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PLANNED EXPERIENCES AND PIAGET'S THEORY OF INTELLECTUAL DEVELOPMENT

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Carol Lynne Tovell

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ABSTRACT OF THESIS

The purpose of the present research was to consider the effects of planned experiences on the development of various concepts in children, and the relation of these experiences to Piaget's theory of intellectual development.

Sixty children from Kindergarten and Grade One classes in two Winnipeg Schools were given a pretest and two posttests on the Piagetian concepts of conservation of length, distance, number, mass, and area. One half of these children received one, two, or three training sessions in the conservation of length concept. The training sessions consisted of direct verbal reinforcement and manipulation of the training objects. The remaining thirty subjects comprised three control groups. To control for the effect of interaction with the experimenter, the subjects in the control groups were asked to draw a picture which took approximately the same length of time as the training sessions for the experimental subjects.

The results indicated that the concept of conservation of length could be induced by making the child aware of the principle of reversibility and that the effects of these planned experiences did not deteriorate over a period of twenty days. The results also suggested that the planned experiences in the concept of conservation of length facilitated the development of the concepts of conservation of distance, number, mass, and area.

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CHAPTER I

INTRODUCTION

1. STATEMENT OF THE PROBLEM

Two major approaches to the study of intellectual development have evolved within the past seventy years. Psychologists involved in the area of intelligence testing have considered the content aspects of intelligence whereas psychologists such as Piaget who are involved in the developmental area of intelligence have emphasized the process aspect. It is believed that the study of the process aspect will lead to important information as to what underlying modes of intellectual functioning are present in various individuals at various age levels.

Piaget has developed a detailed stage-analytic theory of intelligence. Within his theory he has provided an explanation of how various concepts are naturally acquired by children. The purpose of this study is to consider the effects of planned experiences on the development of various concepts in children and the relation of these experiences to Piaget's theory of intellectual development. Planned experiences refer to those tasks which are developed to assist subjects in the learning of a particular concept using an analysis of the tasks to be learned and taking into consideration the stage of intellectual development of the learners. Unplanned experiences are those which the environment happens to provide. It is hypothesized that planned experiences in one concept should also facilitate the development of other related concepts.

2. HISTORICAL BACKGROUND

In all behavior involving the manipulation of symbols, both the content and process aspects of intelligence are inextricably confounded. This behavior involves what has been learned in the past as well as how effectively learning takes place in the present. Jean Piaget, in his investigation of intelligence, has emphasized the process aspect in his formulations of the stages of cognitive development in terms of the abstract logical operations achieved. On the other hand, most of the studies surrounding the growth of intelligence testing have considered the content aspect of intelligence.

J. McK. Cattell (1896) believed that by applying a series of mental tests and measurements (which were measures of sensory discrimination and reaction time) to a large number of individuals, the constancy of mental processes and their interdependence and variation under different conditions could be discovered. However, he made no clear attempt to conceptualize intelligence as an entity; the tests he constructed were simple, discrete, and specific, and presumably the "powers" they measured were likewise. The publication of Cattell's proposals was followed by a great deal of interest in mental testing but this enthusiasm did not last for long. In 1901, Clark Wissler correlated Cattell's tests with each other, with anthropometric measures and with college grades and found either low or negative correlations. He concluded that each of Cattell's tests measured an independent ability and that such tests had very limited value for determining the capacities of an individual.

Alfred Binet argued that the most important differences among individuals were to be found in the higher mental activities. In 1896, he proposed several tests to measure eleven mental faculties including memory, imagry, imagination, attention, comprehension, suggestibility, aesthetic appreciation, persistence, moral sentiments, motor skills and judgment of visual space. He then conducted long series of investigations with children, both normal and defective, to discover which of these tests showed the clearest relationship to age, school attainment and to teachers' estimates of mental ability. In 1905, Binet produced the first successful test of general intelligence. It was a pragmatic tool intended to screen from the school population children who would be unable to profit from regular instruction. Preconceptions or theories about the nature or even the existence of a general intelligence hardly entered into the picture at all. In 1908, Binet revised his earlier scale and classified the tests by age levels according to the age at which the average child could perform them successfully. Thus Binet's 1905 scale was an empirical device to meet a specific social need. His later revisions assumed their final form not by deduction from a formal theory of intelligence but by gradual selection of specific test ideas and procedures arising from a lifetime of research. Nowhere in his writings did Binet define intelligence; at different times he emphasized different aspects. He considered that the separate mental faculties in intelligence were inextricably interwoven both in real life and in the test situation. Intelligence was the resultant of all the higher processes in complex interaction and could be measured only by an extensive sampling of many kinds of behavior. Binet sought to measure an average level "intelligence in general" rather than an entity or single dimension such as "general intelligence".

In 1910, H. H. Goddard introduced the Binet scales to the United States and vigorously advocated Binet's approach to the measurement of intelligence. However, he substituted the concept of a single underlying function of intelligence for Binet's concept of intelligence being a complex of interrelated functions.

While Goddard was in the forefront of the Binet movement in America, it was L. M. Terman's revision of the Binet test in 1916 which provided the first thoroughly revised and restandardized test for American children. The educational system in the United States demanded a simple and convenient method of screening for over-all scholastic ability and to achieve this aim, Terman had ignored the theoretical question of the ultimate nature of intelligence. The success of the Stanford-Binet (Terman's revision) lead to the development of many other tests, each with a special purpose. For example two group tests, the Army Alpha and the Army Beta were used to select and classify draftees for World War I.

The theoretical validity of the intelligence tests is a more controversial issue than is the discussion of their practical usefulness. In 1904, Spearman proposed that an assortment of tests yielded a measure not of "intelligence in general" but of a unitary underlying causal factor "general intelligence" which is revealed in all cognitive activities. Note that Spearman's concept of intelligence is different to Binet's idea and yet frequently they are considered equivalent. Spearman believed that all mental activity was made up of two factors, one general factor "g" and a number of specific elements "s". The *g* factor remains the same for any one individual although there are individual differences with respect to the amount of *g*. The amount of s varies from individual to individual as well as from one ability to another within an individual. Each test contains some *g* and the s unique to the activity of answering the particular items in the test. Any correlation between two tests results because both tests are a measure of *g* to some extent. The implications of Spearman's theory for testing were quite clear; test construction should concentrate on the development of tests highly saturated with *g*. As more and more data was gathered, tests involving quite similar activities showed correlations greater than would be expected on the basis of overlap of *g* alone. Thus a new intermediate class of factors, the group factors, was postulated. However, these group factors remained in a relatively unimportant position in Spearman's theory and his followers still emphasize that *g* is the most important influence in intellectual behavior.

G. H. Thomson's view was opposite to Spearman's in that he rejected the existence of a universal trait of intelligence in favor of a very large number of independent elementary abilities. The behavior of any person in any given activity is a reflection of the particular sample of elements called forth. However, the sampling theory made very little headway against Spearman's doctrine.

Over the years a considerable number of group factors accumulated as various test batteries were studied; this situation spoiled both the elegance and parsimony of Spearman's two-factor theory. In 1947, L. L. Thurstone proposed the multiple factor theory. Spearman's *g* was abandoned in favor of a small number of broad group factors each of which enters with different weights into the performance of specific tasks. By means of factor analysis Thurstone determined seven primary abilities: verbal comprehension, word fluency, number, spatial relations, associative memory, perceptual speed, and reasoning. As more work was done with factor analysis the list of factors increased. For example, F. B. Davis (1947) reported twenty-nine factors which represented different mental abilities. He felt that there was no objective way of determining whether the names attached to the factors discovered in the analysis were accurate descriptions of the mental abilities represented by the factors. Thus the suspicion grew that the factors which had been discovered were not the basic dimensions of the mind but were simply more or less arbitrary classifications within the tests.

The history of the theories of intelligence has gone in a complete circle. In 1890, separate faculties of the mind were postulated by Cattell and tests were invented to measure them. Binet and Terman, guided more by empirical considerations than theory, sampled widely the adjustive powers of the mind and produced an over-all average. Thomson's theory tended to identify intelligence with the number of connections possessed by the mind. Spearman proposed that there was a unitary underlying causal factor in all mental activity. The failure of Spearman's theory with psychometric facts forced a retreat to the neo-faculty postion of Thurstone. If the already numerous group factors continue to multiply there is the possibility that a number of factors as vast as the sampling theorists' "elements" will exist.

In 1946, H. E. Garrett proposed a developmental theory of intelligence which reconciled in part some of the differences of the previous theorists. According to him, the mind of the small child is relatively undifferentiated and contains a large amount of Spearman's *g*. As the child grows with age the *g* is differentiated into loosely organized groups of ability or factors. Garrett believed that the over-all general ability (*g*) which is important during the elementary school years becomes progressively less important at the high school and college level where he has shown by factor studies that its existence is difficult to identify.

Up until now intelligence tests have proven useful in the absence of a satisfactory theory of intelligence. However, fundamental progress will almost surely depend upon providing our tools with a more solid theoretical foundation. Perhaps a better approach would be to study the process aspect of intelligence rather than placing so much emphasis on the content aspect. The present tests can reflect differences between individuals of different intelligence but little information is gained about what underlying mechanisms cause the individuals to score differently on the tests.

Jean Piaget (1896 -), a Swiss psychologist, has concentrated on the process aspect of intelligence. With his theory now established, construction of developmental intelligence tests is just beginning to be developed. Piaget himself has never attempted to formulate a standard intelligence test out of the various tasks which he has created but such an endeavor is a logical extension of his work. Two major attempts at test construction using Piaget's tasks are presently being carried out by Vinh-Bang and Bärbel Inhelder at the University of Geneva and Father Adrièn Pinard at the University of Montreal. Full publication of the details of either of these tests is not as yet available.[1] It appears however, that a useful and very informative developmental intelligence scale will soon be published.

The traditional intelligence tests do not indicate how a specific mode of thought develops. One must conclude on the basis of whether the individual passed or failed certain items, whether or not a certain ability has been developed. With Piaget's clinical method, after each child has given a direct response to the question, the examiner interrogates the child further to discover the reasons for the answers he gave. In this way the underlying mode of intellectual functioning can be determined. A transition stage in the child's thinking becomes evident only when Piaget's method is utilized. During this stage the child will vacillate between a more highly organized level of intellectual functioning and a less organized one. This information is impossible to obtain from the conventional psychometric study of intelligence.

The standard intelligence tests developed so far are inadequate for an elaborate and detailed theory of intelligence. They measure only a very narrow range of mental abilities which are associated mainly with academic success. Piaget's clinical method has been used for an almost inexhaustible number of studies on human experiences and knowledge. The scope of Piaget's work has ranged from the study of mathematical concepts to play and imitation in children. It may be that developmental scales based on Piaget's theory might be able to predict criteria other than the conventional ones such as academic achievement. For example, the

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[1]Adrien Pinard, personal communication.

creativity and imagination of the individual may be measurable using Piaget's tasks. It also may be that a developmental intelligence test which has theoretical coherence would be a better predictor of the conventional criteria than the psychometric tests now available.

Piaget's method has contributed greatly to the understanding of intelligence. To date, this theory is the only detailed stage-analytic theory of intellectual development in existence. Piaget himself has supplied more concrete information about intellectual behavior at various levels of development than any other single worker. This accomplishment in itself means that Piaget's system should be an indispensible point of reference for any theoretical or empirical project which deals with the area of intellectual development.

Initially Piaget searched for systematic patterns of thought which would correspond to the biological hierarchy of cell, organism, and species. He searched for a research methodology which would be applicable to qualitative research. While working in Binet's laboratory, Piaget observed that the child's answers to certain questions rather than the questions themselves, were a potential source of data. Within the following thirty years, Piaget and his associates created over fifty new research techniques which were based upon his earlier insights that the child, the child's interpretation of his own comments, and the child's questions provided the key to research on intellectual development. For a long time Piaget's clinical method of investigation was the sole tool for the exploration of intellectual processes.

One assumption underlying Piaget's research, which has been severely criticized, is that he assumes that a detailed investigation of any small sample of a species will yield basic information inherent to all members of the species. However, as a result of this criticism, and after he had developed a theoretical framework (1939), Piaget's subsequent research has shown a consistent increase in the number of subjects used for testing each new hypothesis. To him, the children of Geneva and his own in particular, were representative of children everywhere. Until recently, he made no allowance for sex differences; his samples were segregated only according to the desired age span.

Another assumption held by Piaget is that all sciences are interrelated; a theorem established in one branch of a science is directly relevant to the laws and principles of other branches. This insistence on universal order provides one explanation for his notion that his samples are representative. He assumes that any deviation, whether cultural or hereditary, is an inconsequential variation to the regular process of development. A third assumption in his theory is that biological growth points to all mental processes as being continuations of inborn processes.

Since the 1930's, Piaget's research has undergone some gradual but profound changes. He is turning to more exact and experimental methods of collecting data. For example, his methodology now includes close observations of infants, giving older children practical tasks and putting precise questions to them about events enacted in front of them, and psychophysical experiments with both children and adults. His theory has become more detailed and more ambitious in scope, drawing on his knowledge of biology, logic, and history of science.

Most concept studies with children use either the interview-questionnaire method or the performance method. Each of these procedures presents certain obstacles to the discovery of the subject's knowledge of a specific concept or his ability to use the concept. In an interview-questionnaire setting the experimenter questions the child in an objective manner about some phenomena, striving to obtain from the child his interpretations thereof. Implicit in this method (as illustrated by Piaget's earlier works) is the assumption that knowledge of a concept is necessarily accompanied by the child's ability to translate it into words. In the performance method, the experimenter places the child in a situation which involves the learning or use of one or more concepts and observes the child's behavior. The difficulty with this method is that performance may be a function of factors other than knowledge of the specific concept under investigation. For example, the correct performance of the task may be a simple conditioned response. Realizing the difficulties inherent in these two methods Piaget, in his later research, has combined the two methods and thus united that which was most expedient in the two methods while avoiding their respective disadvantages.

3. PIAGET'S DEVELOPMENTAL THEORY

Piaget postulates the existence of cognitive structures which are the organizational properties of intelligence. These structures can be inferred from the behavior of the organism. They are created by maturation, physical experience, and social interaction, and through the progressive equilibration of assimilation and accommodation. Crucial to any discussion of structural change in Piaget's system is an examination of the functional invariants — organization and adaptation. These invariants remain constant throughout life forming an intellectual core concerned with the manner in which an organism makes cognitive progress. Adaptation consists of two interrelated components, assimilation and accommodation. Assimilation is the process whereby the individual perceives events in the environment in such a way that they can become incorporated into the cognitive structures of the organism. Accommodation is the process of modification in the organism's existing cognitive structures so that an event in the environment may be assimilated. Assimilation and accommodation occur simultaneously and cannot be dissociated as they operate in a cognition. However, the balance between these two invariants varies both between phases and within a given phase of intellectual development. Organization refers to the fact that every act of intelligence presumes some sort of intellectual structure within which it proceeds. All intellectual organizations are conceived as systems of relationships between events which have been assimilated and therefore any act of intelligence is always related to a system of which it is a part.

An organism can assimilate only those events which are extensions of past assimilations. That is, there must be a system of meanings, an existing organization which is advanced to the point where it can be modified and the new event can be assimilated. Those events whose interpretation requires a complete extension or reorganization of the existing structures cannot be accommodated to and thence assimilated. This theory gives rise to the hypothesis that planned learning experiences can induce a concept in a subject by developing a system of meanings which enables the organism to assimilate events of the concept to be learned. Thus the normal intellectual development with respect to that concept should be facilitated. On the basis of generalization these planned experiences should also facilitate the development of other related concepts. Generalization refers to the fact that the cognitive structures can be advanced to such a point that those events whose interpretations do not require a complete reorganization of the existing structures can be assimilated.

Piaget views development as an inherent, unalterable, evolutionary progress with a series of distinct developmental phases and subphases. He designates five major phases in the course of development: sensory-motor, preconceptual thought, intuitive thought, concrete operations, and formal operations. These phases are just points of reference to understand the sequence of development; they serve only to demonstrate the course of development and are not the development itself. Each phase reflects a range of organizational patterns which occur in a definite sequence within an approximate age span in the continuum of development. The completion of one phase provides a passing equilibrium as well as the beginning of an imbalance of a new phase. Each phase entails a repetition of processes of the previous level in a different form of organization. The differences in organizational patterns create a hierarchy of experience in action.

This study is primarily concerned with the developmental change within the period of intuitive thought which covers the age range of four to seven years. According to Piaget, during this period a gradual coordination of representative relations and conceptualizations becomes evident as the child advances from the symbolic or preconceptual phase to the beginning of the concrete operations phase. The child does not arrive at reversibility during the former stage because his mode of thinking is unidirectional and any assimilation centered on a perceptual configuration is also unidirectional. The child will focus sporadically on this or that momentary condition but cannot link a whole set of successive conditions into an integrated totality. Thus if a child is shown two sets of objects which are in two rows, he will agree that there is the same number of objects in each row if the rows are equal in length. However, if the objects in one row are piled up, the child will no longer claim that the two sets have the same number of objects. In the latter case the child focuses on the perceptual cues of the situation and disregards the fact that the two sets were originally equal. This example illustrates that during this stage of intellectual development the child's mode of thinking is unidirectional. He knows what the situation was initially and he concentrates on the final perceptual configuration but he cannot link the initial and final situations together.

Gradually through coordination of different viewpoints, the child becomes aware of decentralization, reversibility and conservation. Decentralization refers to the fact that the child no longer focuses sporadically on only one dimension but can combine two or three dimensions either simultaneously or relate them to each other in succession. Reversibility is evident when the child realizes that whenever a change in form or arrangement of objects occurs, the initial situation can be brought about again by an inverse change. Conservation refers to the principle that a particular dimension of an object will remain invariant under changes in other irrelevant aspects of the situation. Thus before the child has reached the final stage in conservation of mass, he believes that any change in the shape of a plasticine ball will change its mass (or quantity). He relies solely on the perceptual configuration which is actually an irrelevant cue. When the child acquires conservation of mass he realizes that the mass of the ball will remain the same regardless of how much the shape of the ball is changed. It is obvious that the attainment of the principle of conservation depends to a large degree on mastering the idea of reversibility.

When conservation is confirmed by a subject as a certainty in his thought, the initial stage of concrete operations has been reached. Thus for the first time an equilibrium is established between the assimilation of an event to the cognitive structures and the accommodation of the latter to the event. Operational thought occurs when a certain basic stock of concepts has been acquired and when these concepts have been organized into coherent systems.

4. VALIDATION STUDIES

Piaget and his associates have studied extensively the development of conservation in many areas and have established age norms for the attainment of various concepts in the average child. Generally, when conservation of distance, length, and number is attained, the beginning of the "concrete operations stage" has been reached and conservation of mass, area, weight, and volume soon follow. Piaget has outlined three developmental stages which the child passes through to attain the concept of conservation of length. In the first stage the child will state that two sticks are equal in length if their end points are lined up. However, any change of position leads to nonconservation of length; the child will now claim that the two sticks are unequal in length. In the second stage the child may recognize conservation if both sticks are moved simultaneously but not if only one stick is moved. He may guess at conservation but his method of verification will not imply operational reversibility. In the third stage the child recognizes that the two objects will be the same length regardless of their position. The development of the concepts of conservation of distance, number, mass, and area proceeds through a similar set of three stages: nonconservation, transition, and finally conservation.

The work of Piaget and his associates set the stage for a host of subsequent investigations. Hazlitt (1930) criticized Piaget and said his claims, which rested solely on his methodology, were unwarranted. She conducted experiments using the performance method alone and concluded that children display a grasp of relations very early and that their only limitation is lack of experience. However, there were problems implicit in Hazlitt's methodology for she used the performance method alone. The question arises as to whether the child was responding correctly because of his knowledge of the concept or whether he was responding as a function of some other factor. She criticized Piaget's conclusions by saying that it was only the child's lack of experience which made him unable to see relations. This is an unwarranted criticism for Piaget himself stated that one of the conditions which is necessary for the growth of cognitive structures is physical and social experiences. If the child has not had sufficient experience the structures will obviously not be fully developed.

Estes (1956) found no evidence to support Piaget's theory of stage development in the concepts of conservation of number and claimed that those children who were unsuccessful in achieving conservation did not show any of the stages described by Piaget. There are several things about this study which caution one about placing too much emphasis on these negative findings. First, the report of the procedure and results is excessively brief; there is no detail concerning the exact instructions. Secondly, Estes drew her three tasks from an overly-brief popular account of Piaget's work in number conservation (Piaget, 1953) rather than from his book on number. Thirdly, she misinterpreted Piaget's conclusions by stating that he found that children who did not have conservation of number could not count objects correctly with change of arrangement. This is not what Piaget meant at all. He stated that although the child might know the names of the numbers, he has not grasped the essential idea of number until he realizes that the number of objects remains the same regardless of the arrangement. The child may count the number of objects in two rows and come up with the same number for each row but still insist that the longer row has more objects.

Braine (1959) investigated the additive nature of length using a nonverbal method. He claimed that it was impossible to study how a concept develops with methods employing verbal cues to evoke the concept. He believed a child may have developed the concept without acquiring the adult use of the words designating the concept. Again as the performance method was used, there were many problems implicit in the methodology. Smedslund (1963a) criticized Braine's methodology and argued that the subjects did not attain the transitivity of length concept but were responding according to primitive generalization processes.

The majority of psychologists who have replicated Piaget's work on the concepts of conservation have found results similar to those described by Piaget. As the present investigation is concerned with the concepts of conservation of length, distance, number, mass, and area special consideration will be given to validation studies on these concepts. Dodwell (1960) was able to identify in his subjects' protocols, Piaget's three stages in the development of number conservation. Hyde (1959) found similar results using European, Arab, Indian, and Somali school children. Elkind (1961a) replicated Piaget's work on conservation of number and conservation of mass (1961b) and validated Piaget's findings for both these concepts. He concluded that the stages reported by Piaget suggest that success in comparing quantity depends jointly on the age of the child and the type of quantity comparison required by the test. In his study, Elkind found that liquids were the most difficult materials for children to compare.

Lovell and Ogilvie (1960) also confirmed the stages proposed by Piaget for conservation of mass and the answers given by their subjects often agreed closely with those reported by Piaget. Lovell, Healey and Rowland (1962) found that the main stages as proposed by Piaget in the development of the concepts of conservation of distance, length, and area were confirmed among English school children.

Goodnow (1962) found that using four different social and ethnic groups the similarities across milieus on conservation tasks were far more striking than the differences. She found that for these tasks, variables such as schooling or socioeconomic status had little influence on the ability to make the judgment "equal". They did however, influence the reasons provided for the children's answers. Ausubel (1958) stated that it is inevitable that the acquisition of particular concepts are dependent on a rich background of relevant experiences. He believed that concepts in early and middle childhood especially, reflect the cumulative impact of first-hand concrete experiences over extended periods of time. Cultural or social class environment has little effect on the ability to conceptualize but it does sensitize the individual to particular areas of conceptual experiences. According to Piaget and Inhelder (1947) a change in milieu has only a limited effect; it may upset performance on specific tasks, or it may alter the age at which a certain stage is reached but the order and sequence of development should remain constant. Piaget maintains that the important point is the fact that the sequence of the developmental phases remains the same.

Thus a number of studies have replicated Piaget's experiments on conservation of length, distance, number, mass, and area and their findings have generally supported Piaget's conclusions on how these various concepts are developed in children. These studies have been carried out using various ethnic groups and the similar results which have been tabulated seem to suggest that most children, regardless of their cultural background, will progress through the developmental stages as proposed by Piaget in their attempt to attain the concepts. The three studies cited which have reported different findings from that of Piaget have been shown to have methodological problems inherent in their design.

5. EXTENSIONS OF PIAGET'S STUDIES

Ervin (1960) raised the questions of whether children could be taught to use methods of thinking which are characteristic of a later age and, when deliberate training is attempted, whether there is still a typical order of operations whereby certain skills must be mastered before others. She claimed that a major problem in Piaget's research evolved from his failure to control the training histories of his subjects or at least to attempt, by systematic training, to compensate for inequalities. She used a transfer of training design to test the improvement produced by training on one problem which theoretically required identical operations as the test problems. She found that training failed to prepare the children adequately for the test items and that there was evidence that mental ability measures were related to performance on both the training and test items. The seven children who scored low on the Primary Mental Abilities test were the ones who performed poorly on both training and test items. However, no particular mental ability was found to be relevant. She concluded that this relationship of performance to mental ability supported Piaget's contention that there is a maturational component in the test problems. She also stated that the correlation of performance on the training and test items with mental ability did not appear to be due merely to the verbal ability required in answering the questions. One reason why the training session was not effective could have been that the children did not actually manipulate the training items; the training consisted merely of direct observation on the part of the children. Thus the type of training given could have produced the differential effect in the children; those children who were less intelligent, with shorter attention spans, perhaps did not benefit as much from the direct observational training as the more intelligent children.

Beilen and Franklin (1962) studied the limits which maturation placed upon the acquisition of measurement operations when a deliberate attempt was made to induce such operations through instruction in concepts basic to measurement. Using a transfer of training design they found that none of the first graders achieved operational measurement while most of the instructed third graders did. This clearly demonstrated the limits which maturation placed on the acquisition of various concepts using this particular methodology. However, their training session consisted of a group-administered program using concrete examples of the requisite skills and concepts; as in Ervin's study, the children did not manipulate the training items. Since the control groups improved slightly between pretest and posttest as well, Beilen and Franklin concluded that the Piagetian testing situation itself facilitates learning. Their final conclusion was that some gain was made from the instruction given over and above the training effect of the test situation but that the gain was differential, being greater for the older children and with the earlier acquired tasks. Lovell and Ogilvie (1960) also concluded that the Piagetian testing situation facilitated the acquisition of necessary operations. The above experiments suggest that a differential effect may be produced by a transfer of training design where there is no direct manipulation of the training objects by the children. This conclusion gives rise to the hypothesis that direct experience in handling the training items would have alleviated this differential effect so that all the children who received the training would have attained the concept.

Wohlwill and Lowe (1962) evaluated the relative contributions of three types of specific training on the development of conservational thinking using both verbal and nonverbal tests. The three experimental conditions were reinforced practice, addition and subtraction, and dissociation. There was an overall increase in the nonverbal conservation responses from pretest to posttest but no significant differences attributable to the conditions of training. The greatest improvement occurred with the addition and subtraction training but the gain was not significant. Transfer of conservational learning to the verbal posttest was negligible under all training conditions, indicating that whatever learning took place was highly specific and not generalizable. Zimiles (1963) concluded that short training periods as employed by Wohlwill and Lowe should not be expected to be effective in changing the child's approach to conservation. To go from one stage to another in conservational thinking requires the assembling of a number of abilities and gradual familiarization and incorporation of the mechanics necessary for conservation. This change, Zimiles believed, cannot be cultivated in a short training period. Smedslund (1961b) reported that children who had acquired conservation in the course of normal experience did not give up the concept easily in face of challenging experimental conditions. This finding was in contrast to those children who had acquired the concept during a training session involving either practice in addition and subtraction or direct external reinforcement. These two well-planned experiments indicate how difficult it is to artificially induce Piagetian concepts in the laboratory. The training methods impress one as sound and reasonable and yet they have had little success in producing a substantial cognitive change. It is difficult to believe that there is no method of planned experiences which will induce conservational thinking.

Feigenbaum (1961) successfully trained children to understand the concept of conservation of number. His training consisted of direct verbal reinforcement and of an operation whereby irrelevant stimulus cues were reduced. Smedslund (1959) designed an experiment which showed that the effects of direct external reinforcement may aid in the acquisition of conservation and transitivity of weight. In a later study, Smedslund (1961c) reported some effect on the development of conservation of substance due to training. He suggested that the essential condition for the shift from nonconservation to conservation is the introduction of cognitive conflict which induces a cognitive reorganization and results in the acquisition of the concept of conservation.

Wallach and Sprott (1964) were successful in inducing number conservation by using the idea of reversibility. By showing the child that whenever a change in form or arrangement occurred the initial situation could be brought about again by an inverse change, the concept of conservation of number was induced. Smedslund argued that many children already know that it is possible to return to the initial situation prior to attaining conservation. However, Wallach and Sprott showed that conservation may result from direct experience with reversibility; their training session involved the manipulation of the training items by the subject.

Smedslund (1963b) studied the effect of five training procedures in the acquisition of conservation of length. Two of the procedures used were practice in addition and subtraction; another one was change in strength of the Müller-Lyer illusion and the fourth was the anticipation of the outcome of displacements of objects (a method similar to Wallach and Sprott's reversibility procedure). The fifth method was a combination of the previous four. Smedslund found acquisition of conservation in all groups; the highest number was in the anticipation method and the lowest in the illusion group. However, the slight differences between groups in the number of acquisitions precluded any confident interpretation as to which was the best method. Ojemann and Pritchett (1963) showed that using a planned sequence of experiences produced a significant gain in the child's development of the concept of specific gravity. This study raised the question as to whether the child could assimilate events of other concepts after being exposed to a planned sequence of experiences in one concept.

From the review of the above studies, it is evident that the possibility of inducing Piagetian concepts in children is a very controversial issue. The results of the training sessions vary according to the methodology used and no method as yet has been acclaimed as the most profitable in inducing a given concept.

The present experiment will attempt to induce the concept of conservation of length by making the child aware of the principle of reversibility by direct verbal reinforcement and experience in the manipulation of the training items. This method was a combination of that used by Feigenbaum (1961) and that used by Wallach and Sprott (1964). Both methods appeared to be sound and most consistent with Piaget's theory of intellectual development that the cognitive structures are developed partly by direct experience and social interaction and through the processes of assimilation and accommodation. An important variable in any learning situation is the number of training sessions given. This variable appears to have been overlooked in the previous studies and hence different amounts of training were introduced in the present experiment. Assimilation of other concepts, namely conservation of distance, number, mass, and area is hypothesized on the basis that the training program in reversibility would revise the child's cognitive structures in such a way as to prepare him to assimilate these new events. Thus the three hypotheses to be tested are:

1. The concept of conservation of length can be induced in children by the method of direct verbal reinforcement and experience in the manipulation of the training items.

2. The results of the training sessions in the conservation of length will not deteriorate over a period of twenty days.

3. The effects of the training sessions on conservation of length will generalize to the concepts of conservation of distance, number, mass, and area.

CHAPTER II

METHOD

1. SUBJECTS

Two variables were considered in the selection of the subjects for this study; the first was socioeconomic and sex differences and the second was consideration of the stages which the children were at for the various concepts. With regard to the first variable, a pilot study was performed to determine if sex or socioeconomic differences produced any significant differences in the age levels at which the stages in the concepts of conservation of length, distance, number, mass, and area were reached. Twenty children from the Kindergarten and Grade One classes at Strathcona School and 20 children from the Kindergarten and Grade One classes at Montrose School were chosen. Strathcona School is situated in a low socioeconomic area of Winnipeg and the parents of the children chosen for this study were either laborers or on welfare. Montrose School is in a high socioeconomic area of Winnipeg and the parents of the children chosen from this school were either professionals or business executives. The groups were matched for both sex and age; thus there were 10 boys from Strathcona School and 10 from Montrose. The children ranged in age from 5 years 5 months to 6 years 11 months. The same tests for conservation that were used in the present investigation were employed in this pilot study.

There were no significant differences in the age levels at which the various stages of the conservation concepts were reached by the children from Strathcona and Montrose Schools. It was concluded that for these tasks the socioeconomic level of the child's family was not a relevant variable. There were no significant differences between the boys and girls either within the two schools or when the groups from the two schools were combined. It was concluded that for these tasks the sex of the child was not a relevant variable for influencing the age at which the child would reach a certain stage in the conservation tasks.

With regard to the second variable, only those pupils who were classified as being in Stage I or Stage II in the conservation of length pretest and who were not in Stage III for more than two of the remaining concepts were chosen for the present investigation. This restriction on the selection of subjects was imposed to ensure that there would be an opportunity to observe if the training procedure was effective and if it did produce generalization to the other concepts. If the children were in Stage III of the conservation of length concept and also in Stage III for more than two of the remaining concepts, this opportunity would be considerably reduced.

Having considered these two variables, the subjects chosen for the present study were 30 boys and 30 girls attending Kindergarten or Grade One at two Winnipeg schools, Harrow and William Osler. The children ranged in age from 5 years 7 months to 6 years 3 months with the mean age being 5 years 11 months. After being classified for the level of conservation attained for the various concepts in the pretest, the subjects were randomly assigned to the three experimental and three control groups matched on the basis of age. The mean age of each of these six groups was 5 years 11 months.

2. TESTS AND PROCEDURES

Each subject was tested individually by the experimenter. The subject was seated at a small table to the right of the experimenter who recorded the child's answers. The pretest consisted of five subtests measuring the level of conservation attained for each of the following concepts: length, number, distance, mass, and area. The order of presentation of these five subtests was random for each subject.

Length. Two 3 inch sticks (3/8" wide) were placed on the table parallel to each other with their ends lined up. The child was asked, "Are these sticks the same length or is one longer than the other?" One of the sticks was then moved forward one inch and the child was asked, "Are these sticks the same length now or is one longer than the other? Why?"

These questions were again asked when the sticks were placed in an acute angle and then in a T formation. The procedure was repeated using 5 inch sticks and again using 7 inch sticks.

Number. Six egg-cups were laid out in a straight line on the table in front of the child. A pile of ten eggs was placed at the child's left. The child was then asked, "Take just enough eggs for the egg-cups, not more and not less, one egg for each egg-cup. Place them in front of the egg-cups. Is there the same number of eggs and egg-cups? Put the eggs in the egg-cups and see if there is the same number. Is there the same number of eggs as there is egg-cups?"

If there was too many or not enough eggs the experimenter took away or added the appropriate number. The child was then asked, "Now

Mass. Two red balls of clay were presented to the child who was shown and told that they contained the same amount of clay. The experimenter then changed one ball into a ring and the child was asked, "Do you think the ring contains the same amount or more or less clay than the ball? Why?"

The questions were again repeated for the following situations: two equal balls, one of which was changed into a cup; two equal balls, one of which was changed into a triangle; and two equal balls, one of which was changed into an X.

Area. Two large rectangles (8 1/4" x 10 3/4") were shown to the child. It was demonstrated by placing them on top of each other that they were congruent and therefore had the same amount of room. The child was asked, "Is there the same amount of room on here (rectangle A) as there is on here (rectangle B)?" One of the large rectangles was then cut into smaller rectangles, each 4 1/8" x 10 3/4". These two rectangles were arranged perpendicularily and the child was asked, "Is there still the same amount of room on here (A) as there is on here (B)? Why?"

Using only the two smaller rectangles and demonstrating to the child that they were congruent, the experimenter cut up one of these rectangles to form a 4 1/8" square and a 4 1/8" x 6 3/4" rectangle. Both sections were left together so that the form of the initial rectangle was not distorted and the above question was asked.

The cut rectangle was left in its position but the uncut one was then rotated so that its long sides (which were vertical before) were now horizontal and the question was repeated. Using two 4 1/8" x 6 3/4" rectangles, the experimenter cut one diagonally and rearranged the two halves to form a triangle and repeated the question. The question was again repeated for the following situations: the other rectangle was cut into six squares which were randomly arranged in a small cluster on the table; the two triangles were rearranged to form a rectangle; the six squares were rearranged to form a rectangle; and the six squares were put into three pairs with space in between the pairs.

Classification of Subjects

On the basis of their answers to the pretest questions, the subjects were classified into one of three stages for each concept: nonconservation or Stage I, transition or Stage II, and conservation or Stage III.

Length. The child's responses were classified as being in Stage I if two or more sets of questions were answered incorrectly. (A set of questions was taken to include the placing of the 3, 5, and 7 inch sticks in the same position. For example, the answers given when these three different pairs of sticks were placed in an acute angle comprised a set). The child's responses were classified as being in Stage II if more than one set but not all of the questions were answered correctly. Stage III was reached when the child answered all the questions correctly and his method of verification implied operational reversibility.

Number. The child's responses were classified as being in Stage I if the child was unable to make a one-one correspondence and was unable to answer correctly the questions regarding the equivalence of the two sets of objects when the configuration of one set was changed. His responses were classified as being in Stage II if the child was able to make a one-one correspondence but based the equivalence of the two sets of objects on the perceptual comparison of the length of their rows. Stage II also included those children who claimed equivalence of the two sets regardless of their position but were unable to make a one-one correspondence. Stage III was reached when the child was able to make a one-one correspondence and answer all the questions correctly; at this stage the child's method of verification implied operational reversibility.

Distance. The child's responses were classified as being in Stage I if two or more of the first four questions were answered incorrectly and two or three of the remaining three questions incorrectly. If the child answered at least three of the first four questions correctly but only one of the remaining questions correctly, his responses were classified as being in Stage II. If he answered two or more of the first four incorrectly but answered at least two of the remaining questions correctly his responses were also placed in Stage II. The child's responses were classified as being in Stage III if all questions were answered correctly and if his method of verification implied operational reversibility.

Mass. The child's responses were classified as being in Stage I if at least three of the four questions were answered incorrectly. If two questions were answered correctly where conservation was used as an explanation or three questions correctly with no conservation implied, the responses were classified as being in Stage II. The child's responses were classified as being in Stage III if all four questions were answered correctly and the child's method of verification implied operational reversibility.

Area. The child's responses were classified as being in Stage I if six questions or more were answered incorrectly with no evidence of conservation. If three or more of the eight questions were answered correctly and some evidence of conservation was given or if five or more of the questions were answered correctly with no conservation implied, the responses were classified as being in Stage II. To be classified as being in Stage III the child had to answer all the questions correctly with his method of verification implying operational reversibility.

After being classified as either in Stage I or Stage II in the conservation of length concept, the subjects of the experimental groups were given a training session in the conservation of length. The three experimental groups differed as to the amount of training given them. Experimental Group 1 received the training procedure once; Experimental Group 2 received the same training procedure for two consecutive days; and Experimental Group 3 received the same training procedure for three consecutive days.

Two new (unsharpened) pencils $7\frac{1}{2}$" long were used in the training session. The following situations were presented and repeated until the subject made the correct predictions and their method of verification implied operational reversibility.

The pencils were placed on the table parallel to each other with their ends lined up. The child was asked, "Are these pencils the same length or is one longer than the other?" The pencils were then rearranged to form an L and the child was asked, "Do you think these pencils will still be the same length or will one be longer than the other? Why? Put them both together as they were in the beginning and check if they are still the same length. Are they still the same length? Yes, they did not change in length when we moved them, did they?" This series of questions and statements was repeated for the following situations: the pencils were placed in an obtuse angle; then, when they were both parallel, one pencil was pushed forward so that its end was in the middle of the pencil above it.

The three control groups were matched to the three experimental groups for the time lapse between the pretest and posttests. Thus Control Group 1 was matched with Experimental Group 1, Control Group 2 with Experimental Group 2, and Control Group 3 with Experimental Group 3. To control for the effect of interaction with the experimenter the subjects in the control groups were asked to draw a picture for the experimenter which took approximately the same length of time as the training sessions for the experimental subjects. In the subsequent discussion this picture drawing activity will be referred to as the play sessions for the controls.

The day after the last training session (or play session) the battery of subtests which had formed the pretest was readministered to all groups and their responses were recorded and classified according to the three categories. Twenty days after the first posttest had been given, the test was readministered and the subjects' responses were recorded and classified. Four of the subjects were absent from school on the twentieth day and hence were given the second posttest on the twenty-first day. The second posttest was introduced to see whether the effects of the training sessions would deteriorate over time.

3. EXPERIMENTAL DESIGN

In order to test the first and second hypotheses that the concept of conservation of length could be induced by making the child aware of the principle of reversibility and that the effects of the training sessions would not deteriorate over time, a 2 x 3 x 2 factorial design was used; the design used for the analysis of variance was a completely fixed model. The factors in the design were: (1) days tested; (2) amount of training; and (3) experimental and control groups. If a significant difference is found between the days tested, that is, between the pretest and first posttest or the pretest and second posttest, then the indication would be that the results produced by the training sessions were transitory. If a significant difference is found between the number of training sessions given, then the amount of training is an important variable which should be considered whenever an attempt is made to induce the concept of conservation. If there is a significant difference between the experimental and control groups, then it can be stated that the training sessions were effective in inducing the concept of conservation.

In order to test the third hypothesis that the effects of training in conservation of length would generalize to other concepts such as conservation of distance, number, mass, and area, a three factor design with one factor consisting of related measures was used (Winer, 1962). The factors in the design were: (1) amount of training; (2) experimental and control groups; and (3) the four tasks, distance, number, mass, and area which were measures obtained on the same individuals. If a significant difference is found between the number of training sessions given, then the amount of training is also important for the amount of generalization which will occur. If there is a significant difference between the experimental and control groups, then it can be stated that the effects of the training sessions in length generalize to the other tasks. If there is a significant difference between tasks, then it can be said that the training sessions generalize more to some tasks than to others. The design of the experiment is outlined in Table I.

TABLE I

SUMMARY OF THE EXPERIMENTAL DESIGN

	E_1	C_1	E_2	C_2	E_3	C_3
First Day	pretest	pretest	pretest	pretest	pretest	pretest
Second Day	train	play	train	play	train	play
Third Day	posttest	posttest	train	play	train	play
Fourth Day			posttest	posttest	train	play
Fifth Day					posttest	posttest
Twentieth Day (after first post-test)	posttest	posttest	posttest	posttest	posttest	posttest

CHAPTER III

RESULTS

The unit of measurement in the analysis was the difference in stages of conservational thinking on the pretest and posttests for each concept. These difference scores were transformed by the addition of a constant of +3 to each one. Thus the possible range of difference scores was +1 (loss of 2 stages) to +5 (gain of 2 stages). All the data obtained is available in Appendix A.

In order to obtain a reliability measure for the scoring, two raters were used to score the children's responses as there was some subjectivity involved in the identification of the stages. One rater was the experimenter who also instructed the other rater in the various stages as outlined by Piaget. The percent agreement between the two raters was 97.7% for the pretests, 95.3% for the first posttests, and 97.3% for the second posttests.

The summary of the 2 x 3 x 2 analysis of variance of the difference scores between the pretest and posttests on the concept of length is shown in Table II. The level of significance chosen for all the analyses was $p < .01$.

The analysis outlined in Table II reveals a significant interaction between the number of training or play sessions and the experimental and control groups ($F = 9.26$, $df = 2$, $p < .01$). The nature of this interaction is evident in Figure 1. It can be seen that there is a gain in difference scores with increase in the number of training sessions for the experimental groups. However, there is no mean gain in scores with increase

TABLE II

ANALYSIS OF VARIANCE OF THE DIFFERENCE SCORES BETWEEN PRETEST AND POSTTEST ON LENGTH COMPARING THE FIRST AND SECOND POSTTEST, NUMBER OF TRAINING SESSIONS, AND THE EXPERIMENTAL AND CONTROL GROUPS

Source	df	ms	F
Experimental and control groups	1	70.53	
Number of training sessions	2	1.76	
First and second posttests	1	.03	
Interaction: Number of training sessions x experimental and control groups	2	1.76	9.26*
Interaction: Experimental and control groups x first and second posttests	1	.07	.77
Interaction: Number of training sessions x first and second posttests	2	.33	1.74
Interaction: Number of training sessions x experimental and control groups x first and second posttests	2	.27	1.45
Within cells	108	.19	

* $p < .01$

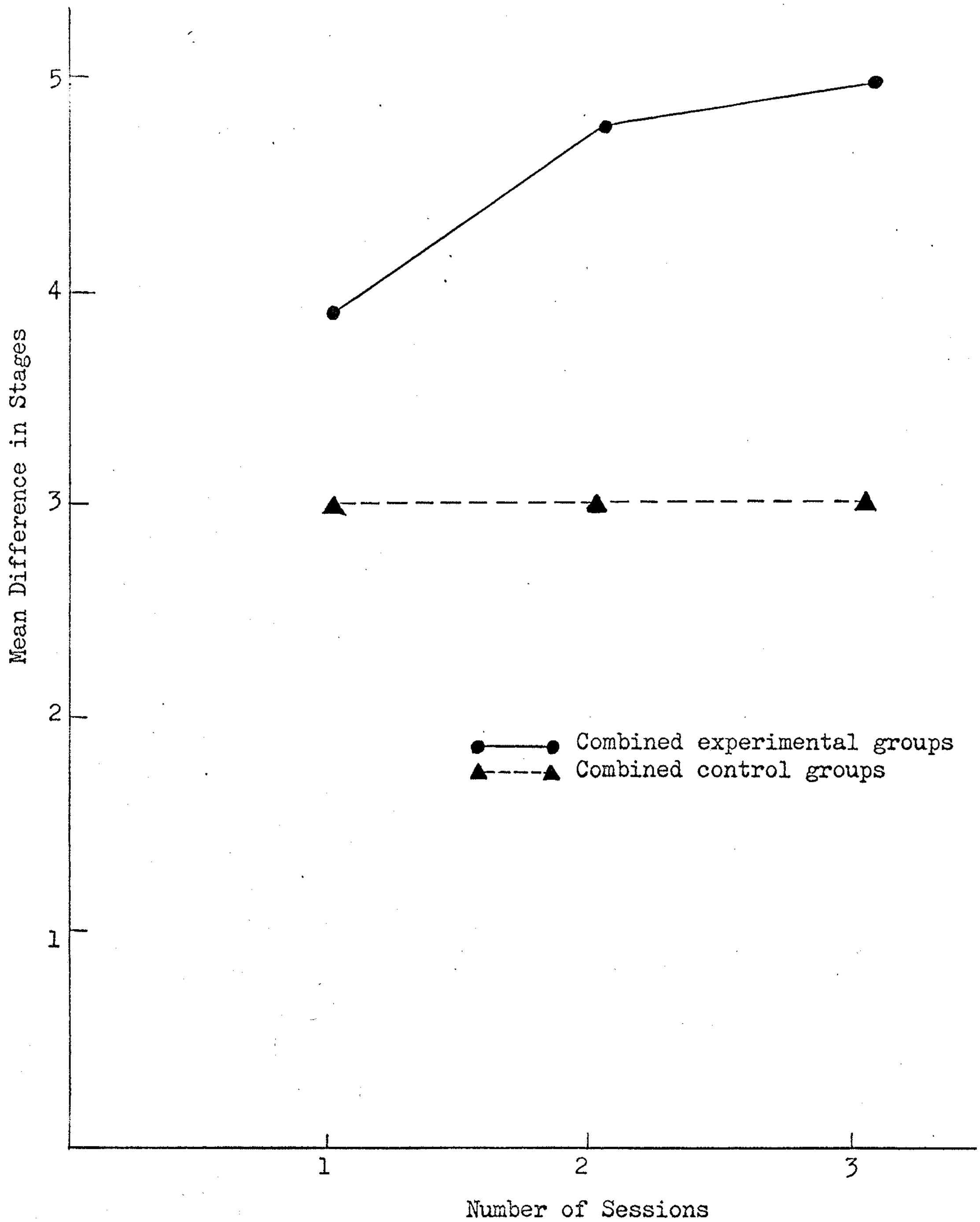

FIGURE 1

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS
FOR THE GAIN IN STAGES FROM PRETEST
TO FIRST POSTTEST IN LENGTH

in the number of play sessions in the difference scores for the control groups. These results indicate that the effects of continued interaction with the experimenter without the training sessions were negligible.

From Figure 1 it is also evident that there is a difference between the experimental and control groups with respect to the difference scores between the pretest and posttests in length. Thus it appears that the experimental groups in all three treatment conditions made a considerable gain over the control groups in the pretest to posttest scores.

It seems evident from Figure 2 that the number of training sessions which the subjects received might have a significant effect on the gain in stages from the pretest to the first posttest in length. In order to test for this effect two t tests were performed. The t test for the mean difference between the effect of one and two training sessions yielded a significant result ($t = 6.92$, $df = 54$, $p < .01$) and the t test for the mean difference between the effects of two and three training sessions yielded an insignificant result ($t = 1.54$, $df = 54$, $p > .01$). Thus the subjects who had at least two training sessions in length made a significant gain in scores from the pretest to the first posttest over those subjects who had only one training session. Table III indicates the number of subjects at the various stages on the first posttest for each of the three training sessions.

The insignificant result obtained from the comparison of the difference scores between the pretest and first posttest and between the pretest and second posttest indicated that the effects of the training sessions persisted over a period of twenty days. These results are illustrated in Figure 3.

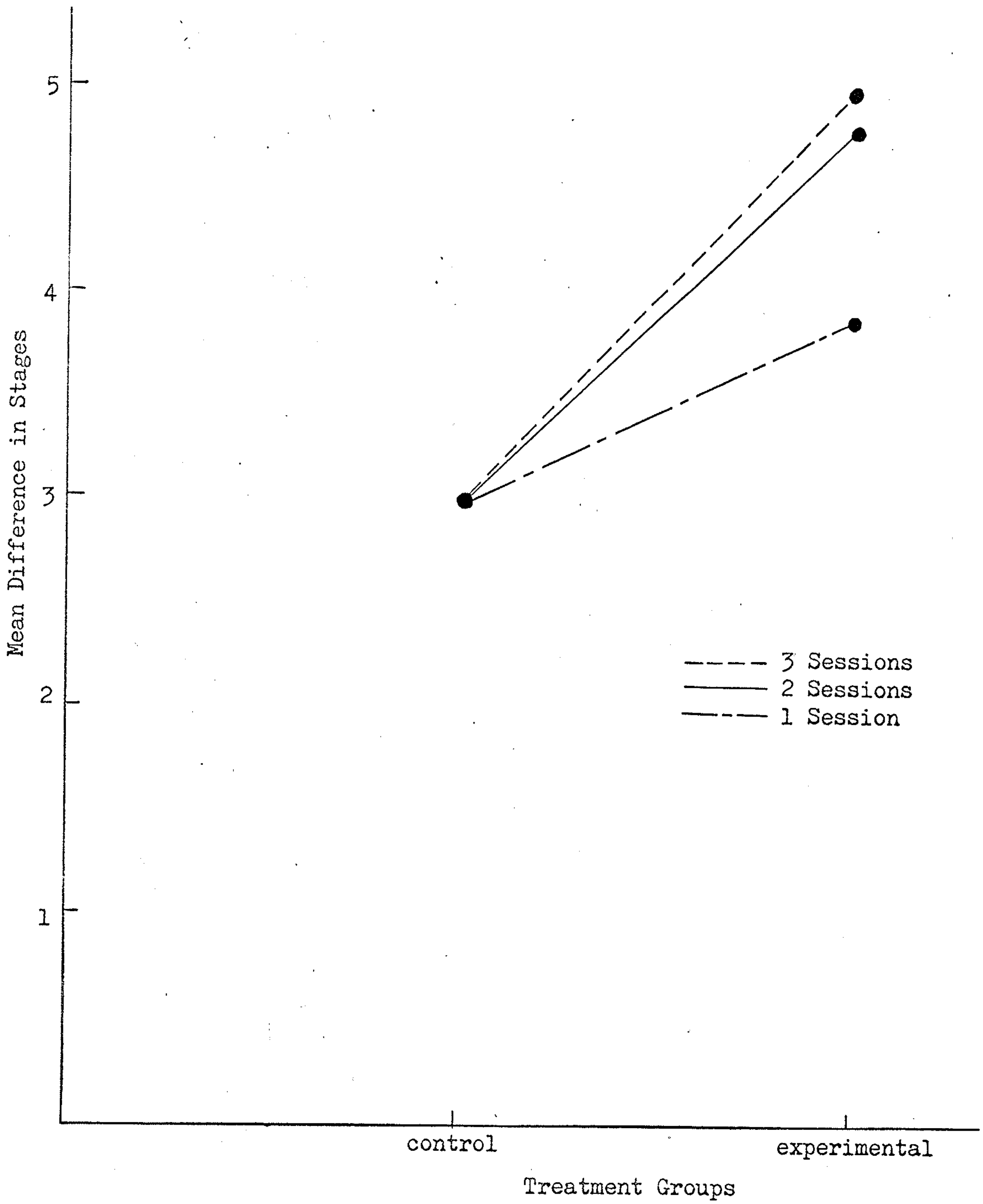

FIGURE 2

COMPARISON OF THE NUMBER OF TRAINING OR PLAY SESSIONS AND THE GAIN IN STAGES FROM PRETEST TO FIRST POSTTEST IN LENGTH FOR CONTROL AND EXPERIMENTAL GROUPS

TABLE III

NUMBER OF SUBJECTS AT THE VARIOUS STAGES
ON THE FIRST POSTTEST IN LENGTH

	Number of Subjects		
Training Sessions	Stage I	Stage II	Stage III
One Session	2	7	1
Two Sessions	0	2	8
Three Sessions	0	0	10

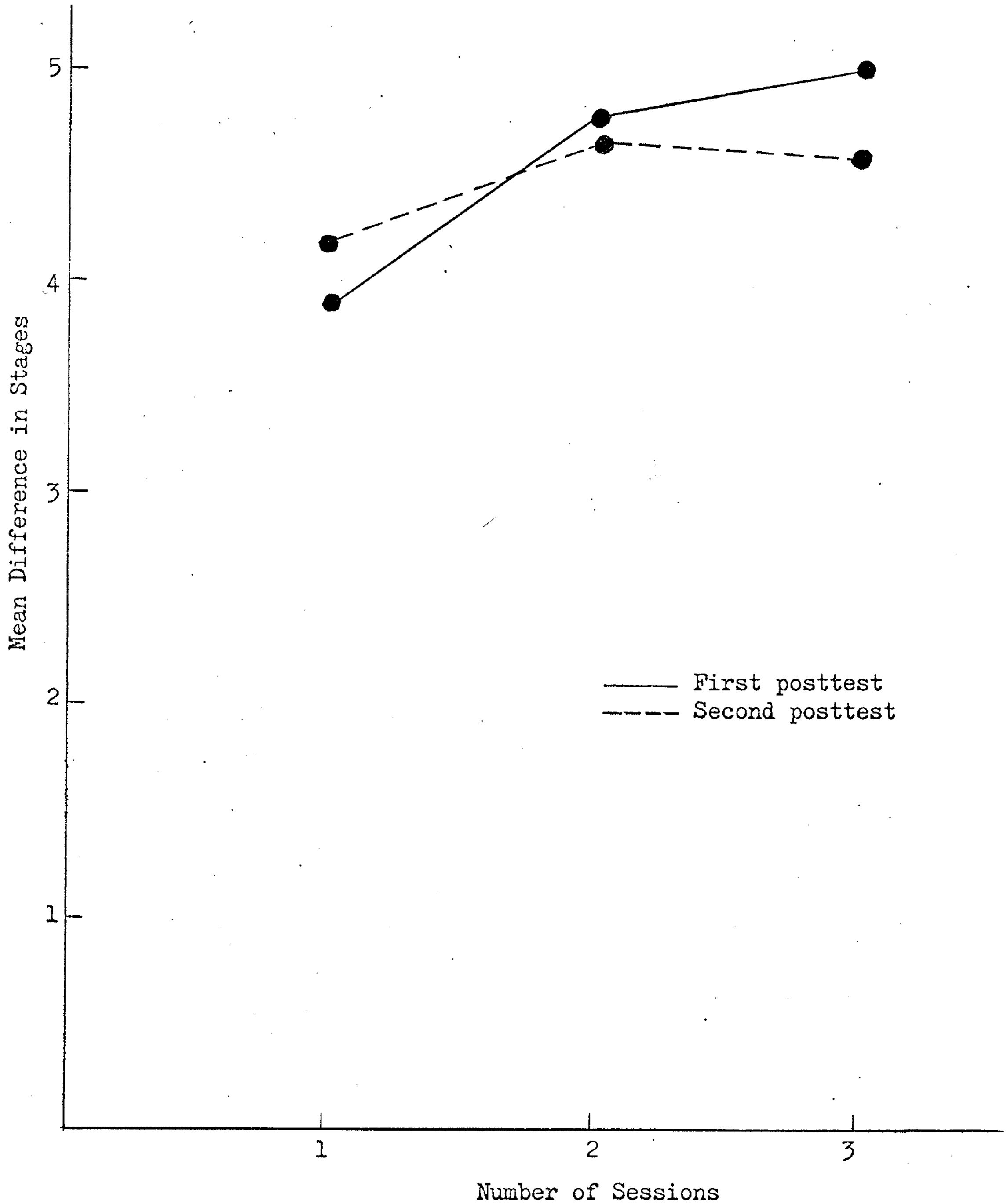

FIGURE 3

COMPARISON OF GAIN IN STAGES FROM PRETEST TO FIRST AND SECOND POSTTESTS IN LENGTH AS A FUNCTION OF NUMBER OF TRAINING SESSIONS

It was felt that the stage at which the child's responses were classified on the pretest for the various concepts was relevant if any conclusions were to be drawn about the amount of generalization from the training sessions in length to the concepts of distance, number, mass, and area. Table IV indicates the number of subjects at the various stages on the pretest and first posttest for the experimental groups. Table IV revealed that the majority of subjects which were at Stage I or Stage II on any of the concepts of distance, number, mass, and area did not reach the final stage of conservation on these concepts as a result of the training sessions given in the concept of length.

The summary of the 3 x 2 x 4 factorial design with related measures used for the analysis of variance between the difference scores from the pretest and first posttest on four of the tasks is shown in Table V.

The analysis of variance in Table V reveals a significant difference between the experimental and control groups. This result indicated that there was some generalization from the training sessions in length to the concepts of distance, number, mass, and area. From Figure 4 it is evident that the largest difference between the experimental and control groups occurred on the concept of area. A critical t test on the mean difference between the difference scores for the three experimental groups and the difference scores for the three control groups yielded a significant result ($t = 3.35$, $df = 54$, $p < .01$). Thus the experimental and control groups differed significantly on the concept of area and it can be assumed that the training sessions in length produced this difference. It was also suggested by Figure 4 that

TABLE IV

NUMBER OF SUBJECTS AT THE VARIOUS STAGES
ON THE PRETEST AND FIRST POSTTEST

LENGTH		Number on Posttest		
Number on Pretest		Stage I	Stage II	Stage III
Stage I	30	2	9	19
Stage II	0	-	-	-
Stage III	0	-	-	-
DISTANCE		**Number on Posttest**		
Number on Pretest		Stage I	Stage II	Stage III
Stage I	16	6	8	2
Stage II	13	1	10	2
Stage III	1	-	-	1
NUMBER		**Number on Posttest**		
Number on Pretest		Stage I	Stage II	Stage III
Stage I	4	-	2	2
Stage II	15	-	10	5
Stage III	11	-	-	11
MASS		**Number on Posttest**		
Number on Pretest		Stage I	Stage II	Stage III
Stage I	24	19	1	4
Stage II	2	-	-	2
Stage III	4	-	-	4

TABLE IV (continued)

AREA	Number on Posttest		
Number on Pretest	Stage I	Stage II	Stage III
Stage I 29	15	9	5
Stage II 1	-	1	-
Stage III 0	-	-	-

TABLE V

ANALYSIS OF VARIANCE OF THE DIFFERENCE SCORES BETWEEN PRETEST AND POSTTEST COMPARING THE CONCEPTS OF DISTANCE, NUMBER, MASS, AND AREA, THE NUMBER OF TRAINING SESSIONS, AND THE EXPERIMENTAL AND CONTROL GROUPS

Source	df	ms	F
Between Subjects	59		
Number of training sessions	2	.71	1.58
Experimental and control groups	1	6.34	14.09*
Interaction: Number of training sessions x experimental and control groups	2	.08	.18
Subjects within groups	54	.45	
Within Subjects	180		
Tasks	3	.12	.40
Interaction: Number of training sessions x tasks	6	.17	.57
Interaction: Experimental and control groups x tasks	3	.46	1.53
Interaction: Experimental and control groups x number of training sessions x tasks	6	.23	.77
Tasks x subjects within groups	162	.30	

* $p < .01$

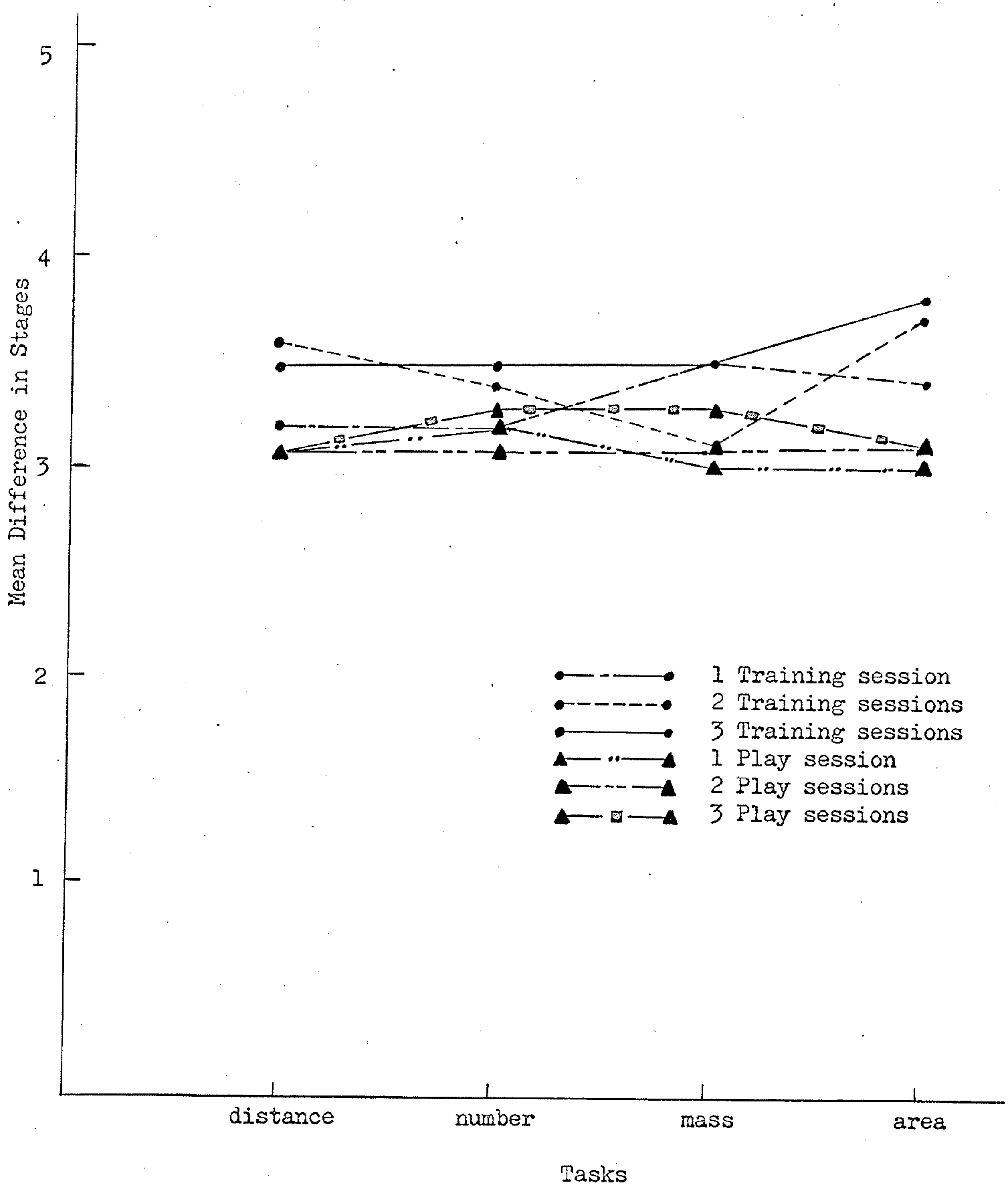

FIGURE 4

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS FOR THE GAIN IN STAGES FROM PRETEST TO FIRST POSTTEST ON FOUR TASKS a significant difference between the experimental and control groups might occur on the concept of distance. However, a critical t test on the mean difference between the difference scores for the experimental groups and the difference scores for the control groups yielded an insignificant result ($t = 1.94$, $df = 54$, $p > .01$). Thus the experimental and control groups did not differ significantly on the concept of distance.

The analysis in Table V revealed no other significant differences other than that between the experimental and control groups. Therefore it can be assumed that the number of training sessions in length had little systematic effect on the amount of generalization produced to the concepts of distance, number, mass, and area. Also there was no significant differences in the difference scores of the groups from pretest to first posttest for any of the four tasks. Thus it can be stated that the amount of generalization from the training session in length did not produce any significant differences between the concepts of distance, number, mass, and area.

CHAPTER IV

DISCUSSION

The results indicate that the planned experiences used in this study were effective in inducing the concept of conservation of length. Thus the hypothesis that conservation of length may be acquired by making the child aware of the principle of reversibility through direct verbal reinforcement and experience in the manipulation of the training objects has been supported. However, two or more training sessions were necessary if the child was to reach the final stage of conservation. From Table III (page 42) it is evident that of the ten children who received one training session, only one reached Stage III in conservation of length, whereas of the ten who received two training sessions, eight reached Stage III and all the children who received the three training sessions reached Stage III. In other words, for the majority of the children in this study at least two training sessions were necessary to reorganize their existing cognitive structures to such an extent that they could completely assimilate the principles involved in the concept of conservation of length.

The fact that the training sessions were so effective is significant in the light of previous research. Wohlwill and Lowe (1962) were unsuccessful in inducing conservation using the methods of reinforced practice, addition and subtraction, and dissociation. Ervin (1960) was unsuccessful with a transfer of training design. Smedslund (1963b) also tried to evaluate various training methods which would induce the concept of conservation of length. Two of the procedures which he used were practice in addition and subtraction; another one was change in strength of the Müller-Lyer illusion and the fourth was the anticipation of the outcome of displacements of objects. The fifth method was a combination of the previous four. He found no significant differences between the five methods studied. However, the anticipation method which produced the best results, only produced seven conservers out of the sixteen subjects given this training.

The positive results in this study concerning the effect of the training sessions were similar to those results reported by Wallach and Sprott (1964). It will be recalled that they used the method of direct experience with reversibility. In their study, thirteen of the fifteen subjects which were given a training session in conservation of number reached the final stage of conservation.

Three explanations for the effectiveness of the present training sessions can be postulated. It may be that the important variable involved in inducing a concept of conservation is the manipulation by the child of the objects used in the demonstration of the concept. This explanation is consistent with Piaget's theory that cognitive structures are created in part by direct experience. The fact that none of the subjects in Wohlwill and Lowe's, Ervin's, or Smedslund's studies manipulated the objects, but the subjects in Wallach and Sprott's study did, provides further support for this explanation. A second explanation may be that the number of training sessions given is an important variable. Piaget noted that the cognitive structures are created in part by direct experience; thus the more experience one has with the concept the more the cognitive structures should be developed. As most of the previous studies used only one training session, support for the above explanation is also suggested. The fact that the child appeared to be aware of the principle of reversibility seems to be the best explanation for the effectiveness of the training sessions in this study. This factor of reversibility has often been stressed by Piaget and yet most experimenters have neglected to make use of it in their methods of training. The only other experimenters who used direct experience with reversibility were Wallach and Sprott (1964) and they also obtained impressive results. It seems that the continued equality of the length of two objects is evident to the child if he can be taught to realize that by reversing the operation whereby the objects were made to look unequal, the criterion of equality would again be observable. Thus once the child is taught the principle of reversibility with respect to a concept he can logically solve problems which involve this principle.

It is interesting to note that in the present elementary school curriculum for the Province of Manitoba some instruction in the concept of length is given in Grade One but there is no mention in the course outline that any attempt is made to illustrate to the children the concept of conservation of length. Thus the child's idea of relying solely on perceptual cues rather than the principle of reversibility is prolonged under this system. However, the revised mathematics program for the elementary schools utilizes Piaget's idea of reversibility and hence enables the child to understand and reason through the concepts which he is taught. Emphasis is also placed on the necessity of direct manipulation and experience with the objects used in demonstrating a concept. Unfortunately this revised mathematics program is not introduced into the curriculum until Grade Three.

From the children's answers on the posttests in length it is evident that those children who were classified as being in Stage III had mastered the idea of reversibility in the concept of length. When asked to give an explanation for their answers, the majority of children stated and demonstrated that since the sticks were the same length in the beginning they would always be the same regardless of what position they were placed on the table. The fact that the children were trained on one set of objects (pencils) and were able to transfer the principle of reversibility to the test objects (sticks) indicated that the children were capable of generalizing the concept of conservation of length to various objects.

The results support the second hypothesis that the effect of the planned experiences on conservation of length would not deteriorate over a period of twenty days. This fact indicates that the planned experiences produced a fairly permanent change in the child's mode of thinking about conservation of length. Wallach and Sprott (1964) are the only other experimenters who included a second posttest when determining the effects of a training method on the acquisition of Piagetian concepts. They also found in their study that the effects of training had not diminished by the second posttest (which was fourteen to twenty-three days after the first posttest) and thus their results lend support to the present findings.

The fact that there was a significant difference between the experimental and control groups on the concepts of conservation of distance, number, mass, and area suggest that the effects of the planned experiences on the conservation of length did generalize to these concepts. Thus support for the third hypothesis has been obtained and the indications are that the training sessions advanced the child's existing cognitive structures sufficiently so that the child could assimilate these other concepts. Inspection of Table IV (page 45) revealed that of the experimental subjects who were at Stage I or II on the pretests of the respective concepts, only 13.7% reached Stage III on distance, 36.8% reached Stage III on number, 23.1% reached Stage III on mass, and 16.7% reached Stage III on area after the training sessions. Thus the generalization which did occur to these concepts was not sufficient to make the majority of the children reach the final stage of conservation. In other words, the training sessions did not advance the child's cognitive structures to such a point that the concepts of conservation of distance, number, mass, and area could be completely assimilated.

It was stated in the Introduction that operational thought occurs when a certain basic stock of concepts has been acquired and when these concepts have been organized into coherent systems. The results of this experiment support in part Piaget's theory that the cognitive structures, which are the organizing properties of intelligence, are created by maturation, physical experience, and social interaction and through the processes of assimilation and accommodation. Thus the concept of conservation of length was experimentally induced by means of physical experience and social interaction as well as through assimilation and accommodation. However, it appears that it was lack of maturity as well as incomplete accommodation which prevented the total generalization of the effects of the planned experiences to the other concepts. By total generalization it is meant that the child would reach the final stage of conservation in the concepts of distance, number, mass, and area. With time and more experience the cognitive structures should become organized such that the other concepts would be completely acquired.

From inspection of Table IV (page 45) it appears that the effects of the training sessions generalized most to the concept of number than to mass, area, or distance. However, it was revealed in Table V (page 47) that the difference between these four tasks was not significant. Therefore the results suggest that generalization from the training sessions occurred to some extent to all the concepts.

The fact that the third hypothesis was supported gives rise to the explanation that once the child appears to be made aware of the principle of reversibility in one concept, he is able to perceive similarities in the other related concepts, but cannot apply the principle directly to these concepts. Thus by teaching the child the underlying principle of a number of concepts he will be able to apply it directly to the concept on which he was trained and to a lesser extent to other related concepts. Through time and more experience the child will presumably apply the principle of reversibility directly to these other concepts. Thus the process of conservation is acquired for each concept separately and is not a general ability which once acquired, can operate for all concepts. This explanation is in agreement with Piaget's implications that the acquisition of conservation of various concepts will appear at different ages in the child.

Some suggestions for further research which can be generated from this study are:

1. In order to test how stable the effects obtained from the planned experiences are, an extinction experiment should be conducted whereby one of the sticks would be replaced by a slightly shorter one without the child's knowledge. Thus it would appear to the child that a change of position actually does change the length of the sticks. If the principle of conservation of length has been firmly established in their minds, the children should show a resistance to extinction of the principle of conservation.

2. In order to determine precisely the order of acquisition of various concepts in individual children, a longitudinal study should be undertaken. The results of a study of this sort could confirm or deny the results suggested by cross-sectional studies.

3. An ecological study of a child's everyday experiences might be undertaken in order to study how these various concepts of conservation of length, distance, number, mass, and area are acquired "naturally".

4. A follow-up study based on the hypothesis that the children in the experimental groups should reach the final stages of conservation in the concepts of distance, number, mass, and area sooner than the children of the control groups could suggest that all the effects of the planned experiences may not be immediately evident.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to consider the effects of planned experiences on the development of various concepts in children, and the relation of these experiences to Piaget's theory of intellectual development. It was proposed that these planned experiences would also facilitate the development of other related concepts.

Previous research suggested that a productive method of inducing conservation was to attempt to make the child aware of the principle of reversibility by means of direct verbal reinforcement and experience in the manipulation of the training objects. Sixty children ranging in age from 5 years 7 months to 6 years 3 months were individually given a pretest on the concepts of conservation of length, distance, number, mass, and area. One half of the children were placed in experimental groups and one half in control groups. The training session consisted of direct verbal reinforcement and manipulation of the training objects. The three experimental groups differed as to the amount of training: Experimental Group 1 received one training session; Experimental Group 2 received two training sessions; and Experimental Group 3 received three training sessions. The day after the last training session a posttest was given to the individuals in each group. The three control groups were matched to the three experimental groups for the time lapse between the pretest and posttest. Twenty days after the first posttest was given, it was readministered to see whether the effects of the planned experiences would deteriorate over time.

On the basis of their answers to the questions on the pretest and posttests, the children's responses were classified into one of three stages for each concept: nonconservation or Stage I, transition or Stage II and conservation or Stage III. The unit of measurement in the analysis of the data was the difference in stages on the pretest and posttests for each child.

The results suggested:

1. The concept of conservation of length could be induced by making the child aware of the principle of reversibility through direct verbal reinforcement and manipulation of the training objects.

2. The number of training sessions given is an important variable. Those subjects who had at least two training sessions made a significant gain from pretest to posttest on the concept of length over those subjects who had only one training session.

3. The effects of the planned experiences used in this study on the concept of conservation of length persisted over a period of twenty days.

4. Some generalization occurred from the training sessions in length to the concepts of conservation of distance, number, mass, and area. There were no significant differences between these four concepts with respect to the extent of generalization from the training sessions.

5. The number of training sessions given did not influence the amount of generalization to the other concepts.

It was concluded that conservation of length can be induced by the method of direct verbal reinforcement and experience in the manipulation of the training objects and that the effects of these

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APPENDIX A

LEVEL OF CONSERVATION REACHED FOR EACH SUBJECT ON PRETEST AND POSTTESTS

LENGTH	Number of Sessions								
	I			II			III		
	pre-test	1st. post.	2nd. post.	pre-test	1st. post.	2nd. post.	pre-test	1st. post.	2nd. post.
	1	2	2	1	3	3	1	3	3
	1	2	3	1	3	1	1	3	3
	1	1	1	1	2	3	1	3	3
Experimental	1	2	2	1	3	3	1	3	3
	1	2	3	1	3	3	1	3	1
Group	1	2	2	1	3	3	1	3	3
	1	1	1	1	3	3	1	3	3
	1	2	3	1	2	2	1	3	1
	1	3	3	1	3	3	1	3	3
	1	2	2	1	3	3	1	3	3
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
Control	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
Group	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
DISTANCE									
	1	2	2	1	1	2	1	3	2
	1	1	1	1	3	3	2	2	2
	1	2	2	1	2	2	2	2	2
Experimental	1	1	2	2	2	2	1	1	3
	2	2	3	1	2	3	1	1	2
Group	2	2	2	2	3	3	1	2	1
	1	1	1	2	2	2	1	2	1
	2	3	2	3	3	2	2	2	2
	2	1	3	1	2	2	2	2	2
	2	2	2	2	2	1	1	2	2
	2	2	2	1	2	1	2	1	1
	2	2	2	2	2	2	2	2	2
	3	3	3	1	1	1	2	2	2
Control	1	1	1	1	1	1	2	2	2
	1	2	2	1	1	1	2	2	2
Group	2	2	2	2	2	2	1	2	1
	2	2	2	1	1	1	2	2	2
	2	2	2	2	2	2	1	1	1
	1	1	1	1	1	1	1	2	2
	1	1	1	2	2	2	2	2	2

APPENDIX A (continued)

NUMBER	Number of Sessions								
	I			II			III		
	pre-test	1st. post.	2nd. post.	pre-test	1st. post.	2nd. post.	pre-test	1st. post.	2nd. post.
	3	3	3	3	3	3	2	3	3
	2	2	2	3	3	3	2	2	2
	2	3	2	3	3	3	2	2	2
Experimental	2	2	2	3	3	3	2	3	3
	3	3	3	2	3	3	2	2	2
Group	3	3	3	3	3	3	3	3	3
	1	2	2	3	3	3	2	2	2
	3	3	3	2	2	3	1	2	2
	2	2	3	2	3	3	1	3	3
	2	2	2	1	3	3	2	2	2
	3	3	3	1	2	1	1	2	2
	2	2	2	3	3	3	3	2	3
	3	3	3	2	2	2	2	2	2
Control	1	2	2	3	3	2	2	2	2
	1	2	2	3	3	3	2	2	3
Group	2	2	2	3	3	3	3	3	2
	3	3	3	3	3	3	2	2	2
	3	3	3	2	1	2	1	2	2
	3	3	3	1	2	2	2	3	3
	2	2	1	2	2	1	2	3	2
MASS									
	1	3	3	1	1	1	1	3	1
	1	1	1	1	1	3	1	1	1
	1	1	1	3	3	3	1	1	1
Experimental	1	1	1	1	1	2	1	1	3
	1	3	3	2	3	3	1	1	1
Group	1	2	2	1	1	3	3	3	3
	1	1	1	3	3	3	1	1	1
	3	3	3	1	1	1	1	1	1
	1	1	1	1	1	3	2	3	3
	1	1	1	1	1	1	1	3	3
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	3	3
	1	1	1	1	1	1	1	1	1
Control	1	1	1	1	1	1	1	2	1
	1	1	1	3	3	3	1	1	1
Group	1	1	1	1	1	1	2	2	1
	2	2	2	1	2	1	1	1	1
	3	3	3	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1

APPENDIX A (continued)

AREA	Number of Sessions								
	I			II			III		
	pre-test	1st. post.	2nd. post.	pre-test	1st. post.	2nd. post.	pre-test	1st. post.	2nd. post.
	1	2	3	1	2	2	1	3	2
	1	1	1	1	1	2	1	2	1
	1	1	1	1	2	2	1	1	1
Experimental	1	1	1	1	1	1	1	1	3
	1	2	3	1	3	3	1	1	1
Group	1	1	1	2	2	2	1	2	3
	1	1	1	1	3	3	1	3	3
	1	3	3	1	1	1	1	2	1
	1	1	1	1	2	3	1	1	1
	1	1	1	1	1	1	1	2	2
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	3	3	3
	1	1	1	1	1	1	1	2	1
Control	1	1	1	1	1	1	1	1	1
	1	1	1	1	2	2	1	1	1
Group	1	1	1	1	1	1	2	2	1
	2	2	2	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	2	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1