowe's (1962) and Smedslund's (1961b, 1961d) addition-subtraction training and dissociation training. Fifty kindergarten children (varying in age from 61 months to 77 months) were placed in two groups. The children in the first training group (reduction of irrelevant stimuli) were blindfolded and told to drop beads into two glasses by

provoked correspondence (for example, one bead into the first glass; one bead into the second glass). Ss were told to pour the contents of one glass into a smaller glass. Questions of conservation were asked. To test for transfer without blindfold, the same operations were performed with wooden blocks. The second training group received practice on addition and sub-traction of items, followed by standard tests for conservation. Addition and subtraction involved showing S a pile of beads to which E added, or from which E subtracted a bead. E then asked S whether or not the number of beads had changed. If S did not give the right answer, E told him. Any S failing to conserve after training for reduction of irrelevant stimuli was then trained in addition-subtraction.

The results showed a significant difference between treatment groups, in favor of the first training method. No Ss who failed after the first training method, succeeded after the second training method.

Zimiles (1963) has offered an explanation for conservation which may explain these results. Children at the preconservation level or transitional conservation level are likely to respond to anyone of a number of dimensions (e.g. perceptual, numerical) depending on what has been manipulated or suggested by E. In this way, when E rearranges items spatially, the child's attention is drawn to this dimension and he gives a non-conservation response. Applying Zimiles' (1963) interpretation to Feigenbaum and Sulkin's (1964) results, the Ss who were blindfolded did not have an opportunity to attend to the perceptual dimension, therefore, they responded in terms of the numerical dimension, and by so

doing, increased their chances of conserving. Zimiles (1963) is concerned with explaining Wohlwill and Lowe's (1962) results in terms of such an analysis. It was noted that most improvement occurred in the control and addition-subtraction conditions.

> The control condition was the only one of the four training periods in which no spatial rearrangement of the test objects took place. The numerical, rather than the perceptual cue was manipulated. For the addition and subtraction conditions, the length of the row was varied, but this was probably obscured by the novelty of adding or subtracting an object two-thirds of the trials, once again supporting a numerical rather than a spatial orientation. (Zimiles, 1963, p. 694).

In the other two conditions (dissociation and reinforced practice) Ss were not given any indication of what dimension they were supposed to respond to, and therefore, these conditions tended to inhibit the adoption of a number set.

It should be noted that the kind of explanation offered by Zimiles (1963) for the training results could also be used as a possible explanation for the differences obtained in ages of attainment of conservation between Piaget (Oleron et al. 1963) and Braine (1959, 1964). In Piaget's procedures the child is not told which dimension is relevant to the solution of the problem, whereas in Braine's procedures an attempt is made to force the child to concentrate on the relevant dimension. Using Braine's procedures, the child is more likely to demonstrate conservation at an earlier age, but whether the child shows the necessary underlying thought

processes which to Piaget indicate an understanding of the principle of conservation is not clear.

With a few exceptions, the attempts at training using the methods outlined have been generally unsuccessful. Smedslund (1961e; 1961f) has recently come around to the view that the essential condition for the development of conservation from no conservation, is a state of cognitive conflict in the S. This supports Piaget's model which asserts that cognitive conflict forces the S to reorganize his thinking and it is this reorganization which leads to conservation. Furthermore, Smedslund does not consider that external reinforcement in terms of feedback about the Ss response leads to conservation. In Smedslund's experiment, cognitive conflict was induced by simultaneous deformation of an object and additions to or subtractions from another or the same object. This means that the two schemata of deformation and addition/subtraction come into contact and perhaps conflict.

> More concretely, the subjects who think that weight is changed when the ball is changed into a sausage, have to combine their impression of this change in weight with the observation that a piece is taken away from the other ball. If they think that the deformation into a sausage has made object A heavier, this is in agreement with the knowledge that object B has become lighter (since a piece has been taken away) and there is really no conflict; object A is judged heavier. On the other hand, if the deformation of object A into a sausage is seen as making object A lighter, there will be real conflict, since object B has also become lighter. The child has to reach a decision as to the relative size of the two changes, and the state

> of inner conflict and uncertainty preceding this decision may well have the effect of inducing pronounced cognitive changes." (Smedslund, 1961e, p. 156-157).

By means of a complicated training procedure, Smedslund (1961e) derives some support for his hypothesis in a study involving 13 children. There was no control group. Every item involved the presentation of two identical plasticine objects. One deformation, and one addition or subtraction was performed followed by the standard conservation question. Next, the reverse transformation of either the addition/subtraction or the deformation was carried out; followed again by the standard conservation question. The results indicated that five Ss consistently noticed the addition/subtraction schema and ignored the deformation. The reverse was true for the other eight Ss. Four out of five Ss who noticed the addition/subtraction changed from no conservation in a pretest to conservation including a logical rationale in the posttest. The small N, the absence of a control group, and the small number of Ss who conserved as a result of training does not provide very substantial support for Smedslund's theory. However, the results of an additional experiment by Smedslund (1961f) with a no-training control group tend to support his cognitive conflict hypothesis. The training was essentially the same except for the use of both continuous and discontinuous materials. The groups trained on either continuous or discontinuous materials improved more than the control group.

This training method may not owe its success to the fact that actual cognitive conflict was induced, but, as Zimiles (1963) interpretation would lead us to believe, to the fact that some of the subjects trained under these conditions had their attention focussed on the numerical dimension, and considered that E wanted them to respond in terms of this dimension. If this is the case then the concept of cognitive conflict is superfluous.

Smedslund (1962) has also obtained data that supports Piaget's theory that conservation requires the understanding of a complete reversibility of the operations of addition and subtraction. In an experiment on discontinuous quantity which involved a number of items of different types of addition and subtraction, only one item involved the principle of reversibility (the subtraction of a piece and a subsequent addition of the same piece, followed by an addition of a piece and a subsequent subtraction of the same piece). This means that E took one piece away from the left pile of 48 squares and then added one piece to the left pile. E then added one piece to the right pile of 48 squares and then subtracted one piece. Conservation was found to be significantly related to this item. Wallach and Sprott (1964) also found that conservation could be induced in first grade children by giving them experience with the reversibility of rearrangements. Wallach and Sprott (1964) consider that the Ss' coming to think of the possibility of reversal may account for attainment of conservation in previous studies. Although most of these studies have not provided training

on reversibility experience was given which might lead Ss who knew about reversibility in ordinary life to take it into consideration. This would also apply to the cases where control groups were used. In other words, the possibility of reversal may be presented to the S by testing for conservation itself which involves some experience with transformations. Any extensive training may be expected to increase attention to possible transformations.

In a recent study by Beilin (1965), 170 kindergarten children were tested, trained and retested on several conservation tasks. Ss received training on number and length conservation using nonverbal reinforcement (S was notified of a correct response by a buzzer or tokens), verbal orientation reinforcement (verbal orientation to the relevant attribute, e.g. "You have to figure out which is the same length (or number) as this one"), verbal rule instruction (a statement of the rule applied to the problem in each instance of an unsuccessful trial response) and equilibration (the spatial arrangement of objects underwent transformation). A control group was also included. All groups (including the control group) significantly improved in conservation from pre- to posttest. Only the verbal rule instruction group improved significantly more than the control group.

It is possible to reach some general conclusions on the efficacy of the training methods which have so far been attempted. It seems, first of all, that children are more likely to change from non-conservers to conservers during the training periods if their attention is drawn to the relevant

dimension, rather than if they are doubtful about which dimension to notice. This could help to explain the relative successes of Wohlwill and Lowe's (1962) addition and subtraction method, Smedslund's (1961e, 1961f) cognitive conflict method, Feigenbaum and Sulkin's (1964) reduction of irrelevant stimuli method, Wallach and Sprott's (1964) reversibility method, and Beilin's (1965) statement of the verbal rule method.

Secondly, it seems clear that no training method has been totally successful. It may be that short training periods are ineffective, because, as Piaget indicates, the acquisition of conservation depends on the child's initial cognitive level and interactions with the environment of a very general nature. On the other hand, it may be that this process can be speeded up by drawing the child's attention to certain dimensions and principles relevant to conservation e.g. the principle of reversibility. Whether the child graeps the importance of these principles may well depend on his cognitive level. However, Feigenbaum and Sulkin (1964) found little difference in ability to change to conservation after training between "bright" and "dull" children (as measured by the "Detroit Beginning First-Grade Intelligence Test").

The conflicting results obtained from the area of cross-cultural testing for Piaget's developmental stages and from the area of inquiry into the processes at work in the acquisition of conservation have determined the direction of

this study. The main purpose of this study is to extend the range of population to which generalizations about developmental stages can be applied by comparing Indian and white children in British Columbia on two Piagetian tasks, namely, conservation of weight and conservation of number. The second purpose is to determine the effects of extinction procedures for conservation of weight and number on those children with conservation and to compare, by this method, Indians and whites in terms of the stability of their conservation responses. A third and subsidiary purpose is to attempt to train for conservation of weight by two methods, in order to assess the effect of different methods of training on the acquisition of the concept.

A recent survey of Canadian Indians by Hawthorne et al. (1966) has shown that the Indians of British Columbia, and of Canada in general, like many subcultural groups, generally live in a deprived and unstable environment: "the majority of the Indian population constitutes a group economically depressed in terms of the standards that have become widely accepted in Canada" (Hawthorne et al., 1966, p. 21). The fathers are usually unemployed for long periods during the year, and when employed, obtain only semi- or unskilled positions. "Owing to extremely high and rising rates of natural increase, Indians are increasing in numbers more rapidly than their local resources and traditional means of livelihood can support." (Hawthorne, et al. 1966, p. 22).

As a result of family size and instability, it seems likely that Indian children receive less attention from

adults than white children whose families are usually smaller, marriages more stable, and employment, even at the lowest level, more permanent. The Indian children's interactions with adults are less likely to revolve around activities and play materials which have direct relevance to intellectual skills to the same extent as in white homes.

Indian children are retarded in language skills.[1] This presumably reflects a lower level of verbal interaction in the home, reflecting the low level of parental education, and perhaps the effects of large and unstable families. Indian children perform poorly in school and on conventional achievement tests (Cameron and Storm, 1965). Cameron and Storm (1965), in a typical concept formation type of experiment with B.C. Indian children showed that motivational factors, differing from white children of a comparable age, contributed to the inferior performance of the subgroup. It seems likely, however, that in addition to motivational and emotional factors, cognitive variables may account for a large part of the retardation in the classroom.

It does not seem to follow from Piaget's theory of intellectual development that the verbally impoverished environment in and of itself should affect intellectual development in Piaget's sense. Environmental differences of the sort reflected in the number and variety of manipulative

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[1]This generalization is based on the author's observation and personal communication with Joan Ryan, co-author of the section on education to appear in the second volume of Hawthorne et al. A Survey of the Contemporary Indians of Canada.

toys might, on the other hand be expected, from a Piagetian point of view, to affect the rate of development of cognitive structures. This is not entirely clear. It might be that the natural environment provides all the experiences necessary to the development of concepts of conservation, and that the added complexities of the white Canadian environment provide no further benefit. If the latter is the case, there should be no differences between Indian and white Canadian children.

Most studies have supported the generality of Piaget's developmental sequence. Therefore, it is to be expected that conservation of number will be demonstrated in both groups before conservation of weight. On the basis of previous studies, one would expect to find a general increase in conservation on both tasks with increasing age, and, specifically, one would expect to find in the white Ss that conservation of number appears around seven years of age and conservation of weight around nine to ten years.

CHAPTER II

METHODS AND RESULTS

Conservation of Weight and Number

Smedslund's (1961b, 1961f, 1962) procedures were selected in order to test for conservation of weight and number. They were chosen primarily because they reduced verbalization, and, in this way, might not appear to discriminate unduly against the Indian Ss. Testing was first carried out on a matched sample of Indian and white children. This sample is referred to throughout as the matched sample. Testing was then extended to a larger group of Indian and white children. This larger sample, which includes the Ss from the matched sample, is called the total sample.

Matched Sample

Subjects

Thirty-four Indian Ss and thirty-four white Ss were selected for the study. Ss were matched on the basis of age, grade, sex and years of schooling. The age difference between matched Ss was never more than three months. Ss ranged from six to ten years of age. The mean age for the Indian sample was 95.94 months; the mean age for the white sample was 95.85 months. Ss were selected from grades one to four. There were 11 Ss from each group in grade one; 5 Ss from each group in grade two; 14 Ss from each group in grade three; and 4 Ss from each group in grade four. All children selected from grade one were in their first year

of school; all children from grade two in their second year; 11 children from grade three in each group were in their third year of school, 3 children from grade three in each group were in their fourth year; all children from grade four were in their fourth year.

The Indian Ss lived on the Capilano Reserve in North Vancouver and went to a Catholic day school. According to their teachers, many Indians came from broken and unstable homes. An attempt was made to obtain information from the teachers and children themselves regarding the occupations of the Indian fathers. This information often could not be provided by these sources, or was very vague. It appeared that the Indian fathers tended to be unemployed, seasonal workers or in unskilled positions. This is consistent with the report of Hawthorne et al. (1966) on the economic status of Indians on reserves.

The white Ss attended a provincial school, also in North Vancouver. More fathers of the white children appeared to be employed in white collar and skilled positions. There appeared to be considerably less unemployment among the fathers of the white children. While no exact comparisons of socio-economic status for Indian and white groups could be made, it seems reasonably certain that differences existed and that in terms of stability of employment, income training, skill, and prestige, the comparisons would have favored the whites.

Procedure

Each S was tested individually in a small room in his

own school. S and E were seated at a table on which the testing materials were placed. The procedure included, in the following order:

1) demonstration of scales

2) test for conservation of weight

3) test for conservation of number

1) Demonstration of scales. Because Ss might be unfamiliar with the process of weighing objects on a balance scale, they were given some preliminary practice to ensure that all Ss would be comparable in this respect.

The scales were made of metal. They were the equal-arm (beam) balance type used in an introductory physics laboratory. They were approximately two feet long, eight inches wide and two feet high. The beam was suspended at its centre on a knife-edge at right angles to the beam; pans of equal weight hung at each end, equidistant from the fulcrum. At the place where the pointer indicated the relative weights of two objects in the pans, the more detailed markings had been covered with a piece of adhesive brown paper. A heavy black line indicated when the pointer was at zero and the beam was in equilibrium.

The scales were demonstrated to all Ss. E began by saying "This is a balance. Do you know how it works?" If S said "No," E said "O.K. Then I'll show you." If S said "Yes", E said "Well, let's go through it just to make sure." E produced two objects, a ball-bearing and a marble of approximately equal size, and said "Now I've got two objects here, a heavy ball-bearing and a marble which isn't as

heavy as the ball-bearing. You pick them up and see which is heavier." S picked up the objects and indicated that the ball-bearing was heavier. E continued "If I take this heavy ball-bearing and put it in this pan on this side of the balance, and take this marble, which doesn't weigh as much as the ball-bearing, and put it in this pan on the other side of the balance, what do you think will happen?" S made a prediction or indicated that he did not know. E said "O.K. Let's have a look." E placed the ball-bearing and marble in the pans on the scale. E said "You see what happens. Because the ball-bearing weighs more than the marble, it pulls the pan down on this side and the pointer," (E drew attention to the pointer in the middle of the scales) "goes off to the other side. Now if I put the ball-bearing in the pan on the other side, and the marble in this pan, what do you think will happen?" S made another prediction. E reversed the positions of the two objects and said "You see, the ball-bearing pulls the pan down on this side now, and the pointer goes off to the other side. Whenever one object weighs more than another, it pulls the pan down on the heavier side and the pointer goes off in the other direction. The heavy side always goes down and the lighter side goes up."

E produced two marbles of identical weight. E said "Now, I've got two marbles here which both weigh the same. You pick them up and see how they both weigh the same." S picked up the marbles and agreed that they felt as though

they weighed the same. (No S ever disagreed on this point.) E continued "O.K. Now, if I put them on the balance, one in the pan at each end, what do you think will happen?" S predicted the outcome. E placed the marbles, one in each pan of the scales and said "You see, the arm at the top stays straight, and the pointer stays on the black line right in the middle. That's because both objects weigh the same. Whenever two objects weigh the same, the pointer stays right on the black line."

2) Test for conservation of weight. This test consisted of three trials following the same procedure. On the first trial, E presented two balls of green plasticine of equal weight and volume. The balls were approximately two inches in diameter. E said "I have two balls of plasticine here, which both weigh the same. Let's put them on the balance to make sure that they both weigh the same." E put the balls on the scales. E said "You see, the pointer stays on the black line in the middle. That's because both balls weigh the same." E placed the plasticine balls back on the table, and said "Now I'm going to make this ball into a cup". E deformed one of the balls. Then E asked the standard conversation question, always putting the alternatives in the same order, "Do you think the cup weighs more, or the same as, or less than the ball?" After S had replied, he was asked "Why do you think so?" S's answer was recorded verbatim.

Each trial involved a different transformation. The stimulus materials were weighed on every trial.

The trials were as follows:

Trial I: Two green balls, one ball was changed into a cup.

Trial II: Two blue balls, one ball was changed into a ring.

Trial III: Two yellow balls, one ball was changed into a cross.

3) Test for conservation of number. This test also involved three trials. On the first trial, E produced two equal collections of 25 red plastic discs. The discs were the kind used in tiddlywinks. E said "I have two piles of plastic discs here. Each pile has exactly the same number of discs in it. I'm going to count the discs in each pile to show you that there's the same number in each. You watch carefully and count with me to check." E counted the discs in each pile, and said "You see there are 25 discs in each pile - the same number in each pile. Now, I'm going to make this pile into a ring." E re-arranged one pile and then asked the standard question: "Do you think the ring has more discs, the same number of discs, or less discs than the pile?" After S had responded, E asked "Why do you think so?" and recorded his answer verbatim.

Each trial involved a different arrangement of the stimulus materials. The stimulus materials were counted on every trial. The trials were as follows:

Trial I : two piles of red plastic discs, one pile was changed into a ring.

Trial II : two piles of yellow plastic discs, one pile was changed into a triangle.

Trial III: two piles of blue plastic discs, one pile was changed into a cross.

In the conservation tests, S's answers to the conversation questions and his explanations of his answers were never positively or negatively reinforced. E asked questions in a neutral voice. The total testing time was approximately 15-20 minutes.

Results

1) Conservation of Weight. The criterion adopted for conservation was three conservation responses out of three trials. Table I presents the results for Indians and whites. Thirteen out of thirty-four whites (36.1%) and thirteen out of thirty-four (36.1%) Indians showed conservation of weight. There was no difference between the two groups.

The relationship between age and conservation of weight is the same as the relationship between grade and conservation of weight (Table 2). All six and seven year olds were in grades one and two; all eight, nine and ten year olds were in grade three and four. There is a tendency for older children (eight, nine and ten year olds) to conserve more than younger children (six and seven year olds). Thus, 30% of the six and seven year olds conserved, whereas 44% of the eight, nine and ten year olds conserved. In the same way, children in higher grades (grades three and four) tended to conserve more than children in lower grades (grades one and two). In order to test the significance of this tendency, the six and seven year olds (or the first and second graders) were compared with the eight, nine and ten year olds (or the third and fourth graders). However, the

TABLE 1

Matched Sample: Conservation of Weight for Indian and White Ss.

Group	Nonconservation		Conservation		Total
Indian	21	(63.9)[a]	13	(36.1)	34
White	21	(63.9)	13	(36.1)	34
Total	42	(61.8)	26	(38.2)	68

[a]All numbers in brackets refer to percentages in this table and in succeeding tables

TABLE 2

Matched Sample: Conservation of Weight by Age and Grade for Indians and Whites Combined

Age	Grade	Nonconservation		Conservation		Total
6 and 7	1 and 2	22	(70)	10	(30)	32
8,9 and 10	3 and 4	20	(56)	16	(44)	36
Total		42	(61.8)	26	(38.2)	68

relationship between weight and age and weight and grade was not significant (χ^2 = .753, df = 1, N.S.). This relationship was not significant for the Indian group or for the white group taken separately (Table 3). Comparing six and seven year olds with eight, nine and ten year olds (or first and second graders with third and fourth graders) χ^2 for the Indians was .00 (df = 1, N.S.) and for the whites 1.31 (df = 1, N.S.).

2) Conservation of number. The criterion for conservation of number was the same as for conservation of weight, that is, three conservation responses out of a total of three trials. Twenty-eight (82.4%) out of 34 Indians and 26 (76.5%) out of 34 whites showed conservation of number (Table 4). The two groups did not differ significantly.

The relationship between age and conservation of number and grade and number is the same (Table 5). There is again a tendency for more Ss to conserve at the upper age and grade levels, but this tendency is not significant. Comparing six and seven year olds (or first and second graders) with eight, nine and ten year olds (or third and fourth graders) χ^2 = .292 (df = 1, N.S.).

It did not appear that either Indians or whites increased significantly in conservation with increasing age (Table 6): It was not possible to estimate a χ^2 since the expected values were too low.

3) Comparative performance of Indians and whites on both tasks.

The number of Indian and white children showing conservation

TABLE 3

Matched Sample: Conservation of Weight by Age and Grade for Indian and White Groups

Age	Grade	Nonconservation		Conservation		Total	
		Indian	White	Indian	White	Indian	White
6 and 7	1 and 2	10(62.5)	12(75)	6(37.5)	4(25)	16	16
8,9 and 10	3 and 4	11(61.1)	9(50)	7(38.9)	9(50)	18	18
Total		21(61.8)	21(61.8)	13(38.2)	13(38.2)	34	34

TABLE 4

Matched Sample: Conservation of Number for Indian and White Ss

Group	Nonconservation	Conservation	Total
Indian	6 (17.6)	28 (82.4)	34
White	8 (23.5)	26 (76.5)	34
Total	14 (20.6)	54 (79.4)	68

TABLE 5

Matched Sample: Conservation of Number by Age and Grade for Indians and Whites Combined

Age	Grade	Nonconservation	Conservation	Total
6 and 7	1 and 2	8 (25)	24 (75)	32
8, 9 and 10	3 and 4	6 (16.6)	30 (83.3)	36
Total		14 (20.6)	54 (79.4)	68

TABLE 6

Matched Sample: Conservation of Number by Age and Grade for Indian and White Groups

Age	Grade	Nonconservation		Conservation		Total	
		Indian	White	Indian	White	Indian	White
6 and 7	1 and 2	3(18.8)	5(31.3)	13(81.2)	11(68.7)	16	16
8,9 and 10	3 and 4	3(16.7)	3(16.7)	15(83.3)	15(83.3)	18	18
Total		6(17.6)	8(23.5)	28(82.4)	26(76.5)	34	34

on neither task, conservation on one task but not the other, and conservation on both tasks is shown in Table 7. Thirteen children did not conserve weight or number. Thirty children showed conservation on one task. The one task on which 29 out of these 30 children conserved was number. This indicated that number was conserved before weight. Twenty-five children conserved both weight and number. There were no significant differences between Indians and whites when they were arranged on this type of scale (that is, conservation on neither task, on one task, or on both tasks), although there was a slight tendency for Indians to show more conservation than whites. χ^2 between Indians and whites was 1.27 (*df* = 2, N.S.).

The same relationship held between age and performance on both tasks as between grade and performance on both tasks (Table 8). Eight, nine and ten year olds (or third and fourth graders) tended to conserve more often than six and seven year olds (or first and second graders), but this did not reach significance (χ^2 = 1.94, *df* = 2, N.S.). Neither Indians nor whites significantly improved in performance with increasing age or grade. Because of the small *N*s, the only way to test this was by comparing conservation on neither task or on one task with conservation on both tasks (Table 9). χ^2 for the Indians was .01 (*df* = 1, N.S.) and for the whites was 1.31 (*df* = 1, N.S.).

TABLE 7

Matched Sample: Comparative Performance of Indians and Whites on Both Conservation Tasks

Group	No conservation on either task	Conservation on one task	Conservation on both tasks	Total
Indian	5 (14.7)	17 (50)	12 (35.3)	34
White	8 (23.5)	13 (38.2)	13 (38.2)	34
Total	13 (19.1)	30 (44.1)	25 (36.8)	68

TABLE 8

Matched Sample: Relationship between Age and Performance on Both Tasks and Grade and Performance on Both Tasks for Indians and Whites Combined

Age	Grade	No conservation on either task	Conservation on one task	Conservation on both tasks	Total
6 and 7	1 and 2	7 (21.9)	16 (50)	9 (28.1)	32
8, 9 and 10	3 and 4	6 (16.7)	14 (38.9)	16 (44.4)	36
Total		13 (19.1)	30 (44.1)	25 (36.8)	68

TABLE 9

Matched Sample: Relationship between Age and Performance on Both Tasks and Grade and Performance on Both Tasks for Indian and White Groups

Age	Grade	No conservation on either task or conservation on one task		Conservation on both tasks		Total	
		Indian	White	Indian	White	Indian	White
6 and 7	1 and 2	11(68.8)	12(75)	5(31.3)	4(25)	16	16
8,9 and 10	3 and 4	11(61.1)	9(50)	7(38.9)	9(50)	18	18
Total		22(64.7)	21(61.8)	12(35.3)	13(38.2)	34	34

Total Sample

Subjects

In order to increase the number of Ss available for testing differences between groups and in view of the possibility that the matched sample might be unrepresentative of the groups from which it was drawn, an additional 33 Indians and 42 whites were tested for conservation of weight and number. This section will present the procedure and results for the total sample of Indians and whites, including those Ss who were in the matched sample.

The total Indian sample consisted of all Indian children present in grades one through four on the days that testing took place. Indian Ss ranged from five to eleven years of age. It was not possible to test all the white children in grades one through four. Therefore, an attempt was made to select and test as many whites as time permitted who approximated the distribution of age and grade represented by the Indians. All white Ss were from grades one through four and were between six and ten years old.

The question arises as to whether this total sample of whites was representative of the total population of white children in the first four grades. Table 1 in the appendix shows that difference between the ages of tested white Ss and untested white children at each grade level was not significant. Table 2 in the appendix shows that there was no significant difference between the number of tested Ss who had been held back and the number of untested children who

had been held back. There was no strong evidence, therefore, that the white sample was unrepresentative of the total population of whites in the first four grades as this school, although the t tests at grades one and four approached significance.

Procedure

The procedure for the additional whites and Indians tested was exactly the same as for the matched sample.

Results

1) Conservation of weight. Twenty-two (28.9%) out of 76 whites and 31 (46.3%) out of 67 Indians conserved weight (Table 10). Significantly more Indians conserved that whites (X^2 = 3.87, df = 1, $.02 < p < .05$).

The number of Ss in both groups showing conservation according to age is presented in Table 11. The results supported the relationship between age and conservation of weight for the matched sample alone, that is, there was a consistent tendency towards more conservation with increasing age, but this did not reach significance (X^2 = 4.51, df = 4, N.S.).

Five and eleven year olds were omitted from this analysis of the relationship between conservation and age because of the small Ns. Their inclusion would not have altered the results obtained. The four five-year olds and the two eleven-year olds in the sample did not conserve weight.

The relationship between age and conservation of weight for each group is shown in Table 12. Although there is a trend

TABLE 10

Total Sample: Conservation of Weight for Indian and White Ss

Group	Nonconserv.	Conserv.	Total
Indian	36 (53.7)	31 (46.3)	67
White	54 (71.1)	22 (28.9)	76
Total	90 (62.9)	53 (37.1)	143

TABLE 11

Total Sample: Conservation of Weight by Age for Indians and Whites Combined

Age	Nonconserv.	Conserv.	Total
6	19 (73.1)	7 (26.9)	26
7	21 (65.6)	11 (34.4)	32
8	22 (62.9)	13 (37.1)	35
9	14 (51.9)	13 (48.1)	27
10	8 (47.1)	9 (52.9)	17
Total	84 (61.3)	53 (38.7)	137

TABLE 12

Total Sample: Conservation of Weight by Age for Indian and White Groups

Age	Nonconserv.		Conserv.		Total	
	Indian	White	Indian	White	Indian	White
6 & 7	15(55.6)	25(80.6)	12(44.4)	6(19.4)	27	31
8,9 & 10	15(44.1)	29(64.4)	19(55.9)	16(35.6)	34	45
Total	30(49.2)	54(71.1)	31(50.8)	22(28.9)	61	76

in the expected direction neither group showed a significant increase in conservation of weight as age increased. Comparing six and seven year olds with eight, nine and ten year olds, X^2 for the Indians was .40 (df = 1, N.S.) and for the whites was 1.62 (df = 1, N.S.).

The relationship between grade and conservation of weight for Indians and Whites combined is shown in Table 13, and for Indians and whites separately in Table 14. There was a strong tendency, approaching significance, for more Ss to conserve in the higher grades (X^2 = 7.06, df = 3, $.05 < p < .10$). X^2 for the Indians alone, comparing first and second graders with third and fourth graders was 1.29 (df = 1, $p > .20$), and for the whites alone was 2.89 (df = 1, $.05 < p < .10$). The relationship between grade and conservation appeared to be a little stronger for the whites than for the Indians.

2) Conservation of number. Sixty (78.9%) out of the 76 whites and 51 (76.1%) out of the 67 Indians conserved number (Table 15). There was no difference between Indians and whites (X^2 = .04, df = 1, N.S.).

The relationship between age and conservation of number is shown in Table 16 for both groups combined and in Table 17 for Indians and whites alone. Five and eleven year olds were again omitted from the analysis. The four five-year olds did not conserve, while the two eleven-year olds did. Conservation did not increase significantly with increasing age, either for both groups combined or for Indians and

TABLE 13

Total Sample: Conservation of Weight by Grade for Indians and Whites Combined

Grade	Nonconserv.	Conserv.	Total
1	33 (76.7)	10 (23.3)	43
2	15 (65.2)	8 (34.8)	23
3	30 (58.8)	21 (41.2)	51
4	12 (46.2)	14 (53.8)	26
Total	90 (62.9)	53 (37.1)	143

TABLE 14

Total Sample: Conservation of Weight by Grade for Indian and White Groups

Grade	Nonconserv.		Conserv.		Total	
	Indian	White	Indian	White	Indian	White
1 & 2	20(62.5)	28(82.4)	12(37.5)	6(17.6)	32	34
3 & 4	16(45.7)	26(61.9)	19(54.3)	16(38.1)	35	42
Total	36(53.7)	54(71.1)	31(46.3)	22(28.9)	67	76

TABLE 15

Total Sample: Conservation of Number for Indian and White Ss

Group	Nonconserv.	Conserv.	Total
Indian	16 (23.9)	51 (76.1)	67
White	16 (21.1)	60 (78.9)	76
Total	32 (22.4)	111 (77.6)	143

TABLE 16

Total Sample: Conservation of Number by Age for Indians and Whites Combined

Age	Nonconserv.	Conserv.	Total
6	7 (26.9)	19 (73.1)	26
7	8 (25.0)	24 (75.0)	32
8	5 (14.3)	30 (85.7)	35
9	6 (22.2)	21 (77.8)	27
10	2 (11.8)	15 (88.2)	17
Total	28 (20.4)	109 (79.6)	137

TABLE 17

Total Sample: Conservation of Number by Age for Indian and White Groups

Age	Nonconserv.		Conserv.		Total	
	Indian	White	Indian	White	Indian	White
6 & 7	6(22.2)	9(29.0)	21(77.8)	22(71.0)	27	31
8,9 & 10	6(17.6)	7(15.6)	28(82.4)	38(84.4)	34	45
Total	12(19.7)	16(21.1)	49(80.3)	60(78.9)	61	76

whites taken separately. χ^2 for both groups combined was 2.73 (df = 4, N.S.); comparing six and seven year olds with eight, nine and ten year olds, χ^2 for the Indians was .02 (df = 1, N.S.), and for the whites was 1.27 (df = 1, N.S.).

A comparison of the total number of Ss conserving at each grade level (Table 18) showed that more Ss conserved in the higher grades than in the lower grades (χ^2 = 7.33, df = 3, $.05 < p < .10$). The relationship between conservation and grade for each ethnic sample is presented in Table 19. Neither group conserved significantly more in the third and fourth grade than the first and second grade (χ^2 for the Indians was .97, df = 1, N.S. χ^2 for the whites was 1.75 df - 1, N.S.).

3) Effects of using a different criterion for conservation.

An attempt was made to see whether the results for conservation of weight and number would be the same if a different criterion for conservation had been used. Ss were scored on the basis of the number of correct (i.e. conservation) responses. Scores, therefore, ranged from 0 - 3 on each conservation task. The scores for Indians and whites for conservation of number are presented in Table 20. Using either of the two alternative criteria - one or more conservation responses or two or more conservation responses - there was still no significant difference between Indians and whites (χ^2 for a criterion of one or more conservation responses was 1.64, df = 1, N.S.; χ^2 for a criterion of two or more conservation responses was .11 , df = 1, N.S.)

TABLE 18

Total Sample: Conservation of Number by Grade for Indians and Whites Combined

Grade	Nonconserv.	Conserv.	Total
1	15 (34.9)	28 (65.1)	43
2	5 (21.7)	18 (78.3)	23
3	10 (19.6)	41 (80.4)	51
4	2 (7.7)	24 (92.3)	26
Total	32 (22.4)	111 (77.6)	143

TABLE 19

Total Sample: Conservation of Number by Grade for Indian and White Groups

Grade	Nonconserv.		Conserv.		Total	
	Indian	White	Indian	White	Indian	White
1 & 2	10(31.3)	10(29.4)	22(68.7)	24(70.6)	32	34
3 & 4	6(17.1)	6(14.3)	29(82.9)	36(85.7)	35	42
Total	16(23.9)	16(21.1)	51(76.1)	60(78.9)	67	76

TABLE 20

Total Sample: Conservation Responses for Number

Group	Number of Conservation Responses				Total
	0	1	2	3	
Indian	3(4.5)	9(13.4)	4(6.0)	51(76.1)	67
White	9(11.8)	2(2.6)	5(6.6)	60(78.9)	76
Total	12(8.4)	11(7.8)	9(6.3)	111(77.6)	143

This indicated that regardless of the criterion adopted for conservation, the lack of difference between Indians and whites was maintained for conservation of number.

The scores for Indians and whites for conservation of weight are presented in Table 21. Using any less stringent criterion for conservation, the difference between Indians and whites that was significant between the .02 and .05 level became more significant (X^2 for a criterion of two or more conservation responses was 4.96, df = 1, p = <.02; X^2 for a criterion of one or more conservation response was 8.92, df = 1, p = <.01). This difference only appeared in a comparison of Indians and whites in the total sample. Table 22 shows that changing the criterion for conservation of weight for the matched sample alone did not lead to any significant difference between Indians and whites (X^2 for a criterion of two or more conservation responses was .00, df = 1, N.S.; X^2 for a criterion of one or more conservation responses was .261, df = 1, N.S.).

4) Comparative performance of Indians and Whites on both tasks. The number of Indian and white Ss showing no conservation, conservation on one task, and conservation on both tasks is presented in Table 23. Only four out of 143 Ss conserved weight without number. This again indicated that in all but a very few cases, number was conserved before weight. Arranging Ss on this three point scale, with conservation on one task as an intermediate value, there was no difference between Indians and whites in their performance

TABLE 21

Total Sample: Conservation Responses for Weight

Group	Number of Conservation Responses 0	1	2	3	Total
Indian	14(20.9)	14(20.9)	8(11.9)	31(46.3)	67
White	35(46.1)	12(15.8)	7(9.2)	22(28.9)	76
Total	49(34.3)	26(18.2)	15(10.5)	53(37.1)	143

TABLE 22

Matched Sample: Conservation Responses for Weight

Group	Number of Conservation Responses 0	1	2	3	Total
Indian	10(29.4)	6(17.6)	5(14.7)	13(38.2)	34
White	13(38.2)	4(11.8)	4(11.8)	13(38.2)	34
Total	23(33.8)	10(14.7)	9(13.2)	26(38.2)	68

TABLE 23

Total Sample:
Comparative Performance of Indians and Whites
on Both Conservation Tasks

Group	No conserv. on either task	Conserv. on one task	Conserv. on both tasks	Total
Indian	13(19.4)	26(38.8)	28(41.8)	67
White	15(19.7)	40(52.6)	21(27.6)	76
Total	28(19.6)	66(46.2)	49(34.3)	143

on both tasks. (χ^2 = 3.56, df = 2, N.S.).

The relationship between performance on both conservation tasks and age for Indians and whites combined is shown in Table 24. Five and eleven year old Ss were omitted. Eight, nine and ten year olds were more likely to conserve on both tasks (43%) than six and seven year old Ss (25.8%), but this did not reach significance (χ^2 = 4.3, df = 2, N.S.).

Performance on both tasks for Indians and whites taken separately (Table 25), comparing six and seven year olds with eight, nine and ten year olds showed the same trend, but not reaching significance (χ^2 for the Indians was 1.78, df = 2, N.S.; χ^2 for the whites was 3.78, df = 2, N.S.).

The relationship between grade and performance on both tasks is shown in Table 26 for Indians and whites combined and in Table 27 for Indians and whites separately. Conservation on both tasks consistently increased in the higher grades, but not significantly (χ^2 for the Indians and whites combined was 9.93, df - 6, $p > .10$). White Ss in grades three and four conserved more on both tasks than whites in grades one and two (χ^2 = 5.59, df = 2, $.10 > p > .05$). Indians were not as likely as white Ss to conserve more in the higher grades than in the lower grades (χ^2 = 3.0, df = 2, N.S.).

TABLE 24

Total Sample:
Relationship between Performance on Both Conservation Tasks and Age for Indians and Whites Combined

Age	No conserv. on either task	Conserv. on one task	Conserv. on both Tasks	Total
6 & 7	12 (20.7)	31 (53.4)	15 (25.9)	58
8,9 & 10	12 (15.2)	33 (41.8)	34 (43.0)	79
Total	24 (17.5)	64 (46.7)	49 (35.8)	137

TABLE 25

Total Sample:
Relationship Between Performance on Both Conservation Tasks and Age for Indians and White Groups

Age	No conserv. on either task		Conserv. on one task		Conserv. on both tasks		Total	
	Indian	White	Indian	White	Indian	White	Indian	White
6 & 7	4(14.8)	8(25.8)	13(48.1)	18(58.1)	10(37.0)	5(16.1)	27	31
8,9 & 10	5(14.7)	7(15.6)	11(32.4)	22(48.9)	18(52.9)	16(35.6)	34	45
Total	9(14.8)	15(19.7)	24(39.3)	40(52.6)	28(45.9)	21(27.6)	61	76

TABLE 26

Total Sample:
Relationship Between Grade and Performance on Both Conservation Tasks for Indians and Whites Combined

Grade	No conserv. on either task	Conserv. on one task	Conserv. on both tasks	Total
1	13 (30.2)	22 (51.2)	8 (18.6)	43
2	4 (17.4)	12 (52.2)	7 (30.4)	23
3	9 (17.6)	22 (43.1)	20 (39.2)	51
4	2 (7.7)	10 (38.5)	14 (53.8)	26
Total	28 (19.6)	66 (46.2)	49 (34.3)	143

TABLE 27

Total Sample:
Relationship Between Grade and Performance on
Both Tasks for Indian
and White Groups

Grade	No conserv. on either task		Conserv. on one task		Conserv. on both tasks		Total	
	Indian	White	Indian	White	Indian	White	Indian	White
1 & 2	8(25.0)	9(26.5)	14(43.8)	20(58.8)	10(31.3)	5(14.7)	32	34
3 & 4	5(14.3)	6(14.3)	12(34.3)	20(47.6)	18(51.4)	16(38.1)	35	42
Total	13(19.4)	15(19.7)	26(38.8)	40(52.6)	28(41.8)	21(27.6)	67	76

Resistance to Extinction of Conservation of Weight and Number

It was decided to duplicate Smedslund's (1961c) extinction procedures, in the first place to see whether children who conserved on both tasks would be resistant to extinction, and in the second place to see whether there would be differences between the two conservation tasks in amount of resistance to extinction.

Subjects

Twelve Indian and 12 white Ss were selected for the extinction procedures. All 24 Ss had shown, in the initial testing, that they could conserve weight and number. An attempt was made to select Ss who approximated the same age and grade distribution (Table 28)

Both Indian and white Ss had previously been tested for conservation over a period of two weeks; Indians as a group were tested before whites. Testing for resistance to extinction occurred three and a half or four and a half weeks after the original testing for white Ss, and six and a half or seven and a half weeks after the original testing for Indian Ss. All Ss were tested for resistance to extinction of weight six days before they were tested for resistance to extinction of number.

Procedure

Testing conditions and materials used during extinction were the same as those used during the original testing.

TABLE 28

Comparison of Age and Grade Level
for White and Indian Ss.

Grade	Age 6		7		9		10	
	Indian	White	Indian	White	Indian	White	Indian	White
1	2	2	1					
2			3	4				
3					1	2		
4					2	1	3	3
Total	2	2	4	4	3	3	3	3

S and E were again seated at a small table on which the stimulus materials and scales were placed. The extinction procedure consisted of three parts:

1) a brief demonstration of the scales

2) extinction of weight

3) extinction of number

1) Demonstration of the scales. In case any of the Ss had forgotten how the scales worked, it was felt that they should be briefly demonstrated again. E said "You've already learned how the scales work. Do you remember?" All Ss did remember. E continued "Whenever two objects which weigh the same, like these two marbles, are placed in the pans, one on each side, where does the pointer go?" All Ss made the correct prediction. E said "That's right, the pointer goes on the black line in the middle, because the two objects weigh exactly the same."

2) Extinction of weight. The first stage of the extinction procedure was identical to the original conservation test. E again presented two balls of green plasticine, of equal weight and volume. On the first trial E said "now I've got two balls of plasticine here that both weigh the same. Let's put them on the balance to make sure." The balls were placed in the pans on the scales. E continued "You see, the pointer stays in the middle on the black line, because both balls weigh the same." The balls were removed from the scales and placed on the table in front of S. E said

"Now I'm going to make the ball into a cup." After the deformation, E asked "Do you think the cup weighs more than, the same as, or less than the ball?" After Ss answer, E asked "Why do you think so?" S's explanations were written down verbatim.

After S had asserted equivalence of weight (which turned out to be the case with all Ss), E suggested "Let's check by putting the balls on the scales." At this point E surreptitiously took a piece of plasticine away from the cup, before placing the ball and the cup back on the scales. Then E said "Why is the cup lighter than the ball?" S's explanation was noted.

Most Ss received three trials following the same procedure. These trials were the same as those in the original testing for conservation of weight. On any trial when an S did not assert equivalence, the objects were not returned to the scales. If an S asserted equivalence of weight on the third trial, but not on the second, a fourth trial was given.

The four trials were:

Trial 1: two green balls, one ball was changed into a cup.

Trial 2: two blue balls, one ball was changed into a ring.

Trial 3: two yellow balls, one ball was changed into a cross.

Trial 4: two red balls, one ball was changed into a triangle.

3) Extinction of number. On the first trial, E presented two equal collections of 25 red plastic discs, and said "Each of these two piles has exactly the same number of

plastic discs in it. I'll count them just to make sure and you watch carefully and count with me to see that I don't make a mistake." After E had counted the discs in each pile, she said "Now, I'm going to make this pile into a ring." E re-arranged one of the piles, then asked "Do you think the ring has more plastic discs, the same number of discs, or less discs than the pile?" Following S's answer, E asked "Why do you think so?" and then wrote down S's answer. Again, all Ss asserted equivalence. Therefore, E said "Let's check by counting them again." Before E began to count, she palmed one of the discs from the ring, without S's noticing. After the discs had been counted E asked "Why are there less pieces in the ring, than in the pile?"

All Ss were given three trials. The trials were the same as those in the test for conservation of number. On those trials in which an S did not assert equivalence, the discs were not recounted.

The three trials were:

Trial 1: two red piles, one pile was changed into a ring.

Trial 2: two yellow piles, one pile was changed into a triangle.

Trial 3: two blue piles, one pile was changed into a cross.

Results

1) Resistance to extinction of conservation of weight. All Ss conserved on the first trial. Eight out of twelve Indians and eight out of twelve whites showed extinction on the second trial, that is, after one trial in which the

two plasticine objects, when placed back on the scales did not weigh the same. Three Indian Ss and one white S showed extinction on the third trial, after two exposures to differential weights of the objects. One Indian S and one white S extinguished on the second trial, reasserted conservation on the third trial, and extinguished again on the fourth trial. One white S extinguished on the second trial, then conserved on the third and fourth trial. The final white S showed no extinction after three trials. There was clearly no significant difference between Indian and whites in resistance to extinction. No trends were apparent. Extinction occurred rapidly for most Ss in both groups.

The majority of Ss (9 out of 12 Ss in each group) accounted for the observed differential weights of the objects by resorting to non-conservation-type explanations (e.g. "this one has been spread out more, therefore it is thinner, therefore it weighs less"). Two Ss in each group reacted to the extinction procedure with puzzlement or sought to explain the difference as a result of E's having taken some away. One S in each group combined these two types of explanations.

2) Resistance to extinction of conservation of number. Again, All Ss conserved on the first trial. Two out of eleven white Ss and no Indian Ss showed extinction after one exposure to unequal numbers in each group of plastic discs. Seven out of eleven Indians and six whites did

not conserve on the third trial after two exposures to unequal numbers. One white S conserved on the first two trials, extinguished on the third and conserved again on the fourth trial. Four Indians and two whites showed no extinction after three trials. Although there is no significant difference between Indians and whites, there is a tendency for Indian Ss to resist extinction longer than white Ss.

Two Indians and four white Ss used non-conservation-type responses to explain the unequal numbers in the two groups (e.g. "you need more chips to make a pile."). Seven Indians and six whites were puzzled and surprised by the unequal numbers and sought some external explanation (e.g. E must have taken one away. Only one S ever said that she saw E take one away). Two Indians and one white combined both kinds of explanations.

3) Comparison of resistance to extinction of conservation of weight and number. Table 29 shows that resistance to extinction was stronger for number than for weight. Most Ss showed extinction of weight on the first exposure to differential weights whereas most Ss showed extinction of discontinuous quantity on the second exposure to unequal numbers in each group. More Ss continued to conserve number than weight on all extinction trials in the face of contradictory evidence. In extinction of number, most Ss appeared puzzled to find different numbers in each group; whereas in extinction of weight, fewer Ss appeared puzzled and the majority of Ss quickly resorted to a non-conservation explanation.

TABLE 29

Comparison of Resistance to Extinction of Number and Weight for Indians and Whites Combined

Resistance	Weight	Number	Total
2 trials to extinction	16	2	18
More than 2 trials	8	20	28
Total	24	22	46

Training Methods

One of the original purposes of this study was to try out two training methods in an attempt to induce conservation. Specifically, it was decided to compare Smedslund's (1961b) method of direct external reinforcement with another method which was in many ways similar to Smedslund's (1961b) method but which seemed as though it might be more effective in reducing irrelevant perceptual cues.

Unfortunately, although a fairly large N was tested on the original conservation tasks, the number of children available for training was quite limited. Too few Ss could not conserve number to make it practical to attempt to train on this conservation task. Therefore, it was decided to try training for conservation of weight. The group eligible for these training methods were those Ss who could conserve number but not weight. The results of the testing for conservation of number and weight previously described indicated clearly that number was conserved before weight. This did not make it seem likely that Ss who could not conserve on either task would be receptive to training for conservation of weight.

There were only 21 Indians available for training (two of the original group conserving number but not weight were absent when training procedures began). In view of this small N and because it seemed necessary to have a control group, it was decided to concentrate on repeating Smedslund's (1961b) method of direct external reinforcement, using a

control group, with as many Ss as possible, and to try out the other method on the few remaining Ss.

Smedslund's (1961b) method involved allowing the S to put the two plasticine objects back on the scale after he had made his prediction concerning their relative weights. The S, seeing that the objects both weighed the same on the scale, was reinforced if he had previously made the right prediction, and presumably had an extinction trial if he had just made the wrong prediction.

The second training method attempted (with unfortunately only four Ss in each group) was called "reverse external reinforcement." This method differed from Smedslund's (1961b) in that the two plasticine objects were initially presented to the S in two dissimilar shapes, which, after being weighed, were made to look the same. It was thought that this method might aid in acquiring conservation because it attempted to demonstrate the irrelevance of perceptual cues.

Subjects

Ten Indians were selected for training by direct external reinforcement of conservation of weight. These Indian children were distributed as evenly as possible over the age and grade range. Ten white children were matched as closely as possible for age, grade and sex with the ten Indian Ss. Matching for sex was sacrificed when all three criteria could not be met. Table 30 shows the matching for age and grade.

TABLE 30

Direct External Reinforcement: Comparison of Age and Grade Level for White and Indian Ss

Grade	Age									
	6		7		8		10		11	
	Ind.	Wht.	Ind.	Wht.	Ind.	Wht.	Ind.	Wht.	Ind.	Wht.
1	2	2								
2			3	2	3	2				
3						2				
4							1	2	1	
Total	2	2	3	2	3	4	1	2	1	

Therefore, there were 10 Ss in each group for training by direct external reinforcement for the first training session. One Indian was absent for the second training session. N for the posttest for the Indians was 10, consisting of 9 Ss who had received two training sessions and 1 S who had only received one training session. All 10 white Ss were present for both training sessions and posttest.

The four remaining Indian Ss were matched with four white Ss and trained for two sessions on reverse external reinforcement of conservation of weight. Two training sessions were followed by a posttest.

The training sessions and posttest were held on alternate days over a period of a week. Whites were tested a week before Indians. Training occurred 10 or 11 weeks after the original testing for the Indians and 6 or 7 weeks for the whites.

It was necessary to have a control group which received no training sessions, but only the posttest. This group was included to control for the possibility that Ss had learned how to conserve weight in the period between original testing and training attempts. Seven Indian Ss were selected and matched with seven white Ss using the same criteria for matching (Table 31). Because there were more white Ss who had conserved number but not weight on the original conservation tests, nine additional white children were included in the control group. The control group was tested on the same day for both Indians and

TABLE 31

Control Group: Comparison of Age and Grade for White and Indian Ss.

Grade	Age 7		8		9		10	
	Ind.	Wht.	Ind.	Wht.	Ind.	Wht.	Ind.	Wht.
1	2	2						
2	1	2						
3			2	1	1	1		
4							1	1
Total	3	4	2	1	1	1	1	1

whites. The test occurred 10 or 11 weeks after original testing for the Indians and 7 or 8 weeks for the whites.

Training Procedures

The procedures were similar in many ways to the original procedure for conservation of weight. The testing conditions and stimulus materials were the same. The procedures consisted of three parts:

1) a brief demonstration of the scales
2) training on direct external reinforcement or reverse external reinforcement of conservation of weight.
3) posttest

1) Demonstration of the scales. E said "You've already learned how the scales work? Do you remember?" All Ss indicated that they did remember. E continued, "Whenever two objects which weigh the same, like these two marbles, are placed in the pans, one on each side, where does the pointer go?" S made a prediction. E said "That's right, the pointer goes on the black line in the middle, because the two objects weigh exactly the same". Most Ss made the correct prediction. However, if an S seemed unsure or made the wrong prediction, E explained in greater detail that whenever two objects weigh the same the pointer always goes in the middle.

2) Training
(a) direct external reinforcement of conservation of weight.

The trials for this training method are presented in the appendix (Table 3). On the first trial, E produced two balls of red plasticine, the same weight and volume. E

said "Now, I've got two balls of plasticine here that both weigh the same. Let's put them on the scales to make sure." E placed the balls on the scales and said "You see, they both weigh the same, because the pointer stays on the black line in the middle." E removed the balls and placed them on the table in front of S. E said "Now I'm going to make the ball into a sausage." When the ball was in the shape of a sausage, E asked, "Do you think the sausage weighs more, the same as, or less than the ball?" After S's answer E said "Well, let's check. You put the sausage and the ball back on the scales." E did not comment on, nor ask S, to explain his prediction. Direct external reinforcement consisted solely in allowing S to see whether his prediction was in agreement with what the scales indicated.

Each S had two training sessions. In each session there were 16 trials. The trials were divided into four groups with four trials in a group. In each group, a pair (or in some cases, two sets) of plasticine objects were presented. Each pair differed from the other three pairs. Within each group of four trials, an object in the same pair was deformed four different times, into four different shapes. After each deformation the object was returned to its original shape, so that it matched the other member of the pair, and the pair was placed back on the scales again for the next trial.

On half of the trials, the objects involved the conservation of inequality. This was introduced to avoid making learning too easy. In this case, the two objects

did not weigh the same, one being heavier than the other. On these trials, the procedure began by E saying "Now, I've got two objects here that don't weigh the same. Let's put them on the scales to see." E placed the objects on the scales and then said "You see, they don't weigh the same. This one (pointing to one of the objects) weighs more than this one. That's because the pointer doesn't stay in the middle, but goes over in the opposite direction from the heavy object and the pan that has the heavy object on it goes down." The rest of the procedure was the same as that for conservation of equality.

(b) Reverse external reinforcement of conservation of weight. The trials for this procedure are shown in the appendix (Table 4). On the first trial of the first session, E presented two objects of red plasticine, one made into a ball, one into a sausage. Both objects weighed the same. The variation in this training method, therefore, consisted in presenting the objects in dissimilar shapes. E said, "Now I've got two objects here, a red ball and a red sausage. The sausage and the ball weigh exactly the same. I'm going to put them on the scales to show you that they both weigh the same." E placed the objects on the scales and said "You see, they both weigh the same, because the pointer stays on the black line in the middle." E removed the objects from the scales and said "Now I'm going to make this sausage into a ball." After the sausage had been transformed into a ball, E said, pointing at the ball which had

formerly been the sausage. "Now this is the ball that used to be the sausage. Do you think that this ball weighs more, the same as, or less than this other ball?" S was not asked to explain his answer, but told to check by putting the objects back on the scales.

Each S had two training sessions with 16 trials in each session. Again, there were four groups of trials with four trials in each group. On each group of four trials, one plasticine object was always the same, while the other one varied, e.g. in trials 1-4 a red ball was always presented together with, in the order of presentation, a red sausage, red snake, red cake and red pancake. On two out of four trials the ball was changed to resemble the other object and on the other two trials the other object was changed to resemble the ball. The same procedure was followed for all trials in both sessions. Half of the trials again involved conservation of inequality. E prefaced the presentation of the objects on these trials by saying "Now, I've got two objects which don't weigh the same, the ..... is heavier than the ..... Let's put them on the scales to check." Then E said "You see, they don't weigh the same, the ..... is heavier than the ..... because the pointer doesn't stay in the middle, but goes in the opposite direction from the heavy ..... and the pan with the heavy ..... goes down." The rest of the procedure was the same as for conservation of equality.

Each training session for both training methods took approximately half an hour.

3) Posttest. The posttest consisted of administering the original test for conservation of weight. There were three trials. On each trial, E presented two balls of plasticine of equal weight and volume. The balls were placed on the scales to demonstrate equivalence of weight. They were removed from the scales and E performed a deformation on one of the balls. E then asked the standard conservation question. S made a prediction and was asked to explain it. The trials were:

1) Two green balls, one ball was changed into a cup.
2) Two blue balls, one ball was changed into a ring.
3) Two yellow balls, one ball was changed into a cross.

This posttest was administered to the control group as well as to the Ss in both training groups.

Results

1) Direct external reinforcement. After two training sessions on direct external reinforcement, six out of ten Indian Ss and eight out of 10 white Ss conserved in the posttest (Tables 32 and 33). However, on the first trial of the first training session, seven Ss from each group conserved. Therefore, 14 out of 20 Ss conserved weight before training procedures began, although the Ss selected for training had not shown conservation in earlier testing. During the training procedures, Indian Ss, in fact, tended to conserve less on later trials than they had on the first trial (for example, by the fourth trial of the first training session, only two Indians conserved, and on the fourth trial of the second training session, five Indians conserved).

TABLE 32

Results of Training on Direct External Reinforcement: Indian Ss

Trials	Training Session I (N = 10)		Training Session II (N = 9)		Posttest (N = 10)	
	Conserv.	Nonconserv.	Conserv.	Nonconserv.	Conserv.	Nonconserv.
1	7 (70)	3 (30)	5 (55.6)	4 (44.4)	6 (60)	4 (40)
2	4 (40)	6 (60)	4 (44.4)	5 (55.6)		
3	4 (40)	6 (60)	4 (44.4)	5 (55.6)		
4	2 (20)	8 (80)	5 (55.6)	4 (44.4)		

TABLE 33

Results of Training on Direct External Reinforcement: White Ss

Trials	Training Session I (N = 10)		Training Session II (N = 10)		Posttest (N = 10)	
	Conserv.	Nonconserv.	Conserv.	Nonconserv.	Conserv.	Nonconserv
1	7 (70)	3 (30)	9 (90)	1 (10)	8 (80)	2 (20)
2	6 (60)	4 (40)	8 (80)	2 (20)		
3	7 (70)	3 (30)	6 (60)	4 (40)		
4	6 (60)	4 (40)	8 (80)	2 (20)		

White Ss tended to remain the same on later trials of the training session as they had on the first trial (for example, six whites conserved on the fourth trial of the first session and eight on the fourth trial of the second session).

Moreover, five out of seven Indian Ss and six out of seven white Ss in the control group showed conservation without any training sessions (Table 34). In the additional group of nine white Ss who were not included in the matched control group, but, like the control group, were given a posttest without any training sessions, six Ss conserved weight (Table 34).

2) Reverse external reinforcement. Any results for the reverse external reinforcement training proceudres are limited by the extremely small N in each group. One out of four Indians and four out of four whites conserved on the posttest after two training sessions (Table 35). However, all four whites conserved on the first trial before training had begun and one Indian conserved on the first trial.

It seems clear that the training procedures did not increase conservation in comparison with the control group. It would have been difficult for any training procedure to have increased conservation over the apparently spontaneous acquisition of conservation shown by the controls. The instability from trial to trial within the training sessions of the Ss responses also makes it difficult to attribute any changes to the effects of the training procedures.

TABLE 34

Control Group: Conservation of Weight on the Posttest for Matched Indian, Matched White and Nonmatched White

Subjects	Conserv.	Nonconserv.	Total
Indian	5 (71.4)	2 (28.6)	7
Matched White	6 (85.7)	1 (14.3)	7
Non-matched White	6 (66.7)	3 (33.3)	9
Total	17 (73.9)	6 (26.1)	23

TABLE 35

Results of Training on Reverse External Reinforcement: Indian and White Ss

Trials	Training Session I				Training Session II				Posttest			
	Conserv.		Nonconserv.		Conserv.		Nonconserv.		Conserv.		Nonconserv.	
	Ind.	Wht.	Ind.	Wht.	Ind.	Wht.	Ind.	Wht.	Ind.	Wht.	Ind.	Wht.
1	1	4	3	0	0	4	4	0	1	4	3	0
2	2	3	2	1	0	4	4	0				
3	1	2	3	2	0	3	4	1				
4	0	1	4	3	1	2	3	2				

CHAPTER III

DISCUSSION

In general, the results of the present study showed that conservation of both weight and number consistently increased with age, although not significantly. The results from the matched sample were consistent with the results from the total sample in this respect. Conservation of weight and number also increased at higher grade levels. This relationship was not significant in the matched sample. The relationship between grade and conservation of weight approached significance (especially for the white Ss) in the total sample. The relationship between grade and conservation of number was significant in the total sample when both Indians and whites were combined (nonsignificant for each cultural group taken separately). In terms of sequential development, conservation of number was attained, in all but a very few cases, before conservation of weight. These results are in basic agreement with the original hypotheses advanced for this study, except for the failure to find a more pronounced appearance of conservation of number around seven years of age and conservation of weight around nine to ten years.

Most importantly, the overall results demonstrated, with one exception, no significant differences between Indian and white children. The exception was on conservation of weight on the total sample where significantly more Indians than white Ss conserved.

The results from the extinction procedures indicated

fairly rapid extinction on both conservation of weight and number. The training methods were unsuccessful in comparison with a no training control group.

These results will be discussed, in the first place, in terms of their relationship to Piaget's studies and other studies on the attainment of conservation of weight and number. Secondly, the implications for the area of cross cultural testing for Piaget's developmental periods will be discussed. Thirdly, comparisons will be drawn between the results from Smedslund's extinction procedures and the present study. Finally, the results of training will be discussed.

The present study, in agreement with most other studies (Almy et al., 1965; Sigel and Mermelstein, 1965; Smedslund, 1961f), demonstrated the sequential invariance in conservation on different dimensions postulated by Piaget (Wallach, 1963). These other studies have examined sequential development on other conservation tasks. The present study indicated that number was conserved before weight.

The relationship between age and conservation of weight and number was not as strong as that demonstrated by Piaget (Oléron et al.) and other studies (Elkind, 1961b, Feigenbaum, 1963; Hood, 1962; Lowell, 1961; Lovell and Ogilvie, 1961; Smedslund, 1964). The relationship between grade and conservation on both tasks in the total sample approached significance. If this finding could be

replicated in another study, then the present data could be viewed as offering some support for Piaget in that grade may be a better indication of mental age defined in terms of cognitive structures than chronological age. However, the relationship between grade and conservation of weight and number was not as strong as Piaget's relationship between age and conservation.

In Piaget's studies, 72% of the nine year olds and 76% of the ten year olds showed weight conservation (Oléron et al., 1963). Similarly, Elkind (1961b) found that 73% of the nine year olds and 84% of the ten year olds conserved weight. In the present study, only 48% of the nine year olds and 52% of the ten year olds conserved weight. Conversely, Piaget found that 84% of the six year olds and 76% of the seven year olds did not conserve (Oléron et al., 1963). Only 73% of the six year olds and 65% of the seven year olds did not conserve in the present study. The same kinds of results hold for conservation of number. For example, Piaget found that there was a steady growth in number of subjects conserving number from 15% at the five year level to 74% at the seven year level. In the present study, there was no difference between six and seven year olds in number conservation, 73% of the six year olds conserved and 75% of the seven year olds. Feigenbaum (1963) found that 91% of the six and a half year olds conserved number and Hood (1962) found that all Ss between seven and eight conserved. In the present study, 77% con-

served at the nine year level and 88% at the ten year level. conserved number. The data from the present study indicate that, in comparison with Piaget (Oléron et al., 1963) and the supporting studies (Elkind, 1961b; Feigenbaum, 1963; Hood, 1962), more of the younger children and fewer of the older children conserved.

It is difficult to explain these discrepancies between Piaget's and other's results and our own in percentage of Ss conserving at each age level represented. One could simply take the results at face value and conclude that these samples of Canadian children, Indian or white, are more heterogeneous in cognitive development at each age level than previous samples tested, although it is particularly difficult to see why this should be so of the Indian children. Or one could say that the percentage figures reported by Piaget (Oléron et al., 1963) and others (Elkind, 1961b, Feigenbaum, 1963; Hood, 1962) are unstable estimates of the true population estimates. If such is the case, a greatly increased N might reveal no discrepancies between the results of the various studies reported. Two other kinds of explanations might be offered. One possibility is that differences in procedure and criteria account in some way for the differences in results. Another is that differences between the populations of the previous studies and the combined white and Indian populations are responsible. Differences in the populations could be of a purely intellectual nature or could be essentially non-intellectual. Each of these possibilities will be considered in turn.

It seems unlikely that the differences between these results and Piaget's and other's are attributable solely to differences in testing procedures. The procedure used in this present study was based on Smedslund's (1961b, 1961f, 1962) standardized testing procedure. Smedslund's (1964) results are in basic agreement with Piaget as to the ages at which conservation is attained for weight and number. However, Smedslund (1961b) like Piaget, uses verbal criteria for assessing conservation. The S must state one of the principles underlying conservation (for example, the principle of reversibility) in order to be considered a true conserver. Verbal criteria in terms of an adequate justification were not used in this study. It was sufficient for the child to make a response "they weigh the same" when confronted with two differently shaped plasticine objects on three trials to be called a conserver. Although S was asked to explain his judgement, verbal justifications were not taken as the criteria for conservation. This might mean that some Ss classified as conservers were unable to state any principle underlying conservation. As a consequence, more children in this study might have been classified as conservers then Piaget or Smedslund (1961b) would include in conservation groups. This would help to explain why more children conserved at the younger age levels, but not why fewer children conserved at the older age levels.

The criterion for conservation used in the present study was the same as that used by Frank (in Bruner, 1964)

and Braine and Shanks (1965). In their procedures, too, a child is usually asked to justify his response to the conservation question, but he is deemed a conserver on the basis of his response to the conservation question and not on the basis of his justification. Frank (in Bruner, 1964) and Braine and Shanks (1965) obtain age norms for conservation younger than those obtained by Piaget (Oléron et al., 1963), Smedslund (1964) and others (e.g. Elkind, 1961a, 1961b). However, Braine and Shanks (1965) and Frank (in Bruner, 1964) employ testing procedures designed to force the child to distinguish between the real and phenomenal properties of the objects. In Frank's (in Bruner, 1964) experiment, pre-training was given to eliminate perceptual cues. In Braine and Shanks' (1965) experiment, the Ss were given reinforced pre-training in learning to make the distinction between the real and phenomenal size of two objects. In the present study, although the same criterion for conservation was used, no such pre-training was employed.

Gruen (1965) in a study on conservation of number, examined the results in terms of the two different criteria used by these two groups (Piaget and his supporters on the one hand, and Braine and Shanks and Frank on the other). Forty-five five year old Ss were given verbal pre-training to discriminate between the terms "more", which always meant more in number, and "longer" which always meant more in length. Therefore, they were taught that the conservation question "Are there more corks in this row, the same number of corks in both rows, or more corks in that row?"

only meant more or the same in number and not in length. An additional 45 children of the same age were not given verbal pre-training. Both groups were given six conservation problems following the training of the first group.

Gruen's (1965) results showed that an analysis of the responses in terms of Smedslund's (1961b) criteria revealed no significant differences between the trained and non-trained groups. However, using the criteria employed by Frank (in Bruner, 1964) and Braine and Shanks (1965) significantly more Ss inthe verbal pre-training group conserved. This is because 37 of the 44 responses that were classified as non-conservation responses according to Smedslund's (1961b) criteria and reclassified as conservers using the Braine and Shanks' (1965) criteria were made by Ss who received verbal pretraining. However, an examination of the responses of the group which did not receive verbal pre-training (and which was, therefore, comparable to the sample used in the present study) indicates that 23% of the responses were classified as conservation responses according to Smedslund's (1961b) criteria, whereas 25% of the responses were classified as conservation responses according to the criteria used by Frank (in Bruner, 1964) and Braine and Shanks (1965). Therefore, if no verbal pre-training is given, the use of either criteria results in almost the same number of responses being classified as conservation responses. This suggests that differences in criteria for conservation in Piaget's studies and the

present study do not account for the particular discrepancies being discussed.

An explanation in terms of intellectual retardation of the Ss in the present study does not seem to fit the data. If the sample were mentally retarded fewer children should conserve at each age level, in comparison with Piaget's age norms, and the age of attainment of conservation should be more advanced. Mental retardation might help to explain why fewer older children conserved, but not why more younger children conserved, in comparison with Piaget.

Finally, there is the possibility that a non-intellectual factor differentiates the present Ss and Piaget's samples. For example, if our Ss as a group were more anxious to please the adult experimenter and more responsive to general situational cues than the children tested by Piaget, this might have led to greater variation in response independent of intellectual level.

The results from the extinction procedures are consistent with such an interpretation. According to Piaget, once conservation is acquired it should not be possible to extinguish it. This is an obvious conclusion since extinction can only be accomplished by cheating. However, most Ss in this study extinguished fairly rapidly on both conservation of weight and number. This suggests either the possibility that those Ss who did conserve did not do so with any great conviction, or that the Ss in this population tended to accept unquestioningly any conclusions drawn by E. Therefore, when E pointed out that the two

plasticine objects did not weigh the same (E having inconspicuously removed a piece of plasticine from one of the objects) or that the two groups of plastic discs no longer contained the same number of discs, S showed a tendency to disregard his own judgment and switch to E's position.

The above discussion refers to both Indians and whites combined. The results consistently indicated no superiority in the white group, In fact, the only significant difference between Indians and whites was obtained for conservation of weight in the total sample in which the Indians conserved significantly more than the whites. The significance of this difference is increased by using a different criterion for conservation, such as, one or more conservation responses out of three trials, or two or more conservation responses out of three trials. However, reclassifying Ss on the basis of any criterion other than conservation responses on all three trials, involves grouping the children whom Piaget calls transitional conservers with the conservers. Because Piaget requires a verbal response indicating an understanding of conservation from his Ss there might already be some of Piaget's transitional conservers classified in the present study as conservers.

This study seems to indicate that the environmental variables on which these two ethnic groups differ are not important contributors to the development of a grasp of conservation. Although both groups had approximately the same amount of formal schooling in terms of grade placement, the rate of truancy is much higher among the Indian

children (Kee, 1966). It is also likely that quality of instruction differed in favor of the white children. In this way, the present study agrees with the conclusions reached by other studies (Goodnow, 1962; Hyde, 1959; Sigel and Mermelstein, 1965; Vernon, 1965a, 1965b, 1965c; Wohlwill, 1960) that amount of schooling and specific classroom training are not important contributors to a development of conservation. In addition, it does not appear that school performance is a good indication of ability to conserve. Indians typically perform in school at a lower level than white children of the same age (Cameron and Storm, 1965; Kee, 1966).

Family instability and family size do not seem to affect attainment of conservation. Indian families are large (Cameron, 1964). Unstable family conditions, such as marital instability, unemployment, and drunkenness are present to a much greater extent in Indian families than in white families (Hawthorne et al. 1966).

Indian children are less verbally spontaneous, have smaller vocabularies and use less grammatically complex speech (Kee, 1966). This lack of verbal facility does not seem to produce inferior performance on conservation. This agrees with Piaget's postulate that a complex though process underlies the ability to conserve, but that this ability is not dependent on language development, though ordinarily correlated with it.

These results, then, are consistent with Piaget's

view that conservation depends on environmental experience of a very general nature. This general environmental interaction involves repeated operations on the environment, and particularly, interactions with peers. Both of these environmental experiences produce cognitive structures whose existence is reflected in the conservation of invariant quantities such as weight and number. Presumably, these kinds of environmental interactions are present in all cultural groups to the extent necessary for attainment of Piaget's period of concrete operations.

These findings are in general agreement with the Goodnow (1962) and Price-Williams (1961) studies in suggesting a lack of influence of cultural factors on performance in Piaget's conservation tasks. They disagree with the results obtained by Almy et al. (1965), Hyde (1959), and Vernon (1965a, 1965b, 1965). It is not clear why these studies have obtained differences between cultural groups. It does not seem likely that amount of schooling or economic development can account for these inconsistencies between cross cultural studies. Price-Williams' (1961) study involved illiterate bush West African children. Goodnow (1962) found no significant differences between amount of education and performance. Vernon (1965a, 1965b, 1965c) obtained differences between English and West Indian boys in favor of the English boys, but found no significant differences between West Indians of different educational and socio-economic levels. Procedural differences between these cross-cultural studies and differences in criteria

for conservation make comparisons between studies difficult. A possible explanation for Price-Williams' (1961) results could be that he used materials (earth and nuts) presumably familiar to the Ss. It may be that he would have found differences between groups had he used plasticine objects to test for conservation.

The results of the effects of the extinction procedures appear to contradict Smedslund's (1961c) study. Smedslund (1961c) found that children who showed conservation on a pretest did not extinguish on conservation of weight in comparison with children who did not show conservation on an initial pretest, but conserved after two sessions of training on direct external reinforcement. In the present study most Ss extinguished rapidly on both conservation tasks, although the resistance to extinction was stronger for number.

In order to examine the differences between these data and Smedslund's (1961c) study, the verbal responses on the original test for conservation of weight and number were examined. On the test for conservation of weight five (four white and one Indian) of the 24 Ss gave verbal responses which referred to a principle underlying conservation e.g. "You didn't add any, therefore it must be the same." It seems that these responses would be classified by Smedslund (1961b) as "symbolic-logical", that is, "all symbolic explanations which explicitly state that nothing has been added or taken away, or which in any other way contain an explicit reference to necessity" (Smedslund,

1961b, p. 74). The remainder of the Ss appeared to fall in Smedslund's (1961b) "symbolic-category", that is "all explanations which directly or indirectly refer to previous events in the same test item" (Smedslund, 1961b, p. 74), for example, "it weighed the same before, and I think it still does," or in his "ambiguous" category, for example, "they are both heavy." This category "ambiguous" includes all explanations which cannot be subsumed under three categories, the two preceding categories and a third one - "perceptual", that is, "all explanations that directly or indirectly refer to observable features of the present situation " (Smedslund, 1961b, p. 74). It was hard to decide under which category many of the Ss would be subsumed. This was especially so in the case of the Indian Ss whose grammatical structure often made it extremely difficult to tell if they were referring to a past event or the present situation.

In Smedslund's (1961c) extinction experiment he states that the 11 Ss who were trained "gave only correct answers and explanations referring to the initial state (they weigh the same because they weighed the same in the beginning)"(Smedslund, 1961c, p.86). Presumably these are symbolic explanations. It is not clear from Smedslund's (1961c) description whether the Ss who had acquired conservation 'normally' give symbolic explanations or symbolic-logical explanations. However, slightly less than half of these Ss did not extinguish after three extinction trials whereas all the Ss who had been trained did extinguish. It

should be noted that due to small Ns (13 Ss who had acquired conservation 'normally' and 11 Ss who had acquired conservation through training), Smedslund's (1961c) results cannot be considered conclusive. Only six Ss who had acquired conservation 'normally' did not extinguish.

In this study, only one S did not show extinction of conservation of weight after three trials. This S was one of the five Ss giving a symbolic logical explanation. However, the other four Ss giving symbolic-logical explanations extinguished on the second trial. In resistance to extinction of conservation of number, four Indians and two whites showed no extinction after three trials. The two white Ss gave symbolic-logical explanations in the original conservation task. The four Indian Ss gave symbolic explanations in the original conservation task. No Indian gave symbolic-logical explanations in the initial conservation task on number whereas five white Ss gave symbolic-logical responses (three of these five extinguished on the second or third extinction trial).

Verbal explanations in this study do not seem to explain adequately the extinction results. Although some of the Ss giving the highest level of explanation, according to Smedslund's classification, did not extinguish, others did. On the other hand some Ss who gave explanations at a lower level maintained resistance to extinction. It also appears interesting that there were no more symbolic-logical explanations resulting from the test of conservation of number than from the test of conservation of weight. Chil-

dren who grasp the principle of the invariance of weight, even if they cannot explain it adequately, should still be able to offer an adequate explanation about the invariance of number since it is assumed that this type of conservation precedes conservation of weight. It may be that children who conserve both weight and number assume that the reason for the invariance of number is so obvious, that it does not have to be stated. On the other hand, it may mean that children cannot produce adequate explanations in terms of external verbalizations, and yet they still grasp the idea of conservation. This raises the question about the validity of verbal explanations as the sole or the major criterion for conservation, particularly in less verbally facile minority groups. It seems that the white children were more likely to give superior verbal explanations (and this appeared to the E from general observation to be the case throughout the total white sample) than the Indian children. However, the white children were no more likely than the Indian children to make correct judgments about conservation, and were no more resistant to extinction. In fact, if any group showed slight superiority in regards to resistance to extinction, it appeared to be the Indian group. A possible interpretation of the results of the extinction procedures has already been proposed in terms of a temperamental variable.

Training procedures in this study, were not successful in terms of changing non-conservers to conservers in comparison with the control group. This generalization is

limited, however, by the very small N employed in both training methods, particularly in the method of reverse external reinforcement, and by the fact that a great many of the Ss showed conservation on the first trial, before any training had begun , e.g. 70% of both Indians and whites selected for the training method of direct external reinforcement.

There are two possible explanations for why so many Ss conserved on the first trial. The first explanation could be that the period of time which had elapsed between the initial test for conservation of weight and the onset of the training procedures was sufficient to produce conservation in a large number of Ss. Training began for white children six or seven weeks after initial testing and for Indian children ten or eleven weeks. However, it seems implausible that so many children should grasp the principle of conservation of weight spontaneously in a relatively short period. In addition, this hypothesis would also lead to the conclusion that conservation was grasped within a six week period after initial testing; otherwise, there should be a difference between Indians and whites resulting from a longer period of time between conservation testing and the onset of training for Indians.

A second explanation appears more acceptable. This would indicate that the initial testing for conservation constituted a learning experience. Although the E reacted neutrally to all responses made by the S, correct or

incorrect, it is hard to maintain complete neutrality. A certain change in tone on the part of the E when the S made a correct response, or a slight indication of disappointment when the S made the incorrect response may have furnished some clue to the child about the kind of response which was expected of him. More importantly, however, the mere fact of having the child's attention drawn to operations of weighing and counting followed by the questioning procedure, may have started the S thinking about what was involved in the task. He may have thought about it and came to an understanding of the principle of conservation by himself, or he may have talked about it with his peers and parents. It seems likely that the actual experience of being in an experiment, which involved being absent from the classroom and receiving individual attention, constituted a significant event for these children worthy of thought and discussion. E was on several occasions told by the teachers in both schools that the children enjoyed the experiment and were eager to participate.

CHAPTER IV

SUMMARY

This study was designed to explore, cross-culturally, the generality of developmental sequences and to provide, in a tentative way, some information about the determinants of cognitive development. If two groups, the same chronological age, but differing in many aspects of home and cultural environment, differ in performance on a cognitive task, the suggestion is that one or more of the environmental variables on which they differ is relevant to the cognitive performance. However, if two such groups do not differ, the suggestion is strong that performance on the cognitive task does not depend importantly on the environmental variables on which they differ.

Indian and white children of British Columbia were compared on two related tasks, the conservation of number and conservation of weight. Both tasks originate in the work of Jean Piaget and his collaborators and are relevant to his theory of intellectual development (1952). According to Piaget, number in conserved around seven years of age and weight around nine to ten years. An initial sample of 34 Indians matched with 34 whites, on the basis of age, sex, grade and years of schooling, was tested. All Ss ranged in age from 6-10 and in grade from one to four. There were no differences between Indians and whites in attainment of conservation. Conservation of number was demonstrated before conservation of weight. Although there

was an increase in conservation in both tasks with age and with grade, the relationship between age and conservation and grade and conservation did not reach significance. A second sample, including the matched sample, consisted of 67 Indians and 76 whites, ranging in age from five to eleven. All children were in grades one to four. The results from the matched sample were, in the main, confirmed. On the whole there were no differences between Indians and whites except on conservation of weight where significantly more Indians conserved. There was a consistent tendency for conservation of both number and weight to increase with age and grade. The sequential development of conservation of number before conservation of weight was again demonstrated.

A second purpose of this study was to determine the effects of extinction procedures on conservation responses, and to compare, by this method, the stability of conservation in the Indian and white Ss. Twelve Indian Ss were compared with 12 white Ss. All Ss had demonstrated in previous testing that they could conserve number and weight. Most Ss made nonconservation responses after one or two extinction trials in which S inconspicuously removed a piece of plasticine from one of the plasticine balls (conservation of weight) or a plastic disc from one of the piles of plastic discs (conservation of number). These results were in disagreement with Piaget and Smedslund (1961c) and indicate either that conservation responses were less stable in the

population tested or that temperamental differences, e.g. greater acceptance of authority, accounted for the fairly rapid extinction of most Ss. There were no differences between Indian and white Ss.

A subsidiary purpose of this study was to explore the effectiveness of two methods of training in producing conservation responses in Ss who did not initially conserve weight. Unfortunately, N was very small. Ten Indians and 10 whites were compared using Smedslund's (1961b) method of direct external reinforcement. By this method, after an S has made a judgment as to the equality or inequality of the plasticine objects he is allowed to return the objects to the scales to see whether his judgment was correct. Direct external reinforcement consisted solely in his receiving confirmation or disconfirmation of his previous judgment. A second method, reverse external reinforcement, (N = 4 in each ethnic group) consisted in presenting the plasticine objects in dissimilar shapes initially, then performing a deformation to produce similarity in shape. Again, the S returned the objects to the scales to receive information about his judgment of their relative weights. A control group of 7 Indians, 7 matched whites and 9 additional whites was included. The control group did not receive any training. Training methods were unsuccessful in comparison with the control group. Indian and white children did not differ. Although there was an increase in conservation responses from pre-test to posttest in both training groups and the control group, a large number of

Ss gave conservation responses on the first training trial. The results seemed to indicate that conservation had been acquired in the interval between pre-test and posttest. It's hypothesized that the pre-test constituted a learning experience for S, drawing his attention to the operations of weighing and leading to an understanding of the principle of conservation either independently or through interaction and discussion with peers and parents.

In conclusion, the main results of this study gave no evidence that Indian children attain conservation later than white children or that their conservation responses were any less stable. This failure to find a differences between Indians and whites is in agreement with some, although not all, previous cross-cultural studies. These findings have implications for theories concerning the determinants of conservation. They suggest that the environmental differences between the two cultural groups do not play an important part in determining the acquisition of conservation.

In support of Piaget, the developmental sequence of conservation of number before weight was confirmed. Although there was an increase in conservation on both tests with age, the relationship between age and conservation was not as strong as Piaget has found.

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APPENDIX I

TABLE 1

Age Comparison of Tested and Untested White Children at Each Grade Level

Grade	Tested Children			Untested Children			t	p
	N	$\bar{x}$(mths)	SD	N	$\bar{x}$(mths)	SD		
1	22	81.45	3.81	16	79.13	3.54	1.91	>.05
2	12	92.83	5.90	25	95.00	4.18	1.29	N.S.
3	30	106.33	5.44	9	105.11	4.17	.62	N.S.
4	12	119.83	5.24	26	116.42	5.22	1.87	>.05

TABLE 2

Number of Tested and Untested White Children at Each Grade Level who had Repeated one or more Grades

Grade	Tested Children	Untested Children
1	1/22	0/16
2	3/12	4/25
3	5/30	1/9
4	1/12	3/27

Appendix 1 (cont'd)

TABLE 3

Trials for Direct External Reinforcement of Conservation of Weight

Session I

Trials 1 - 4: 2 red balls, same weight, One ball was changed into:

a) sausage b) snake c) cake d) pancake

Trials 5 - 8: 2 blue cakes, different weight. The heaviest cake was changed into:

a) pancake b) snake c) no. 8 d) 2 balls

Trials 9 -12: 2 yellow snakes, same weight. One snake was changed into:

a) no. 8 b) 4 balls c) ball d) sausage

Trials 13-16: 2 groups of 2 green balls, different weight. The lightest group of balls was changed into:

a) pancake b) 4 balls c) snake d) sausage

Session II

Trials 1 - 4: 2 blue sausages, different weight. The lightest sausage was changed into:

a) cake b) 4 balls c) 2 balls d) no. 8

Trials 5 - 8: 2 groups of 2 green balls, same weight. One group of balls was changed into:

a) ball b) cake c) no. 8 d) 4 balls

Trials 9 -12: 2 yellow pancakes, different weight. The heaviest pancake was changed into:

a) 2 balls b) cake c) ball d) 4 balls

Trials 13-16: 2 red no. 8s, same weight. One no. 8 was changed into:

a) snake b) ball c) pancake d) sausage

Appendix 1 (cont'd)

TABLE 4

Trials for Reverse External Reinforcement of Conservation of Weight

Session I

Trial 1: one red ball, one red sausage, same weight. The sausage was changed into a ball.

Trial 2: one red ball, one red snake, same weight. The ball was changed into a snake.

Trial 3: one red ball, one red cake, same weight. The cake was changed into a ball.

Trial 4: one red ball, one red pancake, same weight. The ball was changed into a pancake.

Trial 5: one blue cake, one heavier blue pancake. The pancake was changed into a cake.

Trial 6: one blue cake, one heavier blue snake. The cake was changed into a snake.

Trial 7: one blue cake, one heavier blue no. 8. The no. 8 was changed into a cake.

Trial 8: one blue cake, two heavier blue balls. The cake was changed into 2 balls.

Trial 9: one yellow snake, one yellow no. 8, same weight. The no. 8 was changed into a snake.

Trial 10: one yellow snake, 4 yellow balls, same weight. The snake was changed into 4 balls.

Trial 11: one yellow snake, one yellow ball, same weight. The ball was changed into a snake.

Trial 12: one yellow snake, one yellow sausage, same weight. The snake was changed into a sausage.

Trial 13: two brown balls, one lighter brown pancake. The pancake was changed into 2 balls.

Trial 14: two brown balls, 4 lighter brown balls. The 2 balls were changed into 4 balls.

Trial 15: two brown balls, one lighter brown snake. The snake was changed into 2 balls.

Trial 16: two brown balls, one lighter brown sausage. The balls were changed into a sausage.

Appendix 1 (cont'd)
Table 4 (cont'd)

Session II

Trial 1: one blue sausage, one lighter blue cake. The cake was changed into a sausage.

Trial 2: one blue sausage, 4 lighter blue balls. The sausage was changed into 4 balls.

Trial 3: one blue sausage, 2 lighter blue balls. The balls were changed into a sausage.

Trial 4: one blue sausage, one lighter blue no. 8. The sausage was changed into a no. 8.

Trial 5: two orange balls, one orange ball, same weight. The ball was changed into 2 balls.

Trial 6: two orange balls, one orange cake, same weight. The 2 balls were changed into a cake.

Trial 7: two orange balls, one orange no. 8, same weight. The no. 8 was changed into 2 balls.

Trial 8: two orange balls, 4 orange balls, same weight. The 2 balls were changed into 4 balls.

Trial 9: one yellow pancake, two heavier yellow balls. The two balls were changed into a pancake.

Trial 10: one yellow pancake, one heavier yellow cake. The pancake was changed into a cake.

Trial 11: one yellow pancake, one heavier yellow ball. The ball was changed into a pancake.

Trial 12: one yellow pancake, 4 heavier yellow balls. The pancake was changed into 4 balls.

Trial 13: one red no. 8, one red snake, same weight. The snake was changed into a no. 8.

Trial 14: one red no. 8, one red ball, same weight. The no. 8 was changed into a ball.

Trial 15: one red no. 8, one red pancake, same weight. The pancake was changed into a no. 8.

Trial 16: one red no. 8, one red sausage, same weight. The no. 8 was changed into a sausage.