The Effects of Test Materials and
the Order of Presentation of the
Materials on Young Children's Understanding
of Conservation of Number

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ABSTRACT

Sixty kindergarten and first-grade children were presented with Piagetian one-one correspondence tasks. The children were selected only if they demonstrated an understanding of the terms 'more' and 'less'. Each subject performed a task twice, once with materials which were familiar to the child and once with materials which were unfamiliar. One-half of the children were asked to perform one-one provoked correspondence tasks and the remaining children were given one-one spontaneous correspondence tasks. The results were subjected to a three-way analysis of variance and to correlated t-test procedures. A significant difference was found between the tasks performed with familiar materials as compared to unfamiliar materials. No significant differences were found between the provoked and spontaneous correspondence tasks nor between the order in which the materials were presented.

RESUME

On a fait accomplir par soixante enfants des classes de maternelle et de première année des tâches de correspondance un-à-un selon le modèle de Piaget. Seuls les enfants qui ont démontré une compréhension des termes 'plus' et 'moins' ont été retenus. Chaque enfant a dû accomplir une tâche deux fois, une fois avec des objets connus et l'autre fois avec des objets inconnus. On a demandé à la moitié des enfants d'accomplir des tâches de correspondance un-à-un dans un cadre dirigé, alors que les autres ont accompli leurs tâches de correspondance un-à-un dans un cadre spontané. Les résultats ont été soumis à une analyse de variations à trois modes et à des épreuves de corrélation <u>t</u>. Des différences utiles ont été repérées entre les tâches accomplies avec les objets connus par rapport à celles accomplies avec les objets inconnus. Aucune différence appréciable n'a été observée entre les tâches de correspondance en cadre dirigé par rapport à celles en cadre spontané, ni quant à l'ordre dans lequel les objets ont été présentés.

Short Title of Thesis

The Effects of Test Materials on Conservation of Number

Yelin

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D) PAGE

LIST OF TABLES

LIST OF TABLES (CONT'D) PAGE

LIST OF FIGURES

INTRODUCTION

It was the author's original intention to explore the area of learning disabilities using Piaget's developmental approach to cognition. It was thought that Piagetian tasks, specifically those dealing with conservation, might yield some insight into the cognitive difficulties of learning-disabled children.

While looking for an appropriate developmental scale based on Piaget's theory, it was observed that many researchers were experiencing difficulties constructing such a test. One of the fundamental problems in developing this type of scale related to the consistency of subjects' responses. For example, subjects, when administered conservation items which were considered to be at the same level of difficulty, did not necessarily respond to those items in the same manner. That is, they would demonstrate conservation for some tasks and not for others. During the process of examining why this occurred, the following question arose. Do the materials used to assess an individual's understanding of conservation concepts affect his ability to acquire those concepts? In other words, does it matter if he is presented with bottle caps or pennies when attempting to conserve number? It was decided that this question was sufficiently relevant to warrant an investigation. Thus the present study was undertaken.

CHAPTER I

REVIEW OF THE LITERATURE

Introduction to the Chapter

Chapter one is divided into three main sections. In the first part, a précis of Piaget's theoretical foundations is provided, and studies both favourable to and critical of his theory are reviewed. The second part is devoted to a description of several attempts to formulate a developmental scale based on Piaget's theory and to a discussion of the ensuing problems. The third section is directly related to the focus of this thesis - one-one correspondence and conservation of number. In addition, research into this area is examined. Finally a number of hypotheses relating to this study involving difficulties encountered in attempting to scale aspects of Piaget's theory are presented.

Piaget's Theory of Cognitive Development

In his early twenties, the Swiss biologist, Jean Piaget, turned his attention to the study of cognitive development in children. His training as a biologist has had a marked influence on the formulation of his comprehensive theory concerning the origins and development of intelligence based on the principles of biological adaptation to the environment. He maintains that the cognitive aspects of a child's development are due to an interaction between the individual and his surroundings resulting in a continual assimilation of and accommodation to environmental stimuli. For the past 50 years he has been actively engaged in the task of expanding and revising his theories.

Piaget (1952b) theorised that the organism is continually striving for a state of equilibrium between internal and external forces. This need for equilibrium is achieved by means of the individual's ability to assimilate and accommodate environmental stimuli. The two processes are complementary. Assimilation occurs when one incorporates environmental stimuli into an existing schemata (structure of knowledge). If, however, a particular stimulus does not fit into an existing schemata, then that schemata must either be altered or a new one must be developed. This is accommodation. Organization of and adaptation to the environment (by means of assimilation and accommodation) are what Piaget considers to be the "functional invariants of intelligence" (p. 3).

Intellectual structures develop in a sequential and hierarchical manner and, hence, at each stage a person's thought processes are qualitatively different from those of the preceding stage (Flavell, 1963). Piaget (1971b) states that cognitive stages are "characterized by successive structures which do not replace each other, but which are integrated into one another. The simplest ones become incorporated into later, more complex ones" (p. 7).

Piaget (1950, 1952b, 1970; Piaget & Inhelder, 1969) has outlined four major developmental levels; the sensorimotor from birth to approximately 18 months to 2 years of age; the preoperational period, from about 2 years of age to 7 years, during which language is acquired; the concrete operational stage beginning at approximately 7 years of age in which the youngster develops the ability to use logical operations; and finally at around 11 to 12 years of age, the stage of formal operations. The order of the stages remains invariant. That is, one cannot go from the level of preoperational thought to the stage of formal operations without first having gone through the stage of concrete operations. However, the age at which different children may reach each stage depends upon variables such as mental development, social interaction and culture (Piaget & Inhelder, 1969; Piaget, 1971b).

Piaget has described in great detail the characteristics of each stage. The differences between preoperational and concrete operational thinking are of particular interest to the current investigation. At the preoperational level, for example, the child cannot conserve, because he is still bound by his perceptions. This prevents him from attending to transformations, decentering his perceptions and from reversing operations.

An operation is an internalized action which is reversible. The idea of reversibility is the key to operational thought (Flavell, 1963; Ginsburg & Opper, 1969; Inhelder, 1970; Piaget, 1950, 1952a; Piaget & Inhelder, 1969), and is an essential part of the concept of conservation.

Conservation is the ability to recognize that a particular quantity remains invariant through perceptual transformations. To be more specific, one presents to a child two balls composed of equal amounts of clay, and has him establish visual equivalence. Then with the youngster watching, if one ball is transformed into a sausage shape, the preoperational child will maintain that they no longer have the same amount of substance (clay) in each. The concrete operational child, on the other hand, can reverse the operation and see that one has not added or removed any clay from the ball, but rather, only changed its shape. This, then, cannot affect the mass (Elkind, 1961).

Piaget (1952a) notes that "conservation is a necessary condition for all rational activity" (p. 3), and that "notions of conservation . . . may serve as a psychological indication of the completion of an operatory structure" (Piaget & Inhelder, 1969, p. 97). Throughout the years, Piaget and his associates have devised a series of experiments to determine whether an individual has achieved conservation in a given area. However in order to understand the reasoning behind a child's responses to conservation tasks, there must be verbal interaction between him and the experimenter. As Flavell (1971b) points out, "discovering the underlying conceptual basis for the child's decision is important, because it might illuminate cognitive-structural meaning and developmental origin of conservation" (p. 203). This discovery process is achieved by means of what Piaget labels the méthode clinique which is the technique permitting the necessary verbal exchange. It is important to note, however, that although Piaget does not deny the functional aspects of language, nor minimize the importance of language in helping to illuminate a child's cognitive processes, he maintains that it is cognitive development that influences language systems, rather than the latter affecting the former (Hyde, 1970; Lovell, 1968).

Support for Piaget's theory was provided by a language training experiment conducted by Inhelder, Sinclair, Bovet and Smock (1966). The authors concluded that the type of language a child used was more a function of his ability to conserve, rather than of his age. Language training might help a child on a specific task, but as there is little or no generalization to other tasks, this procedure cannot help in the development of operational thought.

Generally, by 7 years, the child begins to think in a concrete operational manner. He can now recognize that certain properties of an object remain invariant regardless of perceptual transformations. However, the quality of his thought is still limited because he can only perform operations on concrete stimuli. It is in the final stage, that of formal operations, that the individual can think abstractly and use the hypothetico-deductive method.

It should be emphasized that, according to Piaget, development directs learning. The more developmentally advanced one is, the more aware he is of environmental stimuli. This enables him to respond to his surroundings in new ways (Ginsburg & Opper, 1969; Iano, 1971, Kohlberg, 1968; Piaget, 1952b, 1964). As Piaget (1966) states:

> Learning cannot explain development but the stage of development can in part explain learning. Development follows its own laws, as all of contemporary biology leads us to believe, and although each stage in the development is accompanied by all sorts of new learning based on experience, this learning is always relative to the developmental period during which it takes places, and to the intellectual structures whether completely or partially formed which the subject has at his disposal during this period. (p. v)

There are four factors or laws involved in an organism's developmental growth. According to Piaget and Inhelder (1969), the first is maturation which concerns the development of the central nervous system and the endocrine system. The second factor, physical experience is composed of two types. As Ginsburg and Opper (1969) note, one is direct in the sense that by interacting with his environment, and by manipulating objects the individual can

> abstract or extract the physical properties of objects . . . . [The other involves] logical-mathematical experience which results in knowledge that is acquired through an internal coordination of the individual's actions, and not through physical experience. (p. 169)

The third element effecting developmental growth is social interaction which involves the transmission of ideas from individual to individual. The fourth and final factor is equilibration, "the mechanism by which the child moves from one state of equilibrium to the next" (Ginsburg & Opper, 1969, p. 172). The nature of this factor is such that it (Ginsburg & Opper, 1969, p. 172) "integrates the effects of the other three factors."

There is a biological need for the individual to achieve equilibrium between internal structures and external environmental stimuli. When certain answers no longer satisfy a child or when a situation of cognitive dissonance has been created, he must look for new solutions to again establish equilibrium. According to Piaget (1964), learning or knowledge which develops in this manner cannot be extinguished for "this development of knowledge is a spontaneous process, tied to the whole process of embryogenesis" (p. 176). Smedslund (1961a, 1961b) hypothesised that if a Piagetian conservation concept was based on the equilibration theory it could not be extinguished, whereas if it were based on the principles of external reinforcement, it could. In an experiment, which supports Piaget's theory, he demonstrated that children who were trained to conserve showed less resistance to extinction than those who acquired the ability naturally.

A child does not go from a state of ignorance to one of knowledge in one step. Within each stage of development there are substages. The first is a preparatory one which leads to the final substage of achievement (Flavell, 1963). Flavell states:

> When confronted with problems appropriate to the stage-in-process, the child's cognitive activities are likely to reflect a mélange of organized, but inappropriate earlier structures and the halting and sporadic use of a yet incompletely organized new structure. The preparatory phase, with its flux and instability, gradually gives way to a later period in which the structures in question form a tightly knit, organized and stable whole. It is only in this phase of achievement, of stable equilibrium, that the structures defining the stage exist as the 'structures d'ensemble'. (p. 21)

Support for and Criticism of Piaget's Theory of Development

Although the stage theory of development has been criticized, there has been much support and proof for it based on many replication and research studies. The results of a study conducted by Dudek and Dyer (1972) support Piaget's theory that children progress slowly and continuously, with each level of thought building upon its predecessors, but being qualitatively different from them. Elkind's (1961) replication study of conservation of mass, weight and volume provided support for Piaget's stage theory, as did Brown's (1973) experiment. Brown compared the difference between chronological age and mental age in affecting children's ability to conserve and found that older, more intellectually average children performed better than the younger, more intelligent ones.

In general, experiments by Almy (1966), Dodwell (1960), Hyde (1970) Pinard and Laurendeau (1964) and Uzgiris (1964) agree with the stage concept of development. But, Almy, Hyde, and Pinard and Laurendeau demonstrated that cultural background affects age of attainment of conservation. Dodwell and Uzgiris both found that the sequence of the stages was consistent with that of Piaget, but that any individual might give responses that were at different stages of development depending upon the concept used to determine conservation.

Englemann (1971) rejects Piaget's stage theory commenting that it is basically only a well defined observation of what children are able to accomplish at various ages. He maintains that by means of external reinforcement, one can teach the concept of conservation. In his experiment designed to teach six year old children to conserve weight, he demonstrated this fact. However, his remarks appear to be based on research that is not well defined. In addition, when Kamii and Derman (1971) tested and questioned those children whom Engelmann had trained to conserve weight, they found that those youngsters could no longer adequately do so.

Feigenbaum (1963) obtained results which were inconsistent with Piaget's theory. In Feigenbaum's study of conservation of number, he found that some subjects in his youngest group (45 to 54 months) encountered no difficulty with the majority of the tasks. However, Pinard and Laurendeau (1969), and Tuddenham (1966) point out that Piaget's concern is with the invariance of the sequence of the stages, not with the ages of attainment of the stages.

Variables Effecting Cognitive Development

Generally, research provides support for Piaget's stage theory of cognitive development, but there are some problems concerning the consistency of this theory. These difficulties pertain to the questions of horizontal décalage, time lags, cultural background, socio-economic status, experience, and the material used to assess whether a conservation concept has been attained.

Before one can consider obstacles to a stage theory, one must study the major characteristics of a developmental stage. A stage consists of a group of operations joined together to form a structure, for an operation does not exist alone. At each developmental stage, the structures which characterize a child's level of thought are qualitatively different from previous ones. The stages develop in an invariant sequence (Inhelder, 1970; Piaget, 1964, 1972). But this does not mean to say that an individual, depending upon the task, cannot be functioning at different levels, especially since the transition from one period to another is a gradual process. In the early development of a stage, the characteristic structures are being formed, and are therefore, not stable (Ausubel, 1968; Flavell, 1963, 1971a; Ginsburg & Opper, 1969). Flavell and Wohlwill (1969) note that:

> Even restricting ourselves to a single grouping, or domain, we can expect to find departure from inter-task consistency during the transition period. For it is precisely during this period in which the newly emerging structures are in process of formation that the child's responses may be expected to oscillate from one occasion to the next, to be maximally susceptible to the effects of task related variables, and accordingly to evince a relative absence of consistency. (p. 95)

Piaget does attempt to account for this by means of horizontal <u>décalage</u> and "time lags". However, these provide further indications of how bound a young child's thought processes are to specific situations and materials.

<u>Horizontal décalage and time lags</u>. Horizontal <u>décalage</u> "refers to a repetition which takes places within a single period in development" (Flavell, 1963, p. 22). Flavell (1963) and Ginsburg and Opper (1969) point out that although a particular structure characterizes one's thoughts, one will not necessarily be able to solve all problems involving that structure at the same age. For example, even though the same structure is involved in the child's understanding of the invariance of mass and weight of the same object (e.g., clay balls), the former is acquired by the youngster at least a year before the latter.

"Time lags", on the other hand, are evident when the child can solve a particular problem with one content, but cannot solve the same problem using a different material. These lags may be as short as several months or as extreme as one to two years.

In order to illustrate the idea of a "time lag", in which content can play an inhibiting factor in the understanding of certain concepts, Piaget (1952a) provides an example dealing with the "additive composition of classes" (p. 162). Youngsters were shown a box with two white wooden beads mixed with a number of brown wooden ones. The children were then asked if a necklace which was made from the wooden beads was longer than a necklace made from the brown beads. He discovered that children younger than 7 to 8 years of age could not correctly answer the question. Even with further probing, the purpose of which was to direct their attention to the wooden composition of both the brown and white beads, the children still had difficulty. However, when Piaget questioned youngsters on the same concept, but used a different content, e.g., children (Are there more girls or more children in this class?), he found that approximately half of the 6 year old children and some 5 year olds could correctly answer the question. Thus, although the mental or cognitive process is the same, the concept is understood at an earlier age when the content deals with children as opposed to beads. Piaget (1971b) maintains that

> time lags are always due to an interaction between the person's structures on the one hand, and the resistance of the object on the other . . . . Some resistances of objects are unpredictable. When one encounters them, one can explain them, but always after the events. It is not possible to have a general theory of these resistances. (p. 11)

It appears that although horizontal décalage and "time lags" are obstacles in determining the overall developmental level of a child, they are not inconsistent with the concept of a stage theory of development (Flavell, 1971a). Why, then, do "time lags" and décalages occur? Szeminska (1970) believes that they are "a result of the influence of other factors such as language and acquired knowledge and the type of activity in which the subject has acquired them" (p. 612). Piaget (1971a) also acknowledges the effect of various factors and explains that:

> If a continuous action of the internal maturation of the organism and of the nervous system alone intervened, the stages would not only be sequential but also linked to relatively constant chronological dates, as is the case of coordination of vision and prehension about the age of four to five months, the appearance of puberty, and so forth. According to individuals and the family, scholastic, and social milieus in general, we find in children of the same city often considerable progress or retardation which is not inconsistent with the order of succession, which remains constant, but reveals that other factors are added to the epigenetic mechanisms. (p. 48)

As previously stated, Piaget has discussed these other factors by using the terms 'physical experience', 'social interaction' and 'equilibration'. Other theorists have employed different terms when discussing the influence of environment on development.

Environmental Factors

Goldschmid (1971) faults Piaget for not dealing in more depth with the potential effects of social and emotional factors on cognitive growth. In his 1968 (Goldschmid) study, he noted that children who had high scores on his conservation concept test were better liked by their peers, were described more favorably by their teachers, were more objective about themselves, and had mothers with less dominant views toward child-rearing. Dudek (1972) found that youngsters who achieved operational thought early, were more mature, brighter, and more emotionally stable than those who acquired it later.

Feigenbaum (1963) discovered a positive relationship between ability to succeed in conservation tasks and intelligence. Goodnow and Bethon (1966) found a positive correlation between mental age and conservation ability, since their superior 8 year old youngsters performed as well as intellectually average 11 year olds. Brown (1973), on the other hand, noted that bright children functioned more like their peers of the same chronological age rather than their mental age equals.

Socio-economic factors. Research seems to indicate that cultural and socio-economic aspects do not appear to affect the sequence of the developmental stages, but rather their rate of acquisition. This is not in disagreement with Piaget's basic assumptions, for as Flavell (1963) notes

> Piaget has also for a long time freely conceded that not all 'normal' adults, even within one culture, end up at a common genetic level; adults will show adult thought only in those areas in which they have been socialized. In other words . . . a given individual need not be able to function at the same structural level for all tasks. (p. 20)

Almy, et al (1966) found that, as children progressed from kindergarten to grade two, the percentage of those who could not conserve in any task decreased. However, the percentage of conserving children was greater in middle class schools than in lower class ones. Wasik and Wasik (1971) also noted that culturally deprived children were able to conserve, but did so at approximately one to two years later than the normal population. Gaudia's (1972) research also supports the results of the above studies. Furthermore, Gaudia discovered racial differences among three different groups of children (American Indians, blacks and whites) from the lowest socio-economic class in New York State. The black children acquired the ability to conserve later than did the white youngsters or the American Indians.

Cross cultural factors. Cross cultural studies indicate that cultural environment is another factor influencing the rate of acquisition of conservation ability. Vernon (1969) contends that intelligence develops "differently in different physical and cultural environments. It should be regarded as a name for all the various cognitive skills which are developed in, and valued by, the group" (p. 10). He studied the cognitive abilities of children from East Africa, Jamaica and Canada (Indians and Eskimos), and compared them with those from an English normative population. He found that societal value will influence a person's abilities. For example, because the Africans he studied generally worked to help advance their groups, rather than to achieve personal benefits, they had no interest in obtaining high scores in tests he administered. Vernon used a

Piaget Battery of tasks and tests dealing with verbal and educational ability and found that more culturally backward groups of children will progress cognitively at a slower rate than youngsters from more advanced countries. Moreover, those from the former group will not necessarily attain the same developmental leval as those from the latter group.

Other cross-cultural researchers obtained results similar to those of Vernon. Hyde (1970) compared the cognitive abilities (based on a battery of Piagetian tests) of European, Arab, Indian, and Somali children living in Aden. She concluded that generally in the European group, there were a higher number of subjects giving conservation answers for each age level than in the Arab, Indian and Somali community.

Lloyd (1971) studied conservation ability in Yorubian children from elite and traditional homes. The parents in the former group had at least secondary education, whereas, in the latter, they were, for the most part, illiterate. It was found that, for both groups, ability to conserve increased with age, but children from elite homes acquired this capacity earlier.

Price-Williams (1962) also discovered that although African youngsters from the Tiv tribe in Nigeria lagged behind Western children, they did reach the stage of concrete operations. In addition, Pinard and Laurendeau (1964) noted that when they administered a battery of Piagetian tasks to French-Canadian children, they reached certain developmental stages slightly later than Swiss children.

The above studies support Piaget's stage theory of development, but point to the fact that many factors influence the rate of development. However, despite the difficulties in determining the effects of the various influences on development, many theorists support the idea that knowledge of an individual's developmental level could have implications for education.

The Usefulness of Piaget's Theory to Education

The ability to determine when an operatory structure has been completed or at what stage a child is functioning appears to be potentially helpful for educational purposes. Hence, many of today's educators and researchers have discussed the possible application of Piaget's developmental approach to curriculum planning and to the diagnosis of various learning problems (Almy, 1966; Ausubel, 1968; Ayers, 1971; Bruner, 1960; Elkind, 1969; Green, 1971; Lunzer, 1970; Pinard & Laurendeau, 1964; Robinson, 1967; Rohwer, 1971; Tuddenham, 1969, 1971; Wadsworth, 1971).

According to Ayers (1971), a measure of cognitive level based on Piaget's theory would have a diagnostic purpose, since it would "reveal the limit of the child's current development in various areas" (p. 246). This information could then indicate to the educator the type of instruction most appropriate for a particular child. Many researchers agree that an effective educational program would be one that would match the curriculum or educational experiences to the individual's developmental level (Ausubel, 1968; Kohlberg, 1968; Rohwer, 1971). It appears to be educationally advantageous to know the developmental level of the child, for as Bruner (1960) points out, "it is only when we are equipped with such knowledge that we will be in a position to know how the child will translate whatever we present to him into his own subjective terms" (p. 53).

This, then, leads to two different approaches to viewing the measurement of intelligence. The psychometric approach is basically a statistical one. It measures inter-individual differences in ability. Piaget, on the other hand, regards intelligence as the unique way in which each individual assimilates and accommodates environmental stimuli at different developmental levels. Therefore, the developmental approach would measure an intra-individual developmental change. Pinard and Laurendeau (1964) fault traditional intelligence tests for not considering this aspect. They pointed out that, for example, in an intelligence test, "a six year old child can compensate for failure at the five year level with successes in items localized at seven years" (p. 254).

Green (1971) commented on the value of an intelligence test based on developmental theory by stating that:

> A test which could place a person on a scale of intellectual development not based solely on norms would have a kind of meaning intelligence test scores do not now have but which is something erroneously attributed to them. That is, one could say something about where an individual or group stood in relation to a standard of development which would give a real indication of what that meant he could do intellectually; present tests cannot

> really do this. At the same time, it would not be necessary to say anything about whether the person was better or worse than anyone else. It would still be possible to do so if one wished, but it would no longer be a requisite feature of a description of his abilities. (p. 216)

Many attempts have been made, using Piagetian concepts, to design standardized tests assessing developmental levels (Goldschmid & Bentler, 1968; Lunzer, 1970; Tuddenham, 1969, 1970, 1971; Pinard & Laurendeau, 1964). In addition, in the development of the British Intelligence Scale (Warburton, 1969) an attempt was being made to contain items based on Piaget's theory in the hopes that this would help to determine the qualitative level of one's thought processes. Inhelder (1971) notes that her colleague, Vinh Bang, has been working on standardizing Piagetian tasks for approximately 25 years.

Difficulties Encountered in the Construction of a Developmental Scale Based on Piagetian Theory

Several researchers have attempted to construct a developmental scale of intelligence based on Piagetian theory.

Tuddenham (1969, 1970, 1971) selected children in the transitional stage of pre-operational to concrete operational thought, and, based on this, specific items were chosen for the test. However, when all the test items were intercorrelated, the results were unexpectedly low. The two items which intercorrelated highly (.65) were clay and water pouring. Other intercorrelations ranged from .01 to .41. Even when conservation items were considered alone, the intercorrelations were still low, although not as low as those of all test items.

Lunzer (1970) also attempted to apply more traditional standardization techniques to both the administration of and the analysis of a battery of 21 tests based on Piagetian theory. The purpose of this pilot study was two-fold. Firstly, Lunzer wanted to "test out the measuring devices themselves" (p. 53). Secondly, although he was aware of the theoretical potential value of Piaget's theory to education, he wanted to verify whether it would be possible to apply the theory in such a way as to demonstrate this value. With this in mind, he collected data on a sample of 75 children ranging in age from 5 to 10 years. This age span was chosen because it represented most phases of the concrete operational period of development.

Lunzer (1970) found that the results were sufficiently meaningful to warrant further investigation, but did point out, however, that "the calculation of reliability from item-battery correlation yields an index which is spuriously high, for it is inflated by the great spread in the subjects selected" (p. 67). He further noted that when another researcher used a narrower age range and employed only 10 of Lunzer's tests, a reliability of 0.89 was obtained. In spite of the fact that his study gave additional proof to the point that all characteristics of the concrete operational period did not occur at the same time, and that "task difficulty [was] very much dependent on its articulation, on its content, and on the manner of its presentation" (p. 67), Lunzer still concluded that "the type of task introduced by Piaget is quite compatible with the requirements of reliability in educational measurement" (p. 67).

Goldschmid and Bentler (1968) devised two homogenous, scales A and B, to assess conservation. Since the items they chose were specifically designed to measure conservation, their test, in this respect, is more homogeneous than those of Tuddenham and Lunzer. Each item in the two scales has a behavior and explanation part to it. They obtained high intercorrelations when comparing the categories of behavior and explanation both within scale A and B and between each scale. However, they did not mention the intercorrelations for the six items within each category of either scale A or B. It appears difficult, then, without this knowledge, to know whether their scales do measure an overall developmental level, and if it can, therefore, be used for this purpose.

Certain difficulties, then, seem to hamper the construction of standardized tests that adequately measure an overall developmental level. The first question to arise is whether there actually is an overall developmental level for each individual? Piaget (1971b) questions whether it is "possible to detect broad periods in development with characteristics that can be applied in a general manner to all the events of these periods" (p. 2). This might partially be due to the effects of the horizontal <u>décalage</u> and "time lag" factors. In addition, it is very difficult to retain the essence of what Piaget is trying to achieve, if by standardizing his tasks, one must eliminate or radically alter the use of the <u>méthode clinique</u>. By analysing the quality of a child's responses, one can discover developmental differences. A wrong answer can be equally as informative as a correct one.

It appears, then, that the question is not whether it is worthwhile to devise a developmental scale of cognitive ability, but how one can overcome the obstacles preventing the construction of such a scale. Perhaps the most fundamental obstacle is that of the "time lag" concept. Hence, does the material used to assess if an individual has acquired a conservation concept have an effect on his understanding of that concept? The following section is devoted to research which has been done in this area.

Studies Related to the Effect of Content on the Acquisition of a Conservation Concept

Generally, research seems to support the hypothesis that the material used can affect ability to conserve in a particular task, especially during the time at which this conservation ability is forming. However, the sequence of the stages remains invariant.

Dodwell (1960), in experiments designed to clarify children's understanding of number, encountered no problem when attempting to classify a specific answer according to level of conservation. It was difficult, however, to determine an overall level of functioning for each child as the stimuli used and the situation had an effect on ability to conserve. In addition Schaeffer, Eggleston and Scott (1974) pointed out that it was more difficult for young children to deal with a large number of objects when grouping them and counting them. Robinson (1967) found that in experiments dealing with conservation of number and with class inclusion, children who could be classified as conservers when using one materials, could not necessarily conserve in the same or similar tasks when using another. Based on her Aden experiments dealing with conservation of substance and number, Hyde (1970) also concluded that the type of content used will influence the ability to conserve.

On the other hand, when Dodwell (1962) studied the concept of classification, he found that there was no significant difference in the material used. That is, even though there could have been intra-individual differences, generally subjects could deal with the concept equally as well when the content dealt with boys and girls (children) or with rakes and shovels (tools).

Kahn and Garrison (1973) used paper clips and smarties to determine if there would be any difference in youngsters' capacity to conserve number. They discovered that the interaction between the materials employed and the order in which they were presented affected operativity. Although there was no significant difference between the materials themselves, if, in the first trial, the test stimulus presented was very meaningful to the child, he would be more likely to give a conservation response during the second trial.

Kahn and Reid (1975) studied the effects of content used, and order of presentation of stimuli on the invariance of number with educably mentally retarded children from both the lower and middle socio-economic classes. They obtained results similar to those of Kahn & Garrison (1973), but, in addition, found a significant interaction between economic class and material.

Lovell and Ogilvie (1960) examined the effects of diverse stimuli on conservation of substance, and ascertained that it was easier to recognize the invariance of substance when a rubber band was stretched than when a ball of plasticine was reshaped into a sausage. Za'Rour (1971), as well, looked into this question, but with conservation of weight. He performed this experiment with Lebanese children, and found that the material used had a significant effect. Unlike Lovell's and Ogilvie's subjects, however, Za'Rour's youngsters could conserve weight more easily with plasticine, than with a rubber band or with a blue liquid in a thermometer.

Uzgiris (1964) also questioned the effect of content on young children's understanding of the invariance of substance, weight and volume, and found that the material used did influence their ability to conserve. However, unlike Kahn and Garrison, and Kahn and Reid, she did not find that the order of presentation of objects was significant.

Brown (1973), on the other hand, in his research dealing with conservation of number in retarded, average and intelligent children, noted that the stimuli used had no significant effect. However, the materials he chose were red and yellow blocks and red and yellow smarties. Even though the objects were not alike, their similar colours might have been enough of a common element to counterbalance their difference in appearance.

Lloyd (1971) wanted to see if Yoruba children would recognize the invariance of number equally as well with culturally familiar and unfamiliar objects. In addition, the order of presentation of the materials was examined. The author discovered that the "use of familiar materials did not affect performance significantly, although order did have a significant effect" (p. 419). However, in the experiment, some subjects received one material and some received another. Thus, the comparisons were inter-subject rather than intra-subject. Furthermore, the procedures used to ascertain whether conservation had been achieved were not as strict as Piaget's, and hence, some children who were classified as conservers would not have been so by Piaget.

To summarize, then, it would appear that many researchers support Piaget's contention that development occurs in sequential and hierarchical stages. However, the process of learning to think in an operational manner might be affected by the test materials used or their order of presentation, especially during the early stages in the formation of this ability. That is, just because youngsters conserve in a particular task with one content, it does not necessarily hold that they will do so with another content. Uzgiris (1964) explained this phenomenon by stating that:

> It may well be that when a schema is developing, specific contacts will lead it to accommodate more in certain areas than in others, producing situational specificity in terms of specific past experiences of the individual. But after a certain number or a certain variety of encounters, a schema may develop independence and start to be applied universally. This leads to the expectation that schemata would be in a greater state of flux while developing, showing situational specificty, but once they consolidate, the situational variability would be expected to disappear. (p. 840)

As was previously discussed, children do not go from a state of non-conservation to one of conservation in one step. Hence, it is during the transitional phase that one could expect the test material or its order to have its greatest influence on operativity. However, there appears to be a controversy among researchers as to which of the two factors, if any, has the greatest influence. It is this question and its application to conservation of number that will be studied in this thesis. Number was chosen as opposed to other conservation tasks because a variety of materials could be used when studying conservation of number. In the following section the three stages through which individuals progress to achieve an understanding of conservation of number will be more fully discussed.

Conservation of Number

According to Piaget (1952a), in order for a child to conserve number (i.e., to achieve operational correspondence), he must first be able to establish one-one correspondence between two sets. There are two types of correspondence, provoked and spontaneous (unprovoked). The former is concerned with establishing correspondence between two elements that are in some way related to each other; e.g., eggs and egg-cups, flowers and vases. That is, one can place the egg into the egg-cup, and the flower into the vase. In the latter case, the correspondence is established between two unrelated objects, e.g., tokens and candies. Piaget points out that provoked correspondence, then, because of the nature of the elements, would be easier to establish. He explains that:

> the closer the one-one correspondence between the elements, the more lasting the equivalence of the corresponding sets will be. If therefore, a flower is put into a vase, or an egg into an egg-cup, the link between the corresponding elements will be closer for the child than when a glass is merely put opposite a bottle. He will therefore have less difficulty in understanding that the quantity of flowers

> or eggs remains equal to that of vases or egg-cups when the flowers or eggs have been taken out and piled together.
>
> This is an important situation .... for if the same children answer the same question better when the correspondence is intuitively closer, they show that it is not a matter of verbal misunderstanding, but that the quantifying value of correspondence is greater or less according to the content of the particular problem. (p. 49)

In one-one correspondence problems, the child is presented with a specific number of objects (A) and is asked to select, from a larger group, the same number of objects (B) as there are in set A. After correspondence is established, the objects, first in set A, and then in set B, are either bunched together or spread apart. In each case, the child is asked if there are as many A^s as B^s or vice-versa. The following pattern is noted.

Conservation of number develops in a sequential manner and must proceed through three stages. During the first stage the child does not comprehend the concept of correspondence. His comparisons are global in nature. His determination of correspondence is based on the length of the two sets, without considering the density. By the second stage, however, the child is able to establish correspondence easily. But, this ability to recognize that the sets are equal, is lost as soon as the visual correspondence is altered. Thus, he is still influenced by his perceptions. Even when he knows that the two sets are equal in number (because, for example, he has counted them) if they are not perceptually identical, he will maintain that one set has more. Furthermore, there is no conflict in the child's mind. He does not realize that his rationale is not logical.

Just as the child is reaching the third stage, he becomes aware that the two sets are alike even though they do not perceptually appear to be similar. However, he can only do this insofar as the distortions are not too great. By the time his thought processes are fully operational (the third stage), he is no longer confused by perceptual configurations and can recognize the equivalence of the two sets. He is able to mentally reverse the operation, to compensate for differences in length by means of density and vice-versa, and finally is aware of the initial identity of the two sets. That is, nothing has been added to or removed from either set.

In the first stage, the child could make conflicting and contradictory statements and not be bothered by them. During the latter part of the second stage, however, a conflict develops between perception and logic or fact. The youngster can determine, by means of one-one correspondence, that two sets are equal, but if one changes the visual configuration of a set, the child can easily be swayed from his original assertion concerning the numerical equivalence especially if his attention is drawn to the perceptual differences. Piaget (1952a) notes that:

> although [the child] himself has just made the one-one correspondence, he reacts like the child at the first stage and thinks that any variation in height or width [or length or density] entails a change in the quantity as a whole. But whereas at the first stage his belief in the equivalence was destroyed, now there is merely a conflict between the two tendencies, neither of which definitely triumphs. (p. 32)

The child achieves conservation by the third stage. It is at this time that he is able to overcome the effects of perceptual distortions by means of the concepts of identity, reversibility and compensation (Piaget, 1952a, 1971a). These concepts are what constitute operational thought. The child is able to rationalize the effects of perception as a result of the knowledge that nothing has been added to or removed from the original sets. Thus, even though the quantities may not appear to be the same, they must be. This is identity.

The concept of identity goes hand in hand with that of compensation. That is, one row may look like it contains more objects than the other because the objects are spread farther apart and, therefore, the row is longer. However, the child is able to compensate for the differences in length by recognizing that there are also differences in density, i.e., in the shorter row the objects are closer together.

Finally, the youngster is able to recognize the fact that the process can be reverted to the original state. One can spread apart the items in the shorter row or move the ones in the longer row closer together, and thus obtain visual proof that the quantities have not been altered. This is reversibility, which is a key element of operational thought. It is usually not necessary to physically reverse a process, for a child can mentally perform this operation. When the concepts of identity, reversibility and compensation are present in the child's though processes, he is no longer bound by his perceptions and can, therefore, think in an operational manner.

Studies Dealing With Conservation of Number

As discussed, research tends to support the fact that children go through three stages to reach operational thought. However the rate of acquisition of the stages varies as a result of many factors. In addition, Dodwell (1960) confirmed Piaget's contention that provoked correspondence is easier to understand than unprovoked one-one correspondence. Dodwell, as well as Wheatley (1970) and Wohlwill and Lowe (1962), noted that ability to count does not necessarily indicate an understanding of the concept of number conservation.

Dodwell (1961), Robinson (1967), and Wheatley (1970) acknowledged that a relationship exists between ability to conserve number and prediction of and achievement in mathematical ability in grade one. Nevertheless, as Robinson pointed out, this does not necessarily mean that youngsters who conserve will succeed in first grade arithmetic. Siegel and Goldstein (1969) found that children younger than approximately 5-1/2 years do not conserve number, and do not understand relational terms such as more and less.

Schaeffer, Eggleston and Scott (1974) found that understanding of number concepts improved with age. Also, young children could group and more easily deal with fewer (two to four) than with more (up to 10) objects, and with more familiar ones. In a similar vein, Feigenbaum (1963) noted that children could conserve more easily with fewer groups of beads than with a greater number of groups.

Gruen (1965) found that, generally, training youngsters to conserve would not truly improve their ability to think in an operational manner. In cases where an improvement was found, it was noted that conservation "when it is acquired in the laboratory over a few days, may not have as much depth or generality as conservation acquired 'naturally' over a long period of time" (p. 978).

To summarize, then, conservation of number develops in a slow, natural, sequential manner as children progress through three hierarchical stages. Furthermore, ability to count does not necessarily imply an understanding of conservation of number. Youngsters appear to find it easier to conserve (in particular, during the second stage when they vascillate between states of conservation and non-conservation) when fewer and/or more familiar objects are used and with materials which provoke one-one correspondence.

The Purposes of the Study and the Research Hypotheses*

The proposed research concerns what is perceived to be one of the most basic questions facing the construction of a developmental scale of intelligence based on Piagetian theory. It relates specifically to the time lag concept. Piaget (1971b) has stated that "there are any number of these problems of time lags between the solution of a problem with a certain material and the solution of the same problem with another material" (p. 11). The question is, if one holds a task constant, does the material make a difference? For example, does one child conserve number when candies are used and fail to conserve when bottle caps are employed, while another youngster performs in reverse. If this is the case, then certain precautions must be taken when constructing an intelligence test based on developmental theory. Is is hoped that the present study will help to clarify questions concerning the effects of content on conservation tasks.

Research hypotheses. The main concern of the study was to examine the relationship between young children's understanding of conservation of number and the test-stimuli (material) used in the performance of the tasks. However, as it has already been pointed out, another variable, the order of presentation of the materials, had been found (Lloyd, 1971) to affect an individual's performance on conservation tasks. As well, researchers (Piaget, 1952a; Dodwell, 1960) have noted that children find the task of provoked one-one correspondence easier to understand than that of spontaneous one-one correspondence. Thus the following three hypotheses were proposed.

1. Children will conserve number (i.e. demonstrate operational correspondence) significantly more often with familiar content (test-stimuli) as compared to unfamiliar content.

2. Children will conserve number significantly more often when presented with the second, as compared to the first, administration of test-stimuli.

3. Children will conserve number significantly more often when presented with provoked as compared to spontaneous one-one correspondence tasks.

In other words, <u>content</u> (familiarity of test-material), <u>order</u> (order of presentation of test-material) and <u>task</u> (provoked or spontaneous one-one correspondence) are the variables that are hypothesized to influence operational correspondence.

CHAPTER II

PROCEDURE

Introduction

The ~~preceding~~ chapter dealt with Piaget's stage theory of cognitive development and with the variables which can influence the rate of acquisition of the stages. In addition, studies related to the effect of content on a child's understanding of a conservation concept were discussed. It was noted that there was a degree of controversy among the researchers. Some believed (Hyde, 1970; Lovell & Ogilvie, 1960; Robinson, 1957; Uzgiris, 1964; Za'Rour, 1971) that it was the nature of the material that had a significant effect on one's ability to comprehend a conservation concept. Others (Lloyd, 1971) felt that it was the order in which the materials were presented, and still others (Kahn & Garrison, 1973; Kahn & Reid, 1975) found that it was the interaction between the two that played the greatest part. Moreover, when dealing with the invariance of number, Piaget (1952a) maintains that children understand the concept of provoked correspondence at an earlier age than that of spontaneous correspondence.

The purpose of the study was to provide some answers to this controversy. With this in mind, a sample of kindergarten and first grade children were administered Piagetian number conservation tasks with several different materials. The results were then analysed to see if there was a relationship between the content (test stimuli), task, the order of presentation of materials and the understanding of conservation of number (operational correspondence).

Tests Administered

The following tests[1] were used for the experiment.

I. Language test - The purpose of this was to assess the child's general understanding of the terms 'more' and 'less'.

II. Conservation of number

1. One-one provoked correspondence with familiar materials (dolls and beds).
2. One-one provoked correspondence with unfamiliar materials (metal nuts and bolts).
3. One-one spontaneous (unprovoked) correspondence with familiar materials ('Chiclets' brand chewing gum).

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[1]The tests are described in detail in the appendix.

4. One-one spontaneous (unprovoked) correspondence with unfamiliar materials (rubber faucet washers).

Conservation of number was chosen for this study because of the availability of a variety of appropriate materials.

Selection of the Sample

The children were selected from all the kindergarten and grade one classes in one public elementary school under the jurisdiction of the Protestant School Board of Greater Montreal. The school population was drawn from a lower-middle class socio-economic area.

The majority of the children were first generation Canadians predominantly from families of Greek origin. There were a total of 94 potential subjects. However, because of the cultural background of the youngsters, in order to be included in the study, they had to meet the following requirements. They had to

1. exhibit no difficulty speaking or understanding the English language.
2. possess a good record of school attendance.
3. be able to interact well with peers.

4. pass a language test assessing their understanding of terms deemed necessary for the Piagetian tasks in question.

Before the language test was administered, 13 children were judged to be unacceptable for the study. Six were experiencing extreme difficulty with the English language. Two had serious social problems, and five were frequently absent. The remaining 81 children were administered the language test to note their comprehension of terms essential to the experiment. The top 60 out of the 62 children who passed the test were used in the study.

There were 36 boys and 24 girls in the study. The distribution of subjects according to sex and grade is shown in Table 1.

Table 1

Distribution of Subjects by Sex and Grade

	Grades		
Sex	Kindergarten	One	Total
Male	8	28	36
Female	11	13	24
Total	19	41	60

The mean age of the sample was 6 years and 8 months. The age distributions of the kindergarten and of the grade one children are presented in Table 2 and Table 3 respectively.

Table 2

Age Distribution of Kindergarten Subjects

	Ages (Years - Months)											
	5-9	5-10	5-11	6-0	6-1	6-2	6-3	6-4	6-5	6-6	6-7	6-8
Number of Subjects	3	2	3	0	0	2	1	0	1	2	1	4

n = 19

Mean = 6-2

Table 3

Age Distribution of Grade One Subjects

	Ages (Years - Months)											
	6-9	6-10	6-11	7-0	7-1	7-2	7-3	7-4	7-5	7-6	7-7	7-8
Number of Subjects	5	5	2	3	3	5	2	5	3	2	3	3

n = 41

Mean = 6-10

The classroom teachers were asked to give to the experimenter an informal rating concerning the quality of the youngsters' school work. All children, with the exception of two, were functioning academically at average to above average levels.

The 19 kindergarten children were randomly distributed into four groups. The 41 grade one youngsters were also randomly distributed into the same four groups so that each section had a total of 15 subjects. The children were seen individually by the examiner on two occasions. They were tested away from their classmates in a small, quiet room, enabling the testing situation to be free from disturbances. The tests were administered between May 10, 1978 and June 7, 1978.

Procedure for Administering and Scoring the Language Tests

Language test[2] - part one. A child's lack of understanding of the relational terms 'more' and 'less' could affect the validity of the experiment. Therefore the children were first given a language test to assess their knowledge

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[2]This test was an adaptation of one part of the language test used by Robinson (1967) for her doctoral dissertation.

of the terms 'more' and 'less', and to see the manner in which they verbalized their ideas concerning the meaning of these words. In their answers, the youngsters were required to use at least one of the two relational terms. For example, if a subject described one doll as having more chocolate bars than the other, it was implied that the other had less. Any child who could not correctly use the words 'more' or 'less' was eliminated from the experiment.

There were two parts to this test. The first was verbal and the second non-verbal. In the first section, two dolls were placed before the child. The examiner then described a situation to the subject in which each doll did an equal amount of extra work in order to help the teacher. As a result, they were rewarded by being presented with chocolate bars. In the first case, one doll was given more chocolate bars than the other. In the second case, the situation was reversed. Finally each doll received an equal amount of candy. The subject observed all the changes in the distribution of the chocolate bars, and after each manipulation was asked if this was fair or if it was right. He was required to explain his answers.

Scoring procedure language test - part one. All answers were recorded verbatim and then later analysed to see if the youngsters had correctly used the terms 'more' and/or 'less'. The following are examples of appropriate responses. In all cases the experimenter had just asked the child whether the distribution of chocolate bars was fair or right and the child was required to explain his answer.

1. "This is not fair. She had two and she (pointing to the other doll) has more than two."
2. "That's not fair. She has more than this one. If you take three away from her then its fair."
3. "That's not fair. This doll has a lot to eat and that one has less."
4. "She has more than her. She has five and she has two only."
5. "Now that's good. Now the teacher's nice because the dolls have three each. They both have the same."
6. "Hey, that's not right! They did the same work, but she has less and she has more."

The following are examples of unacceptable answers because the subjects felt that the uneven distribution of candy was fair, or did not comprehend why it was not fair. Hence they did not truly understand the essential vocabulary.

1. "I don't know why its not fair."
2. "She has a lot and she has a lot."
3. "This is fair because they did the same work." (When the subject made this comment, one doll had two chocolate bars in front of it and the other had five.)
4. "She has two and she has five." (Although this subject was correct, his answer was not appropriate because he did not use the words 'more' or 'less'.)
5. "They helped the teacher."

<u>Language test - part two</u>. The second part of the test was designed to evaluate, in a non-verbal manner, the children's understanding of the essential vocabulary. Two dolls were again placed before a child. A hypothetical situation was then described in which the dolls were the youngster's friends and he or she was required to share some

chocolate bars with them. In the first case the subject was told to give more chocolate bars to one doll than to the other, and in the second case to give each of them the same amount.

Scoring procedure language test - part two. The exact manner in which the children performed the tasks, and the comments, if any, that they made, were written down by the examiner. Generally, the youngsters found this section easier than the former one. However, in order to be included in the study, they had to have been successful in both sections.

Procedure for Administering the Piagetian Experiments

The four groups were administered one-one correspondence tasks. The questions asked, and the ensuing analysis are based on Piaget's (1952a, Chapters III & IV) experiments dealing with provoked and spontaneous (unprovoked) correspondence. In each case, the youngsters performed the task in question twice, once with familiar and once with unfamiliar materials. The order of presentation of the materials varied with the group. That is, of the 30 children who were administered the one-one provoked correspondence tasks, 15 were given the familiar material first, and 15 received the unfamiliar material first. The same procedure was followed with the group of 30 subjects who received the one-one spontaneous correspondence tasks. Thus the design was counterbalanced for order, content and task.

In order to determine if the test-stimuli were or were not familiar to the child, before participating in the experiment each youngster was shown the materials. He was asked to identify them and to explain their possible uses. Of the 30 children involved in the experiments using chewing gum and washers as test stimuli, all could identify the former, whereas only one could identify the latter.

In the tasks involving dolls and beds, and nuts and bolts, all 30 children could easily name the former objects, while only two were familiar with the latter. One of the two, however, did not know that the objects were labelled nuts and bolts, but he could give an adequate explanation of how they could be used. Those youngsters who were unfamiliar with the objects involved were informed of their names by the examiner.

<u>One-one provoked correspondence - familiar materials</u>. Ten doll beds were placed in a row in front of the child, and a clear plastic bag containing 20 dolls was given to him. The youngster was told to remove from the bag just enough dolls as there were beds, so that each doll would have a bed. If the child was experiencing difficulty, he was aided in establishing one-one correspondence by being encouraged to place the dolls on the beds. Once this had been completed and the subject had given his reasons for equating the two sets, the examiner removed the dolls from the beds and bunched them together. This resulted in two rows each containing five dolls (see appendix p. 111). The subject was then asked if there were as many dolls as beds. If he gave a negative response he was asked where there were more or less and why there were more or less. If his response was affirmative, he was questioned as to why they were the same and as to how he knew they were the same.

In the last part, the dolls were again arranged in a row and then were spread farther apart. This time the subjects were asked if there were as many beds as dolls. The same questions were then put to the child depending upon whether his answer was affirmative or negative. After each situation was presented to the child, and after each question was asked, his answers were recorded verbatim for later analysis.

One-one provoked correspondence - unfamiliar materials. The task was the same in this experiment as in the preceding one, however, in this case the materials (metal nuts and bolts) were unfamiliar to the child. If a youngster was experiencing difficulty establishing one-one correspondence, he was shown how to screw the nut onto the bolt. Once this was completed and the child's explanations were recorded, the experiment continued following the same procedure as above.

One-one spontaneous correspondence - familiar materials. The examiner removed 10 pieces of 'Chiclets' brand chewing gum from a clear plastic bag and arranged them in a row in front of the child. This was known as the model. The child was handed the bag containing an additional 20 pieces of gum and was instructed to remove from the bag the same number of pieces of gum (not more, not less) as there were in the model row. The subject was then asked if the rows were equivalent and why they were or were not the same depending upon his answer. All answers were recorded verbatim. If he initially felt that his row did not contain the same amount of gum as there were in the model, he was permitted to alter his row until he was satisfied that the two were identical. If he could establish one-one correspondence, the experiment continued. If he could not do so, it ended at this stage.

The major difference in the experiments dealing with provoked and spontaneous one-one correspondence occurred in part one. In the provoked correspondence tasks, as a result of the nature of the materials, the child was able to form a relationship between the objects involved. That is, the dolls could be placed on top of the beds, and the nuts could be screwed onto the bolts. Thus it was unlikely for a youngster to be unable to establish one-one correspondence. This was not the case with the spontaneous correspondence tasks. There was no link between the objects involved and, hence, it was possible to be unable to form the correspondence. If, however, the subject could do so correctly, the second part of the experiment could proceed.

In the second section, the examiner spread apart the pieces of gum in the model row. The child was then questioned as to whether there were as many pieces of gum in the model row as in his row. He was required to explain his answer. The same procedure was repeated for the third part. In this case, however, the pieces of gum in the model were pushed together. The usual questions were repeated, and all answers were recorded verbatim.

<u>One-one spontaneous correspondence - unfamiliar materials</u>. The procedure in this experiment was identical to the one just described. In this case the test-stimulus (common faucet washers) had been determined to be unfamiliar to the child.

Procedure for Scoring Piagetian Experiments

The scoring method was the same for all four experiments. Each experiment was divided into three parts for which a child could obtain a total of seven points. The first section involved the establishment of one-one correspondence. If a child could correctly do this, he was given a score of one.

The next two parts, sections two and three, dealt with the child's responses concerning the numerical equivalence of the sets as he observed transformations in their visual configurations. There was also a judgment section. That is, it was not only sufficient for the child to give a "yes" or "no" response, but he also had to explain his answer. A judgment section was considered to be important because an analysis of the reasons why a child responded as he did helped to illuminate his thought processes. Several researchers (Goldschmid & Bentler, 1968; Lunzer, 1970) in their studies have awarded point value to a subject's judgment answers.

In each of sections two and three, a youngster could obtain a total score of three. For example, if, after a transformation, an individual could recognize that the sets were still equal, he would receive a score of one. In such case, he would be asked to explain his answer (judgment section) and he would be awarded zero, one or two additional points depending upon the quality of his explanation. If, however, an individual could not recognize that the sets were equivalent, he would receive no points. Nevertheless, he was still asked to explain his answer in order for the examiner to gain further insight into his thought processes.

In order for a subject to have obtained a score of three in either of sections two or three, he would have had to demonstrate that he understood one or more of the characteristics involved in operational thought - that is, identity, reversibility and compensation (Piaget, 1952a, 1971a). These have been previously discussed in Chapter one. The child's total score was then analysed and converted into the Piagetian stage (either one, two or three) at which the subject was functioning for each particular task. This procedure had been followed by researchers such as Dodwell (1960), Goldschmid and Bentler (1968), Lunzer (1970), and Robinson (1967).

A score of zero to two was indicative of stage one thought processes. That is, the child did not truly understand one-one correspondence. If a youngster obtained a score of three to five he was in stage two. This meant that the child had no difficulty in establishing one-one correspondence, but that his belief in the equivalence of the sets could be shaken if the perceptual distortions were sufficiently great. An individual who received a score of six or seven was considered to be in stage three. That is, he truly demonstrated operational correspondence and could not be influenced by perceptual differences. Furthermore, the quality of his judgment responses demonstrated his comprehension of the concepts of identity, compensation and/or reversibility.

Examples of stage one behaviour. The subjects either could not form the one-one correspondence between the two sets or could do so without truly understanding why they were equal. The latter occurred only in cases where materials designed to elicit a provoked correspondence were used. That is, the child was forced to make the correspondence, because he could, for example, only place one doll on one bed, and thus could see when he had the correct amount in each row.

1. S.[3] He took nine nuts from the bag and placed them below the 10 bolts so that the beginning and the ending of each row coincided. Only when he screwed the nuts onto the bolts, could he see that he had an extra bolt. He then added one more nut.

E. "Are there as many nuts as bolts or are there more nuts or more bolts?"

S. "Um - the same. No. Yes, yes, the same."

E. "Why are they the same? How do you know they are the same?"

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[3]'S' represents the subject and 'E' the examiner.

S. "Because."

2. S. He placed seven dolls below the 10 beds.

E. "Are there as many dolls as beds? Are there more dolls or are there more beds?"

S. "I don't know."

E. "How can you check this to see if there are as many dolls as beds?"

S. "Oh, I can put them on the beds." When he did so, he realized that he had three extra beds, and he proceeded to add three more dolls. Thus he was forced to make a correspondence between the two sets, although he did not truly understand why.

3. S. She removed the washers from the bag one at a time, and began to place them below the washers in the model row. However, she did not continue to maintain the correspondence and ended with 12 washers in her row.

E. "Do you have as many washers in your row as there are in this row (model), or does my row have more, or does your row have more?"

S. "We have the same because I took the same as you."

4. S. She removed the washers one at a time from the bag and arranged them in such a way that her row (which contained 13 washers) was perceptually identical to the model row.

E. "Do you have as many washers in your row as there are in this row (model), or does my row have more or does your row have more?"

S. "It's the same."

E. "Why are they the same? How do you know they are the same?"

S. "I don't know."

5. S. He took 12 pieces of gum from the bag and arranged them in a haphazard order under the model row.

E. "Do you have as many pieces of gum in your row as there are in this row (model), or does my row have more or does your row have more?"

S. "You have more."

E. "How can you make them the same?"

S. He added three more to his row giving him a total of 15. "Now they are the same."

Examples of stage two behaviour. The subjects could easily establish one-one correspondence between two sets, but could not necessarily maintain their beliefs in the equivalence if one set underwent a visual transformation. That is, they would vascillate between states of non-conservation and conservation depending upon the perceptual distortions. Moreover, in their responses, they usually did not use the concepts of reversibility, compensation or identity.

1. After one-one correspondence was established, the pieces of gum in the model row were pushed together.

   E. "Are there as many pieces of gum in this row (model) as there are in your row, or are there more in my row, or more in your row?"

S. First she counted the gum in the two rows.

"I have more."

E. "Why do you have more?" How do you know you have more?"

S. "Well, I counted."

She then counted again and this time arrived at the right number.

"We both have the same."

E. "Why are they the same?" How do you know they are the same?"

S. "I counted."

2. After the child correctly made the one-one correspondence, the washers in the model row were spread farther apart.

E. "Are there as many washers in this row (model) as there are in your row, or are there more in my row or are there more in your row?"

S. "I have less. I have nine and you have 10."

E. The examiner then pushed the washers

in the model row close together.

"Are there as many washers in this row (model) as there are in your row, or are there more in my row, or are there more in your row?"

S. "We have the same. There are 10 here and 10 here."

3. After one-one correspondence was established, the washers in the model row were spread farther apart.

E. "Are there as many washers in this row (model) as there are in your row, or are there more in my row, or are there more in your row?"

S. "They're the same. You put yours far apart, but you still only have 10."

E. The examiner then moved the washers in the model row close together.

"Are there as many washers in this row (model) as there are in your row, or are there more in my row or more in your row.

S. "I have more."

E. "Why do you have more?" How do you know you have more?".

S. "Because it's (model) little, and mine is not. If you put it back like mine then it will be the same. Now you have less."

4. After one-one correspondence was easily established between the nuts and the bolts, the nuts were unscrewed from the bolts and pushed together to make two rows containing five each.

E. "Are there as many nuts as bolts, or are there more nuts or more bolts?"

S. "They're the same."

E. "Why are they the same? How do you know they are the same."

S. "They are just the same."

E. The examiner then rearranged the nuts into a row and pushed the bolts together. "Are there as many bolts as nuts, or are there more bolts or more nuts?"

S. "The same."

E. "Why are they the same? How do you know they are the same?"

S. "I don't know."

Examples of stage three behaviour. At this level, the subjects had no difficulty retaining their conviction that the number of elements in the set remained invariant regardless of perceptual transformations. In addition, they were able to justify their responses by means of the concepts of identity, reversibility or compensation.

1. After one-one correspondence was established, the dolls were removed from the beds and pushed together making two rows each containing five dolls.

   E. "Are there as many dolls as beds, or are there more dolls or more beds?"

   S. "They are the same."

   E. "Why are they the same? How do you know they are the same?"

   S. "You just moved them around. You took them out of bed and just moved them around, so that's why its the same.

The procedure was then reversed and the dolls were spread apart. The above questions were repeated.

S. "You changed the place of the dolls and beds. They were the same when they were sleeping, so they are still the same now. You didn't do anything but change the places."

2. E. After one-one correspondence was established, the examiner first spread apart the washers in the model row, and then bunched them together. After eash transformation she asked,

"Are there as many washers in this row (model) as there are in your row, or does my row have more, or does your row have more?"

S. "They are the same. You didn't take any away from here, or put any more here." (In each case the subject pointed to the row he was describing.)

3. After one-one correspondence was established, the pieces of gum in the model row were first spread apart and were then pushed together. The subject, after each manipulation, was asked specific questions.

   E. "Are there as many pieces of gum in this row (model) as there are in your row, or does my row have more, or does your row have more?"

   S. "We have the same."

   E. "Why are they the same? How do you know they are the same?"

   S. "In this row the gum is pushed together, and in this row they are far apart. But, so what, they are still the same."

The foregoing presented a small sample of behaviour exhibited and responses emitted typical of the three Piagetian stages. The quality of a child's answers was very much influenced by the stage at which he was functioning for that particular task.

Statistical Procedure

As this study was attempting to determine the effects of three variables - task (spontaneous and provoked one-one correspondence), familiarity of content, and order of presentation of the content, a three-way analysis of variance (2 x 2 x 2) appeared to be the most suitable design. The SPSS (Statistical Package for the Social Sciences) 'Anova' subprogram was employed.

The experiment was administered so that there were two scores for each subject (i.e., two presentations of the task - one using familiar and one using unfamiliar materials). All raw scores were converted to the Piagetian stage (either one, two or three) which was characteristic of the child's thought processes for that specific task and these stage scores were used in the analysis.

The 60 subjects were divided into four groups, each containing 15 subjects and consequently 30 stage scores, as indicated in Table 4. The first group consisted of subjects who received one-one provoked correspondence tasks where familiar materials were presented first. From this group, the familiar scores of eight randomly selected subjects were chosen for analysis. The unfamiliar scores of the remaining seven subjects in the group were chosen by default. The second group was made up of subjects who received spontaneous one-one correspondence tasks where familiar materials were presented first. From this group, the familiar scores of seven randomly selected subjects were chosen for analysis. The unfamiliar scores of the remaining eight subjects in the group were also chosen by default. In the same manner, the familiar scores of eight and seven randomly selected subjects were chosen from the other two groups respectively, as well as the unfamiliar scores of the remaining seven and eight subjects in each group respectively.

Because of the design employed and the manner in which the data was collected, it was possible to do a replication of the three-way analysis of variance. This involved using the 60 stage scores which had not been chosen for the first analysis. For example, in group one, the seven familiar and the eight unfamiliar scores (which were not chosen for the first analysis) were therefore used in the second analysis. The results of the two analyses are presented in the following chapter.

Table 4

Selection of Subjects Whose Scores were Used in the First Analysis

Group	Order of Presentation of Materials	
	Provoked	
1	Familiar	Unfamiliar
	8[a]/15	7[b]/15
3	Unfamiliar	Familiar
	7[b]/15	8[a]/15
	Spontaneous	
2	Familiar	Unfamiliar
	7[a]/15	8[b]/15
4	Unfamiliar	Familiar
	8[b]/15	7[a]/15

[a]Randomly selected subjects.

[b]Subjects selected by default.

CHAPTER III

ANALYSIS OF THE DATA

Analyses of Variance

First analysis. The familar raw scores (which had been converted to stage scores) were randomly chosen from 30 of the 60 subjects. The unfamilar scores of the 30 subjects whose familiar stage scores were not selected, were chosen by default. A three-way analysis of variance was performed and the conventional .05 level was used to determine significance. Of the three main effects (order, task and content) only content, i.e. the test stimuli used in the performance of one-one correspondence tasks, was significant ($p < .03$). The statistical data relevant to the analysis are presented in Tables 5 and 6.

It would appear that the children were able to conserve number more easily when the materials with which they were dealing were familiar to them. In addition, the order in which these materials were presented had no significant

Table 5

Statistical Description of Variables by Order of

Presentation of Materials

Order	Task		Mean	SD	n
1	Provoked	- FM[a]	2.75	0.46	8
(Familiar materials presented first)		- UM[b]	2.29	0.76	7
	Spontaneous	- FM	2.57	0.79	7
		- UM	2.25	0.89	8
2	Provoked	- FM	2.88	0.35	8
(Familiar materials presented second)		- UM	1.86	0.69	7
	Spontaneous	- FM	2.00	1.00	7
		- UM	2.00	0.93	8

[a]Familiar material.

[b]Unfamiliar material.

effect on their ability to conserve. That is, no practice effect was observed. Furthermore, there was no difference between the level of difficulty of the one-one provoked correspondence task and one-one spontaneous correspondence task.

Table 6

Results of the Three-Way analysis of Variance

Source of Variation	df	Mean Square	F	p
Main Effects				
Order	1	1.067	1.857	ns
Task	1	0.836	1.455	ns
Material	1	3.036	5.284	<.03
Two-Way Interactions				
Order x Task	1	0.250	0.436	ns
Order x Material	1	0.050	0.088	ns
Task x Material	1	1.257	2.189	ns
Three-Way Interactions				
Order x Task x Material	1	0.715	1.244	ns
Error	52	0.575		

Replication analysis. The data was grouped for analysis in such a way as to permit a replication of the first analysis. The statistical results are presented in Tables 7 and 8. The results of the second analysis of variance were not consistent with the former. No significant effects were found in the replication.

Table 7

Statistical Description of Variable by Order of Presentation of Materials (Replication)

Order	Task		Mean	SD	n
1 (Familiar materials presented first)	Provoked	- FM[a]	2.57	0.53	7
		- UM[b]	2.50	0.53	8
	Spontaneous	- FM	2.13	0.83	8
		- UM	2.29	0.95	7
2 (Familiar materials presented second)	Provoked	- FM	2.43	0.98	7
		- UM	2.63	0.52	8
	Spontaneous	- FM	2.75	0.46	8
		- UM	1.71	0.76	7

[a]Familiar materials.

[b]Unfamiliar materials.

Table 8

Results of the Three-Way Analysis of Variance - Replication

Source of variation	df	Mean Square	F	p
Main Effects				
Order	1	0.017	0.033	ns
Task	1	1.458	2.858	ns
Material	1	0.525	1.029	ns
Two-Way Interactions				
Order x Task	1	0.005	0.009	ns
Order x Material	1	0.805	1.577	ns
Task x Material	1	0.933	1.829	ns
Three-Way Interactions				
Order x Task x Material	1	2.001	3.922	ns
Error	52	0.510		

The results of the two analyses are difficult to understand and must be interpreted with caution. Content was significant in the first analysis, but not in the second. In neither analysis were the main effects of order or task significant. Thus, hypothesis one had been partially confirmed, while hypothesis two and three were rejected. In order to investigate hypothesis one more completely, it was decided to analyse the data using an approach more consistent with Piaget's theoretical foundations.

When conducting a three-way analysis of variance, the samples must be independent. In order to do this, only one of each subject's scores were used for each analysis. Thus the comparisons were inter-subject. This, then, deviated considerably from one basic premise of Piaget's theory, which is that an individual's cognitive behavior must be analysed from an intra-individual point of view. In other words, Piaget is more concerned with how a child's performance varies from one task or situation to another, rather than how child 'A' compares with child 'B' when performing various tasks.

The three-way analysis of variance, then, although it was a statistically sound procedure, necessitated making comparisons between subjects. It was decided to re-evaluate the results using an approach which would lend itself to a more traditional Piagetian interpretation (i.e., intra-individual comparisons). It was further decided to disregard the order of presentation of the materials, and the levels of difficulty of the tasks for the ensuing analyses. This decision was based on the fact that the design was counter-balanced for order and task, and also that in both the first three-way analysis of variance and its replication, neither of these two variables were found to have had a significant effect on subject performances.

Further Analysis

In order to further examine the effects of content on conservation of number an intra-subject comparison was made using the correlated t-test and the crosstabs subprograms from the SPSS (Statistical Package for the Social Sciences). It was recognized that there are statistical procedures other than a correlated t-test which would permit a finer intra-individual comparison. However, the correlated t-test procedure was judged sufficient for present purposes.

The correlated t-test was employed because for each subject there were two scores, a familiar score and an unfamiliar score. These were then converted to their respective stages (one, two or three). Correlated t-test procedures were applied to the mean differences of scores achieved by subjects with unfamiliar and familiar materials in three situations. Since it was hypothesized that children's understanding of conservation of number would be facilitated when familiar materials were used, non-directional tests of significance were employed.

Firstly, the mean of all the familiar scores was compared with the mean of all the unfamiliar scores for 60 subjects regardless of task or order. Thus the first set of 60 scores which were being compared to the second set of 60 scores were from the same subjects. This selection process is shown in Figure 1.

Figure 1

The procedure for the selection of scores for the first correlated t-test

Task	Material	n[a]	Material	n
Provoked	familiar	15	unfamiliar	15
Provoked	unfamiliar	15	familiar	15
Spontaneous	familiar	15	unfamiliar	15
Spontaneous	unfamiliar	15	familiar	15

[a]This represents the number of scores. In each cell there are 15 subjects, but 30 scores

Figure 2

The procedure for the selection of the 30 subjects for the second correlated t-test

Task	Material	n[a]	Material	n
Provoked	familiar	15	unfamiliar	15
Provoked	unfamiliar	15	familiar	15

[a]This represents the number of scores. In each cell, there are 15 subjects, but 30 scores.

Secondly, in the next correlated t-test the mean of the familiar scores was compared to the mean of the unfamiliar scores for the 30 subjects who received the one-one provoked correspondence task (see Figure 2). In the third correlated t-test, the same procedure was followed for the 30 subjects who received the one-one spontaneous correspondence task (see Figure 3).

Figure 3

The procedure for the selection of the
30 subjects for the third correlated t-test

Task	Material	n[a]	Material	n
Spontaneous	familiar	15	unfamiliar	15
Spontaneous	unfamiliar	15	familiar	15

[a]This represents the number of scores. In each cell, there are 15 subjects, but 30 scores.

First correlated t-test and crosstabulation. The purpose of the first correlated t-test was to determine if there was a significant difference between the means of the familiar and the unfamiliar stage scores. The conventional .05 level was used to determine significance in this and the following t-tests. The results which are shown in Table 9 demonstrate that there was a significant difference ($p < .001$) between the means. Thus the first hypothesis described in Chapter I was supported. That is children could be expected to more easily understand the concept of conservation of number when they were dealing with content which was familiar to them.

Table 9

Comparison of Means of Familiar Versus Unfamiliar Stage Scores

Groups	n[a]	Mean	SD	t	df	p
familiar	60	2.517	0.725	3.38	59	$< .001$
unfamiliar		2.200	0.777			

[a] Number of cases

A crosstabulation of the frequencies of the familiar stages by the unfamiliar stages was also computed and the results are shown in Table 10. It can be seen that of the 39 children who were in stage three with familiar material, 22 of them remained in this stage when dealing with unfamiliar test-stimuli. Twelve children dropped to stage two and five to stage one. Of the 13 subjects who were giving stage two responses with familiar content, only three of them went up to stage three when the task was performed with unfamiliar content. Similarly, only one out of the eight children who were in the first stage with familiar materials went up to stage two when the content changed. To summarize, 38 children remained in the same stage regardless of test-stimuli. Four children went up one stage when they were dealing with unfamiliar materials, and 18 subjects dropped at least one stage when performing a task with unfamiliar as opposed to familiar test-stimuli.

Table 10

Crosstabulation of the Frequencies of Familiar by Unfamiliar Stage Scores Regardless of Task or Order of Presentation of Materials

		Unfamiliar Material			
	Stages	1	2	3	Row Total
Familiar Material	1	7[a] 87.5[b] 53.8[c]	1 12.5 4.5	0 0.0 0.0	8
	2	1 7.7 7.7	9 69.2 40.9	3 23.1 12.0	13
	3	5 12.8 38.5	12 30.8 54.5	22 56.4 88.0	39
	Column Total	13	22	25	60

[a] number of subjects

[b] Row percent

[c] Column percent

Second correlated *t*-test and crosstabulation. The purpose of this was to determine if there was a significant difference between the means of the familiar and the unfamiliar stage scores in the one-one provoked correspondence task. The results which are displayed in Table 11 indicate that there was a significant difference between the means ($p < .001$). Again the first hypothesis was supported. That is, in provoked correspondence tasks when children were watching transformations which altered the perceptual configurations of the sets, they were more likely to demonstrate operational correspondence when the material that was being manipulated was familiar to them.

Table 11

Comparison of Familiar Versus Unfamiliar Stage Scores in Provoked Correspondence Tasks

Groups	n[a]	Means	SD	t	df	p
familiar	30	2.667	0.606	3.34	29	< 0.001
unfamiliar		2.333	0.661			

[a] Number of cases

A crosstabulation of the frequencies of the familiar stages by the unfamiliar stages was done and the results are shown in Table 12. As indicated in Table 12, when the 30 subjects performed the provoked correspondence tasks, 18 of them remained in the same stage regardless of the materials being manipulated. One child increased his stage score when using an unfamiliar material. However, 11 subjects demonstrated a lesser degree of understanding of the concept when they were confronted with an unfamiliar as opposed to a familiar material.

Table 12

Crosstabulation of the Frequencies of Familiar by Unfamiliar Stage Scores in a Provoked Correspondence Task

Familiar Materials Stages	Unfamiliar Material 1	Unfamiliar Material 2	Unfamiliar Material 3	Row Total
	2[a]	0	0	2
1	100.0[b]	0.0	0.0	
	66.7[c]	0.0	0.0	
	1	4	1	6
2	16.6	66.6	16.6	
	33.3	28.6	7.7	
	0	10	12	22
3	0.0	45.5	54.5	
	0.0	71.4	92.3	
Column Total	3	14	13	30

[a]Number of subjects

[b]Row percent

[c]Column percent

Third correlated *t*-test and crosstabulation. This statistical procedure was used to compare the mean of the familiar scores with the mean of the unfamiliar scores in the spontaneous correspondence task. As shown in Table 13, the results are significant ($p < .04$). That is, the material used in the performance of a spontaneous correspondence task did have a significant effect on a subject's ability to respond in an operational manner.

Table 13

Comparison of Means of Familiar Stage Scores with Unfamiliar Stage Scores in Spontaneous Correspondence Tasks

Groups	n^a	Mean	SD	*t*	*df*	*p*
familiar		2.367	0.809			
	30			1.87	29	<.04
unfamiliar		2.067	0.868			

[a]Number of cases.

The results of a crosstabulation of the frequencies of the familiar by the unfamiliar stages are shown in Table 14.

Table 14

Crosstabulation of the Frequencies of Familiar by Unfamiliar Stage Scores in a Spontaneous Correspondence Task

	Stages	Unfamiliar Material 1	2	3	Row Total
Familiar Materials	1	5[a] 83.3[b] 50.0[c]	1 16.7 12.5	0 0.0 0.0	6
	2	0 0.0 0.0	5 71.4 62.5	2 28.6 16.7	7
	3	5 29.4 50.0	2 11.8 25.0	10 58.8 83.3	17
	Column Total	10	8	12	30

[a]Number of subjects

[b]Row percent

[c]Column percent

For this task 20 children were in the same stage regardless of the material being used. Three of them improved when using unfamiliar materials, and seven of them did better when familiar content was being manipulated.

When the results displayed in this crosstabulation are compared with those in Table 12, it can be seen that in the former, the movement was generally a downward one. That is, children either performed the same or did poorer with the unfamiliar content. In the spontaneous correspondence task, however, the trend was not as clear. Although there was a greater movement from a higher to a lower stage when the material was unfamiliar (seven children), three showed an improvement with unfamiliar materials. This was a ratio of 3:7 as opposed to 1:11 for the provoked correspondence task. Finally, an analysis of all the crosstabulation results (Tables 10, 12 and 14) suggests that the effect of familiar versus unfamiliar content is acting in a very selective way. In Table 10, for example, 18 subjects have lower scores when using unfamiliar material. Of the 18, however, 17 are in stage three when using familiar material. That is, virtually all can conserve number perfectly using familiar materials, but have moderate to extreme difficulties when using unfamiliar materials. This phenomenon may well explain the difficulties most researchers have had when trying to obtain high inter-item correlations on Piagetian scales.

Description of subjects' response

A simple analysis of the subjects' responses revealed certain trends which were not observable through the use of more sophisticated statistical procedures.

Stage one. During the first stage, when the subjects in the study could not establish one-one correspondence, their responses were based on a global or perceptual decision. They generally used the length of the line to decide when two sets were equivalent. There was an exception to this general behavior with regard to the provoked correspondence task. In this case, all subjects, because of the nature of the materials involved, could establish one-one correspondence between the two sets without demonstrating true understanding. In other words, they could, by placing a doll on a bed, or by screwing a nut onto a bolt, have tangible proof that one row contained more. For example, there would be an empty bed if there were not enough dolls. However, they usually could not give an adequate explanation of why the rows contained the same amount. If they could do so, they immediately lost this correspondence once there was a visual transformation in one of the sets.

Stage two. During this stage, the youngsters in the study vascillated between states of conservation and non-conservation. The majority of them used the fact that they counted to explain the equivalence of the sets. This observation supported the contention of Piaget (1952a) and others (Dodwell, 1960; Wheatley, 1970; and Wohlwill & Lowe, 1962) that ability to count does not necessarily indicate understanding of conservation of number.

Stage three. At this stage, children demonstrated operational thought as indicated by their ability to use the concepts of identity, reversibility or compensation in their answers. Generally, the most common argument used by the subjects was that of identity. It was used twice as often as the compensation argument. However, in many cases, the two explanations were used together. An example of a typical response was "You didn't give some more to this row. It just looks longer because you spread it out."

In the cases of identity and compensation, the task involved did not affect the type of argument used. However, a difference was noted for a reversibility explanation. This explanation occurred only once in a spontaneous correspondence situation but 13 times for at least one of the perceptual transformations involved in the provoked correspondence task. It would appear, then, that in the latter task the relationship between the elements in the two sets facilitated the child's realization that the procedure could be reversed. That is, if a doll had been removed from a bed, it could easily be returned to the bed.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

Summary of sample. The subjects consisted of 60 kindergarten and first grade children from one public elementary school in the Montreal area. The subjects had to meet four criteria in order to be included in the study, the major one being that they had to pass a language test assessing their comprehension of vocabulary required to perform the Piagetian tasks used.

Summary of procedure for distribution of subjects into group. The kindergarten children were randomly distributed into four groups, and the first grade youngsters were then randomly distributed into the same four groups. Thirty children were administered a one-one provoked correspondence task, and another 30 were given a one-one spontaneous correspondence task. Of the 30 children who were administered the former task, 15 dealt with the familiar material first, and 15 received the unfamiliar material first. The same procedure was followed with the 30 subjects who received the latter task. Thus, the design was counterbalanced for order of presentation of the material, for familiarity of the material, and for the type of tasks involved.

Summary of statistical procedures and results. For each subject there were two raw scores and each was converted to a stage score (one, two, or three). Two statistical procedures were used to analyse the data. For the first procedure, the stage scores were treated as if they came from independent samples, and two analyses of variance were performed. In the first analysis, only the main effect of content reached significance ($p < .03$), and in the second analyses there were no significant effects.

In the second statistical procedure, the data were subjected to an analysis which was closer to an intra-subject comparison. Correlated *t*-test procedures were used to assess the results of the tasks performed with familiar materials as compared to unfamiliar materials. In the first case, the difference between the mean of all familiar and the mean of all unfamiliar scores was tested. In the second and third cases, the same procedure was repeated with regard to the provoked correspondence and the spontaneous correspondence tasks respectively. In all cases, the effect of content was found to be significant ($p < .001$, $p < .001$, $p < .04$).

Conclusions

The results of the two analyses of variance were not consistent. In the first, only the mean difference between the familiar and the unfamiliar scores reached significance. However, analysis of the data using correlated *t*-test procedures indicated that content was significant. Hence, if the content which was being manipulated was familiar to the child, understanding of one-one correspondence was facilitated. Various researchers (Hyde, 1970; Lovell & Ogilvie, 1960; Robinson, 1967; Uzgiris, 1964; Za'Rour, 1971) have concluded that the type of material used rather than the order of its presentation will influence a child's ability to conserve. Order of presentation of the test-materials was not a significant factor in either analysis.

Familiarity of material appeared to have its greatest effect in the transitional stage. As indicated in Table 10, p. 87, when children were in stage one, and therefore, had no idea of operational correspondence, the materials used did not play a relevant part. That is, of the eight subjects who exhibited stage one behaviour with familiar materials regardless of the task involved, seven of them were also in this stage when unfamiliar materials were being manipulated. This was also the case with 22 of the 39 children who were in stage three with familiar materials.

There were, in total 52 children demonstrating behaviour characteristic of stage two or stage three thinking when using familiar content. However, when the task involved unfamiliar content, 21 of the 52 children exhibited behaviour which was indicative of a different stage of thought, usually a lower stage. Thus, it can be seen that the material will have its greatest effect during the transitional stage when subjects vascillate between states of non-conservation and conservation.

As previously stated, it is possible to miss valuable information when a complex statistical design is favoured over a simple statistical approach that is more in line with Piaget's theoretical premises. For example, although task was not significant in the analysis of variance procedures, certain differences between subjects' responses to provoked and to spontaneous tasks were noted. All subjects in the provoked correspondence task group were able to establish one-one correspondence between the two sets. They were, in effect, forced to see the relationship by being able to put a doll onto a bed, or to screw a nut onto a bolt. However, some did not truly understand why the rows were equal. This was apparent when they had to explain their actions. On the other hand, subjects, in the group performing the spontaneous correspondence task who did not know how to create two equal sets, never reached the stage where an explanation of their behaviour was necessary.

This finding supports Piaget (1952a) and Dodwell (1960) who both noted that the concept of provoked correspondence is understood by youngsters at an earlier age than that of spontaneous correspondence. In addition, conserving youngsters in the provoked correspondence group more often used the explanation of reversibility than did the children who conserved in the other task. This could be accounted for by the fact that the nature of the materials used for the former task was such that it helped the subjects create a more lasting mental image of the relationship between the two sets. Thus it was possibly easier to visualize that the process could be reversed (i.e., that a nut could again be screwed onto a bolt) and that nothing had therefore changed.

As expected, it was observed that ability to count did not necessarily imply understanding of operational correspondence. It was noted that often subjects who counted, did so incorrectly. In addition, many stage two youngsters could not elaborate upon the response of "I counted", to explain their beliefs in the equality of the two sets. Stage three subjects never had this problem.

It seems, then, that Piagetian tasks need not be standardized in order to get valuable information about specificchildren or about the developmental process. The realization of this fact was an important result of the study to the author.

Educational Implications

It would appear that some areas of education (e.g., curriculum planning, assessment of learning problems) would benefit from a practical application of Piaget's theory of cognitive development. Many researchers (Almy, 1966; Ausubel, 1968; Ayers, 1971; Bruner, 1960; Elkind, 1969; Green, 1971; Kohlberg, 1968; Lunzer, 1970; Pinard & Laurendeau, 1964; Robinson, 1967; Rohwer, 1971; Tuddenham, 1969, 1971; Wadsworth, 1971) are aware of this. Hence attempts have been made (Goldschmid & Bentler, 1968; Lunzer, 1970; Pinard & Laurendeau; Tuddenham, 1969, 1970, 1971) to create a battery of standardized Piagetian tasks.

The "time lag" concept and various other difficulties (which have been described in Chapter I) seem to hamper the construction of a developmental scale based on Piaget's theory. The findings of this thesis support the "time lag" concept that children will first achieve operational thought in a specific area with one content, but not with another. In this case the children were able to achieve operational correspondence more easily when the content with which they were dealing was more familiar to them. This same phenomenon was discovered when the effects of content on understanding of conservation of weight and substance was studied (Lovell & Ogilvie, 1960; Uzgiris, 1964; Za'Rour, 1971).

It seems apparent, then, that there will be difficulties standardizing Piagetian tasks, if the effects of content are not taken into account. Thus, if one is considering administering a series of Piagetian tasks to a group of children, then the materials used for the tasks must be ones with which those youngsters are familiar. If the tasks are to be administered to a different population, then the materials must be altered accordingly. That is, the test-stimuli must be meaningful to and applicable to the population being tested, and must be altered when a different sample is being used.

Recommendations for Future Research

The results of this study indicated that neither the order of presentation of the materials used in one-one correspondence tasks, nor the tasks themselves affected subjects' responses. However, this was not the case with the materials (familiar and unfamiliar) which were being manipulated.

Youngsters demonstrated more conservation responses when the content with which they were dealing was familiar. Additional research would be beneficial to ascertain whether the results of this study would be replicated if a sample more representative of the public school system in the Montreal area were used. Furthermore, it would be useful to determine if familiar materials would continue to have a facilitating effect on children's understanding of conservation concepts other than conservation of number.

APPENDIX

Language Test

One-one Provoked Correspondence

One-one Spontaneous Correspondence

LANGUAGE TEST

Part I - Verbal

Materials

1. Two 'Barbie Dolls', 'A' and 'B'.
2. One box of 15 small 'Snickers' brand fun size chocolate bars.

Procedure

The two dolls 'A'and 'B' are placed in front of the child.

E/ "These two girls go to school. One day they stayed after school to help their teacher. They helped her to clean the classroom. They each did the same amount of work. They each picked up the same number of papers from the floor, and each put the same number of chairs on the desk. The teacher now wants to give them a present of chocolate bars for helping her."

1. Place two chocolate bars in front of doll 'A' and five in front of doll 'B'.

E. "This is what the teacher gave to 'A' for doing the work, and this is what she gave to 'B' for doing the same work as 'A'. Is this fair? Is this right?"

"Why?" "Why not?" (depending upon answer)

2. Place two chocolate bars in front of doll 'B' and three in front of doll 'A'. Repeat the above questions.

3. Place three chocolate bars in front of doll 'A' and three in front of doll 'B'. Repeat the above questions.

Scoring

Record all answers verbatim for later analysis to see if the subject has correctly used the terms 'more' and/or 'less'.

Part II - Non-Verbal

Materials

These are the same as those that were used for Part I.

Procedure

Place the dolls 'A' and 'B' in front of the child.

E. "Pretend that these two girls are friends of yours. They are coming to your house to play with you after school. Your mother has given you some chocolate bars, and you are going to share them with your friends."

1. "Give more chocolate bars to 'A' and less to 'B'"

2. "Give 'A' and 'B' the same amount, the same number of chocolate bars."

Scoring

Record if the child is correctly able to perform the above tasks.

ONE-ONE PROVOKED CORRESPONDENCE - FAMILIAR MATERIALS

Materials

1. 10 toy doll beds.
2. One clear plastic bag containing 20 'Fisher Price' toy people.

Procedure

The child is shown the test-stimuli and asked to identify them. If the youngster does not know the name of the objects, he will be told.

Part I

Ten beds are placed in a row in front of the child, but on the examiner's side of the table. Each bed is spaced 2 cm apart.

E. "Here are some beds. What do we do if we are tired?" "Some of these dolls (point to the dolls in the clear plastic bag) are tired and want to rest. What should they do? Take from the bag just enough dolls as there are beds, one for each bed, the same number as there are beds."

The child's behaviour is observed and the manner in which he makes the correspondence between the two sets is recorded. If the child has not placed a doll into a corresponding bed, he is encouraged to do so.

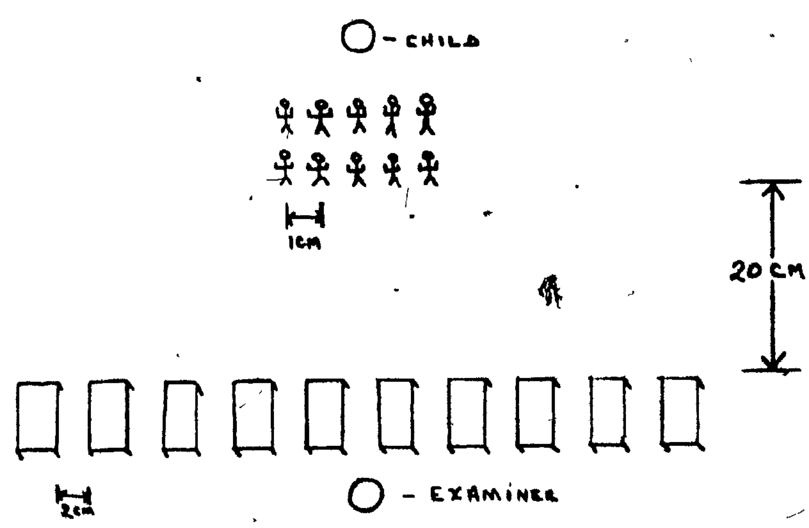
E. "Are there as many dolls as there are beds, or are there more dolls, or are there more beds? Why? Why not? (depending upon the answer) Why are they the same? How do you know they are the same?"

Part II

When the child has achieved equivalence between the two sets, the bag containing the remaining dolls is removed. It is no longer needed for the experiment.

E. "The dolls want to get up and play."

The dolls are removed from the beds and bunched together in two rows with a space of 1 cm between each of them. They are placed 20 cm away from the beds.



E. "Are there as many dolls as there are beds? Or are there more dolls, or are there more beds?"

E. (Depending upon the answer)

"Where are there more? Why are there more? or Why are they the same? How do you know they are the same?"

Part III

The dolls are rearranged in a row with a distance of 5 cm between each doll. The same questions that were asked in Part II are again repeated.

ONE-ONE PROVOKED CORRESPONDENCE - UNFAMILIAR MATERIALS

Materials

1. 10 metal bolts
2. One clear plastic bag containing 20 corresponding nuts.

Procedure

The child is shown the test-stimuli and asked to identify them. If the youngster does not know the name of the objects, he will be told.

Part I

The procedure is identical to that of the previous experiment, except that in this case, the child is encouraged to screw a nut onto a bolt. The same questions are then asked.

Part II and III

Again the procedure is identical to that used in the one-one provoked correspondence experiment with familiar materials.

Scoring

In both experiments, all answers are recorded verbatim and later analysed. All raw scores are converted to stage scores (one, two or three). All stage three responses must indicate understanding of one or more of the concepts of identity, reversibility or compensation.

ONE-ONE SPONTANEOUS CORRESPONDENCE - FAMILIAR MATERIALS

Materials

1. One clear plastic bag containing 30 pieces of candy coated 'Chiclets' Brand chewing gum - white colour.

Procedure

The child is shown the test-material and asked to identify it. If the youngster does not know the name of the object, he will be told.

Part I

Ten pieces of gum are removed from the bag and arranged in a row on the examiner's side ~~of the~~ table. This is known as the model row. There is a space of 2 cm between each piece of gum.

E. "I am taking some gum for myself. (Point to the bag in which there are the remaining 20 pieces of gum). Now you take the same amount of gum as I have, not more, not less."

The child's behaviour is recorded to see whether he can or cannot correctly make the correspondence and the following questions are asked.

E. "Do you have as many pieces of gum in your row as I have in mine? Or do you have more, or do I have more? Why or Why not?"

The child is encouraged to create equivalence between the two rows by adding more gum to or removing some from his row. If he cannot establish equivalence, but believes that the rows are equal, the 'Chiclets' in the row which contains more are bunched together. The above questions are repeated. The purpose of these questions is to note on what the child bases his decision of equality or inequality, e.g. length, density. (If the youngster cannot make the one-one correspondence, the experiment does not go beyond this stage).

Part II

The child has correctly created correspondence between the two sets and has explained his reasons for their equivalence.

The child's row is moved 20 cm away from the model row and the 2 cm space between each piece of gum is not altered. The gum in the model row is then spread farther apart so that there is a distance of 5 cm between each piece of gum.

E. "Do you have as many pieces of gum in your row as there are in this (model) row? Or do you have more, or do I have more?"

(Depending upon the answer:-)

E. "Why are they the same? How do you know they are the same?"

or

"Why is there more in this row? How do you know there is more in this row?"

Part III

The model row is bunched together so that each piece of gum is touching its neighbour. The same questions that were asked in Part II are again repeated.

ONE-ONE SPONTANEOUS CORRESPONDENCE - UNFAMILIAR MATERIAL

Materials

1. One clear plastic bag containing 30 small common rubber faucet washers.

Procedure

The child is shown the test-stimulus and asked to identify it. If the youngster cannot name the object, he will be told its name.

The procedure is identical to that used in the one-one spontaneous correspondence experiment with familiar materials.

Scoring

In both experiments, all answers are recorded verbatim and later analysed. All raw scores are converted to stage scores (one, two or three). All stage three responses must indicate understanding of one or more of the concepts of identity, reversibility or compensation.

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