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AUTHOR Bingham-Newman, A. M.; And Others
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ABSTRACT

This study attempted to develop, implement, and evaluate an experimental preschool education program based on Piaget's theory of cognitive development. A further goal was to examine Piaget's theoretical assumptions and postulated cognitive developmental trends for a 2-year period of the preoperational substage. A total of 48 3- to 5-year-olds participated in the project for the full 2-year period. Half the children attended the experimental Piagetian preschool and half attended a conventional preschool program. Evaluation measures used were the Peabody Picture Vocabulary Test, the RAVEN Coloured Progressive Matrices, and eight representative Piagetian tasks on seriation, classification, transitivity, conservation, measurement, and class inclusion. Normative longitudinal and cross-sectional analyses were used to examine data within the general area of the acquisition of cognitive abilities; within-stage intraindividual performance correspondences, developmental sequences in task performances, experimental/control group comparisons, and sex differences in task performance. The results suggested that although Piagetian theory provided a very workable and stimulating foundation for a preschool curriculum, program effects in this research were overshadowed by the large degree of individual variation in the rate and sequence of cognitive developmental acquisitions in the preoperational stage. (JMB)

LOGICAL OPERATIONS INSTRUCTION IN THE PRESCHOOL

Final Report--Hatch Research Project 142-1769
July 1st, 1971, to August 30th, 1974

A. M. Bingham-Newman, R. A. Saunders, and F. H. Hooper

University of Wisconsin-Madison
Child and Family Studies Program
1270 Linden Drive
Madison, Wisconsin 53706

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PERSONNEL

Year	Classroom	Testing
1971-72:	Wave 1	Wave 1
	Ann M. Bingham-Newman, Lead Teacher	Ruth Saunders, Research Coordinator, R.A.
	Nancy Sheehan, Assistant Teacher, T.A.	Rosie McMahon, Tester
		Virginia Newman, Tester
		Tom Toniolo, Tester
1972-73:	Wave 1	Wave 1 & 2
	Ann M. Bingham-Newman, Lead Teacher	Jane Goldman, Research Coordinator, R.A.
	John DeFrain, Assistant Teacher, R.A.	Rosie McMahon, Tester
	Wave 2	Suellen L., Tester
	Ruth Saunders, Lead Teacher	Mary Fischer, Tester
	Denise Bielby, Assistant Teacher, R.A.	Beverly Nelson, Tester
		Charlotte March, Tester
		Jonna Carson, Tester
1973-74:	Wave 2	Wave 2
	Ruth Saunders, Lead Teacher	Ann M. Bingham-Newman, Research Coordinator, R.A.
	Beth Yelensky, Assistant Teacher, R.A.	Rosie McMahon, Tester
		Jane Noble, Tester
		Mary Fischer, Tester
		Beverly Nelson, Tester

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Abstract

This research represents a direct attempt to integrate developmental theory with the more applied field of education in order to achieve a more thorough understanding of each. The study had two major foci: (1) to develop, implement, and evaluate an experimental preschool education program based on Piaget's theory of cognitive development, and (2) to examine Piaget's theoretical assumptions and postulated cognitive developmental trends for a two-year period of the preoperational substage. Aspects of cross-sectional and longitudinal designs were incorporated into the pretesting and posttesting of two successive and over-lapping waves of experimental and control group populations of preschool children over a period of three years.

A core group of 48 subjects, aged 3-5 years, remained with the project for the full two-year periods desired for each wave. The subjects were evaluated using two standardized measures (Peabody Picture Vocabulary Test and RAVEN Coloured Progressive Matrices) and a representative battery of eight Piagetian tasks. The differences in developmental patterns between the experimental and control groups were examined with tasks in the areas of seriation, classification, transitivity, conservation, measurement, class inclusion, and two matrix tasks (double seriation and cross-classification). Normative longitudinal and cross-sectional analyses were utilized to examine within the general area of the acquisition of cognitive abilities, within-stage intraindividual performance correspondences, developmental sequences in task performances, experimental/control group comparisons, and sex differences in task performance. Of particular concern in this research was the assessment of children's thought processes rather than the accumulation of pass/fail data.

The experimental group attended a program which included a teacher education component and a framework for curriculum decisions guided by nine principles provided by Piagetian theory. It focused on the operations of seriation, classification, number, and spatio-temporal relations in a wide variety of spontaneous, yet integrated, experiences. Integrated experiences, here, refer to what Wohlwill, and Strauss claim lead to optimal development of logical operations--that is, the development of operations in conjunction and collaboration as part of a total structure rather than in isolation. The control group attended a conventional preschool program.

Cross-sectional analyses using the Goodman-Kruskal gamma statistic indicated no outstanding differences between the performances of the experimental and control groups. Longitudinal analyses using the gamma statistic revealed significant gains on several of the Piagetian tasks and subtasks for each group. In general, normative analyses indicated typical performance patterns for three and five year old subjects with a notable degree of individual difference in patterns of performance and absolute level of performance. T-test comparisons of the non-Piagetian measures, pre to posttest, revealed significant gains for all subjects on the PPVT and only for the Wave 2 control group on the Raven CPM.

An analysis of within-stage correspondence, within and across concept domains, indicated a notable lack of synchrony with many individual patterns revealed in both the experimental and the control groups. These results are supportive of previous work of Wohlwill, Flavell, and Turiel which suggests that a high degree of structural mix in response patterns could be expected during the transitional preoperational period. Pretest responses often clustered in the Stage I response category while posttest responses were generally spread across all response categories (i.e., Stages I, II, and III with associated substages). Sex differences were found for the non-Piagetian measures but were notably absent in the Piagetian measures. A time-lag analysis was performed to reveal any evidence of causal linkages from performance on one task at the pretest to another task at the posttest. Very few of these comparisons were statistically significant. However, very different predictability patterns were found for the experimental and the control groups. This factor makes unequivocal inferences about predictability for the present treatment conditions during the preoperational period tenuous.

In conclusion, although Piagetian theory provided a very workable and stimulating foundation for a preschool curriculum, program effects in this research were greatly overshadowed by the large amount of individual variation in the rate and sequence of cognitive developmental acquisitions in the preoperational stage. The almost complete asynchrony evidenced in the development of various operations assuredly brings into question those interpretations of Piagetian theory which depend on synchronous emergence and cohesive, well integrated structures at all stages of development. This research suggests that regardless of how synchronously operations develop in later stages, they follow a more diverse pattern in the preoperational stage.

I. INTRODUCTION

The period of development between ages two to seven or eight years is called the period of preoperational thought by Piaget. There are several aspects representative of preoperational thought which make it difficult for the child to function logically. These idiosyncrasies necessarily determine the types of experiences which can be expected to be beneficial for the preoperational child. Knowledge of the cognitive structures of the young child and of the processes or operations which are the structural underpinnings of the successful grasp of typical subject matter should make possible the formation of a learning environment which is effective in helping to promote the further construction of operational abilities by the child. The development and evaluation of such an environment has been an integral part of this research.

The operational abilities of classification, seriation, measurement, transitivity, and conservation are becoming increasingly organized and operable during the preoperational period. Flavell (1963) characterizes this change from the beginning of the preoperational period to the latter part as a time when rigid, static, and irreversible structures typical in the early part of the period begin to become more flexible, mobile, decentered, and reversible. One of the most striking aspects of preoperational thought is that it is nonreversible. An example of this aspect is that the child does not have the conservation abilities which Piaget states are necessary for logical thought. Conservation may be defined as the ability of an individual to be aware of the invariant properties or attributes of objects or situations despite irrelevant transformations.

Characteristically, the child at the beginning of this period is learning to use language to represent objects and events. Mental symbols enable him to recall things which are not in his immediate environment. He is often misled by the way things appear at any given moment. This centration includes the tendency to focus on only one attribute of an object at one time, e.g., on height without considering width, rather than coordinating the variables. Usually, the variable which the child centers on stands out visually. Because he cannot coordinate more than one variable, he cannot understand the principle of conservation (invariance in the face of irrelevant perceptual change). The child does not yet have the internal system of regulations which can compensate internally for external changes (Furth, 1969). Very often the preoperational child while observing a sequence of change will focus only on a particular state in the transformation rather than on the process itself. Though the preoperational child may realize that reversibility of actions is possible, mental actions cannot yet compensate for apparent discrepancies in the perceived information (Ginsburg & Opper, 1969).

The child at this stage is also what Piaget describes as egocentric, finding it difficult to understand that other people may view things differently than he does. He relies on his own immediate perception, ignoring both his own previous perceptions and the varying perceptions of others. This is true in the understanding of the interests, needs, roles, and feelings of others as well. Gradually, the preoperational child becomes less egocentric, can focus on several aspects of a situation or object at once, follows a dynamic process rather than a static state, and is able to reverse the direction of his thinking. At this point, he begins to form organized and integrated systems of operations with which he can deal with the world.

The present research examines the development of these systems. Of primary consideration was what kinds of experiences are important for cognitive growth and in what manner does experience in a program derived from Piagetian theory affect the changes in the reasoning processes of the preoperational child.[2] The program which was developed, implemented, and evaluated for this research was guided by several principles provided within Piagetian theory. It focused on the operations of seriation, classification, number, and spatio-temporal relations in a wide variety of spontaneous, yet integrated, experiences. Emphasis was placed on critical thinking, in the sense of simple and reflective abstraction, alternative ways of problem solving, individual initiation of learning experiences, intellectual honesty, and appropriate, empathetic social interaction with peers and adults. The use of an integrated curriculum framework implies that the optimal development of logical operations is considered to occur when operations are developing in conjunction and collaboration with all other operations as part of a total structure rather than in isolation (Strauss, 1972; Wohlwill, 1970). With this approach, spontaneous experiences, initiated by the child in an environment of a variety of alternative activities, are considered more appropriate for fostering cognitive development than the very specific, teacher directed activities utilized in some programs. Piaget maintains that the child must actively construct his own knowledge and that good pedagogy must involve presenting the child with situations in which he can experiment in the broadest sense of the term. Therefore, one alternative to the 'American question' would be to help the child establish the processes or intellectual tools underlying cognitive functioning across a wide range of situations, thus, in this manner, expanding the child's intellectual potential.[3]

Nearly eighty preschool children, age 3 to 5 years, participated in this research project which extended over a period of three years. Half of the children took part in the experimental Piagetian program, while the others attended a conventional preschool program in the community. A longitudinal pretest-posttest assessment design over a period of two years was employed to determine cognitive developmental trends and the differential effects of the two preschool settings on children's performances as measured by two standardized non-Piagetian measures and a battery of Piagetian tasks.

Various types of analyses were carried out on the summative evaluation data to determine normative developmental trends for three and five year old children and cross sectional and longitudinal patterns in responses on Piagetian and non-Piagetian measures. When a child performs on a Piagetian task battery, his performance is interpreted as being indicative of the structure of his mental operations and, thus, indicative of a certain stage of development. In addition to summative evaluation, the Piagetian derived curriculum made use of formative evaluation strategies throughout the three years of the project. This was of significant concern due to an emphasis on educational innovation and imaginative thinking, continued improvement of the curriculum and teaching methods, and continued adjustment of the curriculum to the changing needs of the children and teachers.

Specifically, the present study provides information on cognitive developmental changes occurring during a two year period of the preoperational substage for two groups of children aged three to five years. In addition, assessment was made of the effectiveness of a comprehensive Piagetian preschool program. During the three years of the present research project the following accomplishments were implemented:

1. A coded card file of approximately 200 specific small group activities, which were designed to enhance the child's development of thinking processes in the areas of classification, seriation, number, space, time, measurement, and representation has been produced.
2. A list of approximately 200 conversation topics designed to

challenge young children's thinking has been completed.

3. A set of 55 weeks of daily curriculum plans covering a two year period has been completed and implemented for each of two successive waves of subjects.
4. A teacher education program for teachers who will be working in a Piagetian classroom has been designed and used. This includes:
   a) An intensive 2-3 week workshop for graduate or undergraduate credit.
   b) A 2 semester seminar course for graduate or undergraduate credit intended to be given in conjunction with practical experience.
   c) A program for the practicum with discussion topics, observation assignments, self-development goals, and provision for various kinds of evaluation.
5. Various materials dealing with methods and techniques implied by the theory for teaching were developed to supplement text material.
6. A battery of tasks designed to evaluate the developmental changes associated with the Piagetian curriculum was developed and refined.
7. A procedure to train testers to administer and score the task battery was designed and implemented.
8. An analysis of data for 2 successive waves of children has been completed for experimental and control groups. Each wave remained in the program for 2 years.

II. PREOPERATIONAL CHARACTERISTICS OF MENTAL OPERATIONS

The operational abilities with which the present study is primarily concerned are seriation, classification, transitivity, double seriation, measurement and conservation. Within each ability there is a characteristic pattern of development of acquisition which can aid the educator in organizing and interpreting experiences for young children.

Seriation--the ability to arrange elements in an ordered series according to changes along a particular dimension, such as size, color, weight, is one of the operations which develops during the preoperational period. The typical order of development in seriation as defined by Piaget (1952) is: first, the child arranges the items into groups of two or three but cannot coordinate all of the items into a single series. It seems at this point that the child has only a global impression of a series of items. Next, the child, by trial and error, arranges and rearranges the items until they are in a single series but cannot insert a second set of items into the original series; finally, the child approaches the task with a systematic method which consists of placing the smallest item first (or the largest) and then the smallest of those which remain, and so on and can also add items to the original series. The systematic method finally used indicates the child understands that an item can be larger than one other item yet smaller than another which is the essence of seriation and a form of reversibility (Piaget & Inhelder, 19[illegible]). Elkind (1964) replicated Piaget's original seriation experiments and confirmed Piaget's hypothesis of three stages in the development of seriation. Although this study confirms a general sequence of development, it also indicates individual departures from the sequence--especially when task materials are considered. When the child can construct orderings, put two orderings in one-to-one correspondence, and conserve the resulting equivalence he has formed an integrated and comprehensive structure. Siegel (1974) questioned whether there actually is a "preoperational" stage in the development of seriation because in her research she found it necessary to look at such young subjects (age 3 years) before she found the type of responses associated with the preoperational stage.

Classification--An ability to choose criteria and to exhaustively sort objects into mutually exclusive groups is a later preoperational ability. True concrete operations in Inhelder and Piaget's (1964) view of the development of classification abilities, however, make use of the additional understanding of class inclusion relations. Such relations involve quantitative comparisons of subcategories to superordinate categories in a hierarchy. The usual order of developmental acquisition of classification abilities defined by Piaget (see Ginsburg & Opper, 1969) is divided into three stages. Initially the child is unable to coordinate intensivity (similarities among objects) with extensivity (the number of objects sharing the similarity) so that his collections are not true classes but rather "jumbles" of objects lacking a single attribute common to all the members of the collection. Later the child is able to form classes of objects and to create hierarchies but still cannot understand the relationships between parts in the hierarchy. He might arrange a set of blue circles in a group of different colored circles without comprehending that there must of logical necessity be more circles in the set of all circles before him than in the set of blue circles alone. True operational classification ability is said to be present when the child understands both exhaustive criteria-based sorting and class inclusion. The latter according to Brainerd (1973) and Hooper, Sipple, Goldman, and Swinton (1974) appears after the development of conservation abilities and generally in children well into the grade school years. A number of examinations of the parallels between classification and seriation abilities have been made including Lovell, Mitchell, and Everett's (1962) finding of synchrony in the developmental patterns of the two areas. Several others, however, find definite asynchrony. (See Lagatutta, 1970; MacKay, Fraser, & Ross, 1970; Hooper et al., 1974). Differences in findings may be heavily dependent on the specific task formats used. Wohlwill (1968) for example, has found differences in performance when verbal and pictoral presentations are compared. Inhelder and Piaget (1964) have also maintained that the more abstract a presentation is, the more difficult the task becomes for the child.

Cross Classification--The ability to sort objects on two variables simultaneously, cross classification, is frequently assessed with a matrix task in which rows represent one variable (e.g., shape) and columns another (e.g., color). In such tasks the child may be shown a completed block matrix and then asked to reproduce the arrangement shown him when all blocks have been removed. Following the reproduction portion of the task, the transposition problem is presented. In this case, the child must reconstruct a matrix when all of the blocks have been removed and one of the corner blocks has been relocated on the matrix board so as to rotate the arrangement. Theoretically, cross classification ability should emerge in synchrony with class inclusion understandings and both should emerge at about the same time as double seriation abilities (Inhelder & Piaget, 1964). Conflicting findings concerning these relationships have been discussed above. Brainerd (personal communication) has suggested that the colors used in the classification matrix may be considered by some children as a continuous variable along a brightness dimension. It is also possible that some children see the shape distinctions in a similar fashion with the number of corners as the continuous dimension. Individual differences in task perception might account for the lack of consistent findings of either synchrony or asynchrony.

Transitivity--The ability to distinguish that A>B and that B = C leads to another aspect of ordinal relations, namely transitivity. Transitive reasoning allows the child to discern that given these relationships between A and B and between B and C, then the relationship between A and C must be A>C. Piaget, Inhelder, and Szeminska (1960) confirmed that the understanding of serial order is prerequisite to transitive understanding of size relationships. This was further supported by the research of Murray and Youniss (1968). Braine (1959), however, found non-confirming evidence in this regard. Transitivity, in Piagetian literature, is considered to be a measure of inferential reasoning. Piaget hypothesized that the principles of conservation and transitivity develop simultaneously with respect to a given content area. Lovell and Ogilvie (1961) found evidence that transitivity preceded conservation in a study of conservation of weight in the junior school child. Brainerd (1973) and Toniolo and Hooper (1974) also found that the development of transitivity preceded the development of conservation and class inclusion. This is in contrast to the previous finding (Smedslund, 1963) that conservation of length preceded development of transitivity of length. Problems in the relationship of transitivity to other areas of logical thought are compounded by problems in the study of transitivity itself. Smedslund (1965, 1963) and Braine (1959, 1964), for example, carried on a lengthy controversy over the results of Piaget's work in transitivity, finally agreeing that methodologically adequate and more relevant data were needed before conclusions could be drawn.

Double seriation--Inhelder and Piaget (1964) predicted that simple seriation and multiple seriation appear at approximately the same time. Multiplicative seriation may be assessed in a matrix format with series ordered along the horizontal and vertical axes, i.e., two asymmetrical transitive relations (Inhelder & Piaget, 1964). Cross sectional studies of development in this area suggest a sequence of task performance as follows: first, a lack of any true seriation--or graphic alignments which could as easily be classes as series; next, the seriation of one of the two variables and the ignoring of the other or the attempt to seriate both variables but failure because the two seriations are thought of on different planes rather than coordinating them; and, finally, seriation of both variables simultaneously. Mackay, Fraser, and Ross (1970) investigated the development of multiple seriation and multiple classification using a 3 x 3 matrix task and found the multiple classification task to be passed by a larger percentage of young subjects than was the multiple seriation task. The reproduction task was also easier (passed by more subjects at younger ages) than the transposition task. Using cross sectional data and the percentage of subjects passing the task at each age level, Hooper et al (1974) also found evidence to suggest the development of cross classification abilities before the development of double seriation abilities in reproducing a matrix previously seen. In transposing the matrix (reconstructing the matrix when one corner block has been relocated so as to rotate the display), however, the multiple seriation format was easier than the cross classification format.

Conservation--Piaget and Inhelder (1969) point out that at the preoperational level reactions to conservation problems are centered on perceptual or imagined configurations, while at the operatory levels reactions are based on identity or reversibility. Conservation is considered to be the beginning of significantly more complex intellectual activity. This notion of invariance is essential to any kind of measurement in the physical world (Lovell & Ogilvie, 1960). Piaget maintains that conservation ability develops in three distinct stages: first, there is non-conservation in which the child is perceptually oriented; then, a period of transition when the child may conserve at one moment but is apt to lose the idea the next and usually cannot verbally explain the reasoning; and, finally, the child can conserve and support his conclusions verbally. Lovell and Ogilvie (1960) confirmed Piaget's hypothesis of three stages in the development of conservation abilities. Elkind (1961) and Uzgiris (1964) found that conservation of quantity followed Piaget's postulated developmental sequence of mass, weight, and volume. Though the sequence of development seems to be supported, stimulus complexity, stimulus materials, and task format have been identified as influencing the variability of responses in the transitional phase (see also Schwartz & Scholnick, 1970; Murray, 1969; Lovell & Ogilvie, 1961).

Piaget seems to consider the three conservation tasks in the present study, i.e., number, length, and substance, to be of equivalent difficulty (Wohlwill, 1971). Brainerd and Brainerd (1972) found the familiar number then quantity conservation sequence to be much less apparent when explanations were employed than when only judgments were employed. Wohlwill, Devoe, and Fusaro (1971) hypothesized that conservation abilities might be the by-product of spontaneous overt activities in which children are relating stimuli to each other along a particular dimension. They felt that this type of activity was common in the course of everyday life.

Measurement--The ability of the child to compare items along a particular dimension, e.g., height, length, area, involves measurement. Wohlwill et al. (1971) labels this process dimensionalization and states that once children develop ways of relating items in this way they may be expected to incidentally recognize the conservation property as it applies to those items. Wohlwill et al., (1969) did in fact find evidence that early success on measurement tasks was related to later success in conservation tasks. Measurement operations are referred to as "infra-logical" (Inhelder & Piaget, 1969) because they relate to a spatio-temporal level of reality, that is, continuous objects, separations, and proximities. Measurement involves the recognition of the constancy or standardization of the unit as it is applied successively to the whole without overlapping.

III. DESCRIPTION OF PRESCHOOL PROGRAMS AND TEACHER EDUCATION COMPONENT

A. Piagetian Preschool Education Program

The Piagetian Program was guided by general principles drawn from Piaget's theory of intellectual development. Implications from these principles provided a solid foundation for program goals and implementation. The following principles furnished the framework for the Piagetian preschool education program (PPEP).

1. More than the mere accumulation of facts, intelligence is the incorporation of the given data of experiences into an organized framework. It involves the individual's ability to organize and adapt through the reciprocal processes of assimilation and accommodation to various aspects of the environment.

2. Intelligence is developed through interaction between the environment and the organism. Timing and quality in an environment are important factors for an evolving intellect.

3. Growth of intelligence enhances functioning in all areas of psychological development, including affective, cognitive, and psychomotor development.

4. Learning is an active process, subordinate to development, which involves manipulative and exploratory interaction with the environment in the search for alternative actions and properties applicable to objects and events. This involves both mental and physical activity.

5. Each stage in the development of intelligence is characterized by the presence or absence of specific cognitive operations--children think about the world very differently than adults. They make different interpretations and draw different conclusions from given events than adults do.

6. There is an invariant sequence of development through the major periods of cognitive growth: sensori-motor, preoperational, concrete oper-

ational and formal-operations and the within stage sub-sequences associated with the various concept domains. Each individual moves through the sequence at his own pace.

7. Language helps to focus on concepts and to retrieve them. It does not, in itself build concepts.

8. Intellectual growth is fostered by social interaction with peers and adults as well as by interaction with the physical environment.

9. Autonomy with cooperation, rather than simple obedience to authority, contributes to the child's intellectual and moral development.

In defining goals for the Piagetian Preschool Education Program (PPEP) emphasis was placed on the development of intelligence. However, as implied in principle three, it is equally important to emphasize the rapproachment between the cognitive, affective, and perceptual-motor domains of behavior. Cognitive functioning in a particular situation is necessarily subject to one's emotional and physical condition. Likewise, one's ability to deal with emotional and physical aspects of a situation depends on one's intellectual capabilities. The same is true throughout the course of development--the influences are reciprocal. Therefore, emotional and physical development are major concerns in the program and the PPEP goals apply to all three domains.

The long-range goals for teachers and children in the PPEP was directed towards facilitating the development of a particular kind of individual. Desirable characteristics of children and adults are the same, though the expression of those characteristics will differ. The program endeavors to help develop:

1. An individual who relates intellectually, flexibly, and creatively to his environment.

2. An individual who looks for alternative ways of solving problems.
3. An individual who is able to initiate his own learning experiences by exploring, experimenting, and asking questions.
4. An individual who has confidence in himself.
5. An individual who is a critical thinker who does not accept the first answer given as the only answer or the right answer without checking it out (see Piaget, 1964, p. 5).
6. An individual who interacts empathetically and appropriately with peers and other age groups.

To help the child relate to his environment the PPEP focused on four content areas: logico-mathematical knowledge, infra-logical knowledge, knowledge of the physical environment, and knowledge of the social environment. It should be noted that while these types of knowledge can be viewed as distinctively independent, they are developing for any child in conjunction and collaboration with each other. Short-term goals or guidelines within the content areas were incorporated into a wide variety of experiences utilizing many types of materials. It must be emphasized that these goals are stated as general goals for preschool children in the cognitive areas outlined by Piagetian theory. They were used as guidelines for the program, not as endpoints or behavioral objectives for each child's preschool experience. They define a range of expectations for preschool children without imposing group goals on any individual child. The guidelines were flexible and individualized depending on situational variables, such as, materials, space, time, number of children involved, developmental level of child's interactions, and interests of the child.

The short-term guidelines within each content area are:

1. Logico-mathematical knowledge--knowledge of relationships between and among objects, people, and events in the environment. This

is the type of knowledge which must be reinvented in each child's thinking through the child's own actions and logic. Mobility of thought is an important aspect within the area of logico-mathematical knowledge.

Classification--ability to:

a. choose criteria for grouping
b. group objects, ideas, people, events, etc.
c. sort objects, ideas, people, events, etc.
d. rearrange systems for grouping (horizontal reclassification)

Seriation--ability to:

a. recognize relative differences among two or more things
b. order five or more objects in a consistent manner

Number--ability to:

a. equate equal numbers of objects (cardination with 5 or more objects)
b. recognize that four is greater than three is greater than two, etc. (ordination)
c. place five or more objects in one-to-one correspondence (spontaneous)
d. conserve number with 5 or more objects

2. <u>Infralogical knowledge</u>--abstract, logical operations and related measurement abilities dealing with the concrete, physical world of positions, locations, distance, and time sequences and durations.

Space and time--ability to:

a. maintain direction and consistent sequence in copying a linear order of five or more objects

b. take a perspective in establishing a straight line between two points

c. note the difference in viewpoints from different positions in space

d. recognize part-whole relationships in terms of spatial configurations

e. understand time relationships in four or more sequential events

f. differentiate time intervals

3. Physical knowledge--attributes and properties of materials in the environment discovered through repeated encounters with the natural environment. This includes physical phenomena such as causality and gravity. Physical knowledge is acquired through acting on objects and noting the effects. Short-term guidelines for this area include the ability to:

   a. be active both mentally and physically, which expands the repertoire of possible actions and increases the information obtained from possible responses

   b. ask questions

   c. predict outcomes

   d. make use of one action for a variety of solutions and make use of a variety of actions for one solution

4. Social knowledge--cultural use of language and social expectations and conventions which are learned through feedback from people in the environment. The major goal of this content area is for children to recognize appropriate social behavior and to move away from egocentrism towards an empathetic relationship with others.

Short-term goals for teachers are described in depth in Saunders (1974, in preparation).

The daily schedule for the PPEP followed a typical two and a half hour nursery school timetable which included: arrival and free play (60 min), clean up and bathrooming (15 min), juice time (15 min), large group meeting (20 min), small group activity (15 min), and outside play (25-30 min). The sequencing of the components of the schedule was changed from time to time to provide variety and increase effectiveness.

Free play--During free play time the classroom was arranged into interest areas where children were free to choose from a variety of activities and materials planned and set out by the teachers, or to initiate or request activities or materials for their own ideas. The interest centers consisted of art, music, science and animals, children's literature and book making, large motor activities, dramatic play, and small manipulative activities. In this regard, and others, the PPEP was similar to an open classroom. However, in the PPEP events could be interpreted and dealt with in terms of the theoretical framework of principles and goals which greatly aided teachers' understandings of what occurred in the classroom. The outdoors was utilized as an extension of the classroom. After children become familiar with the surroundings, inside-outside days were common in which children and teachers used both areas throughout the day.

Most of the free play activities were planned a week ahead of time by student teachers involved in the PPEP. (See Appendix C for two samples of weekly planning.) While some activities were long-term projects lasting for a week or more, most areas of the classroom changed activities every few days. Great effort was made to integrate learnings possible in one area with those possible in other areas. Art experiences using play dough, for example, could carry over to a bakery set-up in the dramatic play area and to a science experience in mixing ingredients or the effects of heat on the dough. Blocks could be used in classification, seriation, and spatio-temporal understanding as the child gathers the number of various sized blocks he needs in solving spatial problems in his construction. Children were encouraged to work together to discover the physical knowledge inherent in the environment. During the day, some children would spend the entire free play period engrossed in one activity, while others would partake of many activities. Leaving an area in some semblance of order before moving on was the only criterion imposed on a child's decision that he was through with a particular project for that day.

In planning activities for the interest areas of the classroom, everything in the environment was viewed as a resource for knowledge. Planning consisted of a combination of written plans and extensive discussion by the teachers. It included thinking through possible responses by the children to the activities. By being aware of what possibilities each activity held in terms of the theoretically derived framework of principles and goals, the teachers were prepared to respond to a variety of reactions on the part of the children. The teacher's main task was to be continually aware of the theoretical implications of the child's actions and interpretations of events in order to ask open-ended types of questions. This approach would allow the children to extend their activities and their thinking and reasoning capabilities; in short, to create and use spontaneous situations for learning. Teachers were prepared to pursue different avenues of learning as they were indicated by the actions of individual children within a particular activity. Each activity was viewed as having potential for learning in any of the four areas of knowledge.

The program required that the teachers ask open-ended questions since the theoretical framework maintained that because the children were at varying stages of development, there were no right or wrong answers. Rather, there were alternatives. S. Papert (as quoted in Kamii & Peper, 1969), one of Piaget's colleagues, stated, "the child because of his egocentric view of the world always answers correctly the question he asks himself." Differences in answers and styles of problem solving in the physical environment and in personal interactions were treated as highly valuable deviations.

In order to learn about the child's processes of thinking and his stage of development, teachers encouraged the child to give the answers he viewed as correct. If the child's answers were absurd to an adult viewpoint, situations were created in which the child could explore and discover the answer from various alternatives, that is, from objects and events which did not permit the same conclusions. The child was therefore constructing his own knowledge and confident of his own views.

The classroom was viewed as a workshop with a variety of materials and activities for children and teachers. Teaching and learning were viewed as shared processes. The schedule of the day, the areas of the classroom, and the activities which were planned were always flexible and open to spontaneous ideas. However, exposure of children to materials was not considered sufficient. It was the teacher's responsibility to lead

> ...the children to an increasingly clearer understanding of connectives, similarities and differences, the movement of experiences through time, cause and effect relationships, and, as they matured in their intellectual capacities, the relationships between evidence and proof, between behavior and motivation, between facts and opinion. By helping the child penetrate experiences, concrete and abstract, to the level of relationships, the [teachers were] preparing children to order and deal with their world in terms of their society's logic and perception of reality. [Biber, 1972, as cited by Diamond, 1973, p. 3]

In creating this type of environment, two forces were considered to be important: (1) the effect of each child's uniqueness on his learnings and (2) the contributions of each teacher as an individual in influencing the nature and direction of learning. What is done by the teacher and the child cannot be separated from who does it. By using the theoretical framework and planned activities as a guide both teachers and children were freed from an imposed curriculum which did not fit the situation or the persons involved.

Clean up time--The potential for learning experiences was considered to be high during clean up time. Children were encouraged to work together in cleaning up an area which increased the possibility for peer teaching.

The opportunities for using clean up time to help children use the cognitive processes focused on the PPEP were many. Classification of materials, e.g., blocks, dolls, dress up clothes, art materials, or scissors, is important for effective storage. Seriation is an important process which helps a child when he is putting the biggest things in one place, the smallest in another, and the medium-sized ones in a third place. Spatial reasoning is needed to find the particular size which fits a given space or to know that something will not fit a chosen space. Measurement can be involved in determining which thing will fit a particular space. Having each child find five things to put away and then five more was a favorite way to accomplish clean up. Sometimes children show the beginnings of conservation processes during this type of clean up time. For instance, one child noticed that he had put five unit blocks in one pile and five in another but one pile was taller than the other Teachers participated in clean up time both in physically picking up with children and by taking opportunities to strengthen processes. For example, in the above example a teacher might have said to the child, "How could we be sure there are five in each pile?"

Juice time--The juice time lasted about fifteen minutes during which teachers and children had a snack and engaged in conversation. Topics of conversation were planned each week for teachers to use at their discretion. (See Appendix C for a sample of juice time topics.) With the cognitive processes clearly in mind, teachers had the freedom needed to take advantage of the particular interests of their group at a given time. Children and teachers were free to sit at whichever juice table they desired and combinations of children, as well as of children and teachers, varied from day to day. Often conversation topics focused on typical egocentric thinking and reasoning of young children and were, thus, a type of formative evaluation. For instance, one such topic would be--"If you were sitting in _______ chair, what could you see?" Sometimes the conversation topics were thinking games in which children used their imaginations or needed to make a decision, e.g., "If I could be an animal, I would be a _______." or "If I were as tiny as an ant I would _______." No child was required to partake in these conversations but usually everyone did. After a time children would initiate the games themselves.

In addition, juice time posed other opportunities for highlighting cognitive processes. One-to-one correspondence occurred when children passed out one cup for each person or when each person had a chair. Physical knowledge could be acquired from actions performed on food. Biting a carrot stick is very different than biting a marshmallow. The addition of straws requires a different action than drinking from a cup. Cookies break into distinct pieces while a muffin crumbles. The possibilities for using juice time as a learning experience are innumerable.

Large group meetings--Large group meetings were used as a time for children and adults to develop a community feeling. Children and teachers would sit together on a large rug or outside. Sometimes plans for an upcoming trip were reviewed in story form, or teachers told stories which needed children's ideas or responses to be complete. At other times, a problem would be discussed which affected the whole group, or the day's activities would be reviewed and shared. Movies and tape recorders were incorporated to add different dimensions. Songs, movement, and games were common large group activities. Sometimes when a project had been started during free play which required extra attention, a small group would split off from the larger group to finish it or the large group would be called upon to help, such as, when everyone was needed to help knead the bread dough. The large group meeting gave everyone an additional awareness of being part of a total group. All children were encouraged to join and remain in the group but it was not necessary to participate in whatever activity was occurring.

Small group activities--Small group activities were planned by the lead teachers and the researchers. For this time, the children were divided into four groups of five children each with one teacher assigned to each group. The groups were arranged so that each was made up of children who could compatibly work together. When teachers sensed that a group was not the most beneficial to the children involved, the groupings were rearranged. The same teacher remained with a particular group of children for a semester. Four small group activities were chosen each week and rotated from group to group over the four weekly sessions. This allowed all teachers and all children to try out each activity.

During the small group time, each group found a quiet corner of its own to work in. Teachers were encouraged to stress that this was a work time as well as their special time to be together. Each group was encouraged to make their particular location uniquely theirs with pictures or whatever. The small group activities focused on the specific cognitive processes of seriation, classification, number, measurement, space, time, and representation. The number of small group activities which were done in each process area is located in Table 1. Based on a particular group of children's interests and needs, a teacher would revise or even discard the activity assigned for a particular day. A card catalog of over 200 small group activities was devised over the two year period. (Samples of small group cards are included in Appendix C.) The activities were used

TABLE 1

Summary of PPEP Small Group Activities by Process: Wave 1 and Wave 2.

	Wave 1 (P_1)		Wave 2 (P_2)	
	Year 1	Year 2	Year 1	Year 2
Classification	52	45	38	33
Seriation	24	17	21	7
Number	7	18	11	15
Space-Time	25	17	37	26
Measurement	0	5	0	6
Representation	4	3	12	14
Total	112	105	119	101

as a device for teachers to formatively evaluate children's responses to various activities in terms of the four areas of knowledge. Teachers also learned from the small group time to understand and be more aware of thinking processes in other parts of the day. To follow an activity as it was written was not the most important factor. More important was to use the written activity as an idea or starting point and to fit the activity to the particular children's interests and levels of development.

Children were required to go with their group at small group time but were not required to participate. Usually, when a child initially showed disinterest, it took only a few minutes for him to begin to participate on his own. It was more important for the group to be together enjoying what they were doing than for them to do the activity exactly as assigned for that day. Because the teachers were aware of the theoretical framework they could abandon the activity and still turn other activities into similar learning situations. Very often the time was used by the groups in very individual ways, i.e., going for walks and classifying findings, getting the snacks ready, or reading a favorite book a chapter per day.

Outside--The outside area was a modified Adventure Playground suited to the needs of young children. "Junk", such as old tires, boards, crates, ropes, rocks, cable spools, boxes and blankets, etc. were gathered by teachers for children to use in constructing their own climbing equipment, enclosures, or buildings. This facilitated the child's use of his own ideas since he was involved in the total process rather than just the end product of "a playground". Mental and physical involvement was also encouraged because teachers had not already molded the idea of a type of play for a specific piece of equipment. The natural elements of sand, water, fire, and mud were important aspects of the playground. One of the most popular areas was a digging hole with boards lining the edges and bridging the mud which child could stand on while they were digging. Other additions which particularly lent themselves to a variety of uses were a microscope, hammers, nails, and boards; cable spools, and hammocks. Children were able to classify items by using the microscope, or use spatio-temporal reasoning in building "houses" for themselves. A "house" for two or three children was different than a "house" for one child and teachers were alert to pick up on opportunities to query children about these differences. Construction of enclosures also provided many opportunities for planning, problem-solving, and predicting outcomes.

For further information on the implications of the theoretical principles for daily classroom activities, see Bingham-Newman, 1974.

Formative evaluation--was a continuous component of PPEP and it had a variety of forms. Anecdotal records were kept by teachers during the day and after the children left. Small pads of paper and pencils were placed in strategic places around the rooms to aid the teachers in remembering pertinent facts. Parents were kept informed of weekly plans and activities and were encouraged to provide anecdotes from experiences outside of school. Each day one of the teachers would spend two hours observing particular children or activities in an effort to increase observational skills and provide feedback on teacher-child interactions. Approximately one hour of daily discussion was held by the team of teachers after children left for the day. This was for the purpose of sharing experiences and observations of each day. Activities were evaluated in terms of the materials used, the child's and teacher's responses to the activity and in terms of adherence to the theoretical framework.

At various points each year, records were kept in(the manner of the British infant schools)on which children participated in which activities. This aided teachers' perceptions and evaluations of individual children. Finally, evaluations were made daily of small group activities. Each teacher filled out a card for the activity done with the children in her group. This indicated what each child's response to that activity was in terms of several broad goals for the particular process area used. (See Appendix C for an example.) These evaluations were filed with the activity card itself and were utilized in planning future activities and in evaluating a specific child's level of development. Activities which were particularly enjoyable for children and teachers were often reused with modifications in materials or provision for use of additional processes.

B. Conventional Nursery School Program

The control group of subjects for the present study attended a conventional nursery school program (CNSP). Though it used many of the same activities as were used in the PPEP, the way they were used and the reason for using them were rather different. The most significant difference was that the CNSP was not utilizing a Piagetian theoretical framework but rather an eclectic approach which could not be attributed to a particular theory. This meant that teachers planned activities, responded to children, and evaluated children's responses from a different perspective. The aims and goals of the CNSP are primarily concerned with social and physical development. While the PPEP stressed underlying cognitive processes, the CNSP teachers focused on performance skills and concepts which were thought necessary for future school experience, e.g., numbers, letters, colors, shapes, opposites, etc.

The classroom was arranged in the same interest areas as the PPEP, including art, music, dramatic play, nature, large motor, and small manipulative activities. While a new art activity was planned daily, the other areas were not changed as often as in the PPEP. Teachers in the CNSP were likely to plan activities for good socioemotional growth or intellectual skill building rather than viewing the two as interdependent. Opportunities for self-expression and sensory experience were other reasons for planning particular activities. For instance, block building would be included because children like blocks, can pretend with them, can move them around easily rather than viewing blocks also as being excellent materials for classification, seriation, or spatial reasoning. Children were expected to learn through play about the world around them, to work with others, to communicate meaningfully, and to think of school as a pleasant place to be. Greater physical competence, companionship with peers, increased independence, inner control and self-confidence were other goals. Teachers set limits and determined when subject matter, activities and equipment was introduced and available. While the PPEP used similar activities, the theoretical basis added depth and a clearer perspective to teachers' understandings of the value of the activities for young children.

The daily schedule followed by the CNSP was very similar to that used in the PPEP; however, the CNSP did not have a small group time. Here again, while the schedule was the same on the surface, interpretations of procedures differed. Large group times in the CNSP were viewed as an opportunity for teachers to focus mainly on concept learning or for story telling. During the free play period, teachers assumed more of an authority role in the classroom, and children often looked to teachers for help or for answers rather than working autonomously. The teacher's role included facilitating children's interaction, providing materials, helping solve problems, and setting limits. Teachers were also ready to correct wrong answers or misconceptions which children might display. Interactions between children were facilitated by teachers so that they would occur with as little conflict as possible. While teachers were not as actively involved in the children's activities as in the PPEP, they did make use of incidental learning in terms of the skills and concepts they wanted children to learn. When teachers were not solving conflicts or helping a child in a custodial way, it was typical for them to observe children's play or prepare materials rather than become involved in the spontaneous activities.

Snack time was used as a relaxing, socializing time. It was an opportunity to have tasting experiences of foods the children were not used to eating. Clean up time was to provide order and give the children a sense of responsibility for their surroundings. Outside play offered a time for large motor skill development in climbing, running, digging, etc.

Planning was done largely by the head teacher. Sometimes a unit theme was used and other times activities were planned in a less structured fashion or to meet the needs of a particular child. Formative evaluation was general and intuitive. Teachers did not spend any appreciable time discussing children's responses or progress. Summative evaluation was not a part of the regular on-going program and occurred only for children included in the present study.

C. The Teacher Education Program for PPEP[4]

The researchers feel that the Piagetian curriculum framework is only as good as the teachers who implement it. It requires teachers knowledgeable in Piagetian theory and the implications of the theory for working with preschool children. The comprehensive teacher education program which was developed in conjunction with the curriculum framework involved summer workshops, seminars on Piagetian theory, and practical work with the program. Four areas of knowledge and skill were considered necessary for a teacher to be able to function optimally in a Piagetian classroom. These were: (1) Knowledge of Piagetian theory of development; (2) Skills in observing children's behavior and making useful inferences; (3) Knowledge and skill in planning appropriate activities for children; and (4) Interaction skills. It was not possible within the scope of this paper to completely delineate the four areas of knowledge and skill the researchers deemed necessary. The following outline will indicate in a general manner the content of these areas[5]:

I. Knowledge of Piagetian developmental theory

   A. Goals

      1. Know general principles of development

      2. Know sequence of stages

      3. Know characteristics of stage related abilities in processes of classification, seriation, space, time, number, and representation

      4. Know implications of the theory for teaching

         a. Conceptual differences between the terms "theory", "method", and "techniques"

         b. Activities and physical environment

         c. Teacher role behavior

         d. Peer interaction

   B. How to attain goals

      1. Reading

      2. Discussion

3. Films

4. Lectures and demonstrations

5. Workshops

II. Skills in observation and inference

A. Goals

1. Develop habits of hypothesis testing

2. Distinguish between observation and inference

3. Focus on those elements of a child's behavior which have relevance to Piagetian theory

4. Act on basis of accurate observation and inference

B. How to attain goals

1. Observation assignments in natural setting

2. Discussion of observations

3. Observation "games"--mystery boxes, still life, inference board, "following directions" drawing

4. Observation of video tapes--to get conflicting inferences

5. Observation of films--with and without sound

III. Knowledge and skills in planning appropriate activities for children

A. Goals

1. Ability to describe activities and teacher behaviors which would enhance or extend child's development (based on previous observation)

2. Knowledge of possible sequences of activities in accordance with the theory

3. Ability to foresee learning potentials in any given activity

4. Spontaneous curriculum implementation--on-the-spot planning or adjustment and innovation of planned activity to suit needs of the situation and the child. This implies quick analysis of the child's abilities and emotions in terms of theory and appropriate planning.

B. How to attain goals

1. Observation assignments in natural setting
2. Discussion of observations
3. Planning based on observations
4. Curriculum specific equipment centers set up for active participation by student teachers
5. Video tape viewing
6. Films
7. Practical classroom experience using self-devised plans and plans of other persons

IV. Interaction skills (verbal and non-verbal)

A. Goals

1. Recognize and use open ended, thought-provoking questions and answers
2. Recognition of personal values, intellectual honesty and acceptance and encouragement of the same for children
3. Ability to provide cognitive conflict within limits of "the match" (McV. Hunt, 1961)
4. Provide a verbal model for critical thinking (problem solving approach)
5. Stimulate children to interact with peers through arrangement of environment, materials used, schedule of daily activities, and own behaviors

6. Be a co-worker with the child in solving problems
7. Design an environment which stimulates children's maximum involvement with it.
8. Maintain an appropriate social and psychological atmosphere by working with a knowledge of group dynamics

B. How to attain goals

1. Observation of head teacher
2. Discussion
3. Readings
4. Practical experiences with a supervisor
5. Video tapes of self for evaluation
6. Workshops in values, perception and awareness, improvisational drama, and communication skills

The end product of this teacher training course should be a teacher who can integrate theoretical knowledge, skills of observation and analysis, skills of planning, and interaction techniques to provide meaningful experiences for preschool children to meet their immediate developmental needs and to provide for their future growth and development.

IV. EVALUATION[6]

A. Methods and Procedures

1. Experimental Design

This research incorporated combined aspects of cross-sectional and longitudinal designs involving pretesting and posttesting two successive and overlapping groups of experimental and control group populations over a period of three years. The first wave of the samples participated in the research from September 1971 through May 1973 while the second wave participated from September 1972 through May 1974. The subjects were pretested when they entered the program at approximately age three and posttested at approximately age five at the conclusion of the two year period. A summary of the experimental design can be found in Table 2.

2. Subjects

Eighty children were recruited in two waves for this research. Initially, each wave consisted of twenty children in the experimental group and twenty children in the control group. Each group was made up of equal numbers of males and females. The experimental group children were selected randomly from the applications of three year olds for admission to the University of Wisconsin-Madison, Early Childhood Study Center. The control group children were drawn from a conventional preschool in the nearby community. Both programs receive applications from the same population of families. Thus, both groups of children were from professional middle to upper middle class backgrounds and approximately one-half were from graduate student families. Although the control group was

TABLE 2

Experimental Design--Summative Testing Schedule*

Group (Time of Intake)	Time of Testing Fall 1971	Spring 1972	Fall 1972	Spring 1973	Fall 1973	Spring 1974
Wave 1 Fall 1971						
P_1	PPVT Measurement Classification Seriation		Raven	PPVT Raven Measurement Classification Seriation Transitivity Conservation		
C_1	Cognitive Style 1. Kagan MFF 2. WAL/DAL					
Wave 2 Fall 1972						
P_2 C_2			PPVT Raven Measurement Classification Seriation Transitivity Conservation			PPVT Raven Measurement Classification Seriation Transitivity Conservation

* Specific time intervals are given in Tables 5, 6, 7, and 8.

TABLE 3

Description of Experimental and Control Group by Age and Sex

	Wave I											
	PIAGETIAN						CONTROL					
	Boys		Girls		Total		Boys		Girls		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean Age	41.00	59.00	39.25	57.25	40.41	58.41	42.25	60.25	41.25	59.25	41.75	59.75
Range	35-47	53-65	36-42	54-60	35-47	53-65	37-49	55-67	35-48	53-66	35-49	53-67
S. D.	4.69		2.75		4.10		4.99		6.25		5.26	

	Wave II											
	PIAGETIAN						CONTROL					
	Boys		Girls		Total		Boys		Girls		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean Age	41.20	59.20	40.25	58.25	40.78	58.78	38.33	56.33	43.75	61.75	40.50	58.50
Range	38-46	56-64	34-45	52-63	34-46	52-64	36-43	54-61	41-45	59-63	36-45	54-63
S. D.	2.74		3.57		3.08		2.50		1.89		3.54	

TABLE 4

Summary of Sample Attrition Across Duration of Three Year Project

	Wave 1				Wave 2			
	P_1		C_1		P_2		C_2	
Year	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1971	10	10	10	10				
1972					11	11	9	9
1973	8	4	4	4				
1974					10	8	6	4

exclusively Caucasian, the experimental group was ethnically mixed. Sample attrition in both groups generally occurred for three reasons--the need for day care, families moved out of town, and a few older subjects went to kindergarten. The final sample size for subjects who remained for the two year period was 48 children of which there were 18 males and 12 females in the experimental group and 10 males and 8 females in the control group. It is this group of children, henceforth to be referred to as the core group, with which this research summary is primarily concerned. Descriptive information on the subject sample can be found in Tables 3 and 4.

In addition to the fact that each school drew children from approximately the same population, the control school was chosen for the fact that it had an established reputation as being a very good conventional nursery school program with well trained staff.

3. Treatment

The experimental subjects attended the Piagetian Preschool Education Program (PPEP) (described in Chapter 3) four days per week for two and a half hours per day, while the control subjects attended the conventional program five days per week two and a half hours per day. Each program followed the University calendar for holidays and vacations. The teacher-child ratio for each program was one teacher to every five children. This included student teachers as well as regular staff. All the teachers in the experimental classroom took part in intensive courses in Piagetian theory and its application to the classroom concurrently with their work with the experimental children. For a more extensive discussion of the teacher education program, see Saunders (1974) and Burke-Merkle and Saunders and Hooper (1973). The typical daily schedule for both classrooms included active and quiet play, individual and group activities, teacher initiated and child initiated activities, snacks, and outside play. Major differences between the Piagetian program and the conventional nursery school program existed in (1) the use of an explicit theoretical base, (2) guidelines for the child's role in the classroom, (3) guidelines for teacher behaviors, and (4) the use which was made of planning and evaluation (see Chapter 3).

4. Evaluation

The evaluation of the Piagetian-derived program emphasized the assessment of developmental changes in children's thought processes. To a large extent, it will be the individual's reasoning and problem solving abilities which will determine his success in later life. Therefore, included in the evaluation was the assessment of the within-stage growth of the children, the flexibility and applicability of their thinking, as well as the quantitative and qualitative changes in children's thinking across the major developmental stages.

In selecting tasks to be used in evaluating the effectiveness of the experimental program, the concern was with both ethical and conventional research questions. Ethically, it was necessary to make each testing situation a comfortable and interesting experience for the child. This necessitated limiting the amount of testing per child, providing tasks and materials which were appealing to young children, and taking time to establish good tester-child rapport.

Of specific import to this research was (a) assessing cognitive abilities using both Piagetian and non-Piagetian measures, (b) assessing children's thought processes rather than just accumulating pass/fail data, (c) assessing the effects of age, sex, and ability level as defined by PPVT and Raven CPM task performances, (d) assessing the effects of a Piagetian-derived program on these aspects of development, and (e) assessing interrelationships between specific cognitive domains.

Based on these considerations, the following measures were selected for the summative evaluation:

1. The Peabody Picture Vocabulary Test (PPVT)
2. The Raven Colored Progressive Matrices Test (Raven CPM)
3. Five Seriation Tasks (adapted from Burke, 1971)
4. Double Seriation Matrix (Mackay, Fraser, & Ross, 1970)
5. Classification--Dichotomous Sorting Task (adapted from Kamii, 1971, and Kamii & Peper, 1969)
6. Cross Classification Matrix (Mackay, Fraser, & Ross, 1970)
7. Five Measurement Tasks (adapted from Wohlwill, Devoe, & Fusaro, 1971)
8. Transitivity Task (Brainerd, 1972)
9. Three Conservation Tasks--Number (Rothenberg, 1969), Length (adapted from Brainerd, 1972), and Substance (modified from Brainerd, 1972, conservation of weight task)
10. Kagan's Matching Familiar Figures Test (MFF) and WALK-A-LINE/DRAW-A-LINE (Maccoby, 1965)

A descriptive summary of the complete task battery is included in Tables 5, 6, 7, and 8.

The order of administration of all tasks was randomized across subjects. Testing was conducted in eight fifteen-minute sessions

TABLE 5

Descriptive Summary Tables for Complete Test Battery: Pretest Administered to Wave I, 1971-72

Test	Theoretical Range	Average Admin. Time	Dates of Administration		Range		Mean		Testors Subjective Impression
			P_1	C_1	P_1	C_1	P_1	C_1	
PPVT	1-150	15 min.	11/22/71-11/30/71	12/11/71-1/17/72	12-51	38-59	40	48.13	ok
CPM	1-36	15 min.	9/25/72-10/16/72	9/26/72-10/20/72	10-19	10-15	14.83	11.88	ok
CI	III-Has Concept II-Transition I-No Concept		Not Administered	Not Administered					
CC	III-Has Concept IIb-Transition IIa-Transition I-No Concept		Not Administered	Not Administered					
Seri	III-Seriates IIc-Transition IIb-Transition IIa-Transition I-No Concept			1/11/72-1/27/72	III I-IIa-IIb				ok
DS	III-Has Concept IIc-Transition IIb-Transition IIa-Transition I-No Concept		Not Administered	Not Administered					

PPVT = Peabody
CPM = Raven
CI = Class Inclusion
CC = Cross Classification
Seri = Seriation

DS = Double Seriation
Trans = Transitivity
Meas = Measurement
Cons = Conservation
Dicho = Dichotomies

TABLE 5 (Continued)

Test	Theoretical Range	Average Admin. Time	Dates of Administration P_1	Dates of Administration C_1	Range P_1	Range C_1	Mean P_1	Mean C_1	Testers Subjective Impression
Trans	III-Has Concept IIc-Transition IIb-Transition IIa-Transition I-No Concept		Not Administered	Not Administered					
Meas	III-Measures IIc-Transition IIb-Transition IIa-Transition I-No Concept		11/29/71-12/8/71	11/6/72-1/18/72	III I-IIa-IIb	III I-IIa-IIb			Fun
Cons	III-Conserves II-Transition I-No Concept		Not Administered	Not Administered					
Dicho.	III-Classifies IIb-Transition IIa-Transition I-No Concept	15 min.	2/10/72-3/7/72	3/1/72-3/13/72	I-IIa	IIa-IIb-III			ok

PPVT = Peabody
CPM = Raven
CI = Class Inclusion
CC = Cross Classification
Seri = Seriation

DS = Double Seriation
Trans = Transitivity
Meas = Measurement
Cons = Conservation
Dicho = Dichotomies

TABLE 6

Descriptive Summary Tables for Complete Test Battery: Posttest Administered to Wave I, 1973

Test	Theoretical Range	Average Admin. Time	Dates of Administration		Range		Mean		Subjective Impression
			P_1	C_1	P_1	C_1	P_1	C_1	
PPVT	1-150	10 min.	2/13/73-2/19/73	2/19/73-3/2/73	44-62	46-63	53.16	55.87	ok
CPM	1-36	9 min.	2/14/73-2/20/73	2/21/73-3/8/73	8-16	12-22	13.83	14.37	ok
CI	III-Has Concept II-Transition I-No Concept	3 min.	2/28/73-3/20/73	3/5/73-3/28/73					fun
CC	III-Has Concept IIb-Transition IIa-Transition I-No Concept	6 min.	2/28/73-3/20/73	3/5/73-3/28/73					fun
Seri.	III-Seriates IIc-Transition IIb-Transition IIa-Transition I-No Concept	12 min.	3/5/73-3/15/73	3/5/73-3/27/73					frustrating for student and examiner
DS	III-Has Concept IIc-Transition IIb-Transition IIa-Transition I-No Concept	7 min.	3/6/73-3/20/73	3/6/73-3/28/73					fun

PPVT = Peabody
CPM = Raven
CI = Class Inclusion
CC = Cross Classification
Seri = Seriation

DS = Double Seriation
Trans = Transitivity
Meas = Measurement
Cons = Conservation
Dicho = Dichotomies

TABLE 6 (Continued)

Test	Theoretical Range	Average Admin. Time	Dates of Administration		Range		Mean		Subjective Impression
			P_1	C_1	P_1	C_1	P_1	C_1	
Trans	III-Has Concept IIc-Transition IIb-Transition IIa-Transition I-No Concept	3 min.	3/6/73-3/20/73	3/6/73-3/28/73					ok
Meas	III-Measures IIc-Transition IIb-Transition IIa-Transition I-No Concept	6 min.	2/19/73-3/20/73	2/26/73-3/29/73					ok
Cons	III-Conserves II-Transition I-No Concept	10 min.	2/21/73-3/1/73 3/12/73-3/20/73	3/2/73-3/29/73					Frustrating at times
Dicho	III-Classifies IIb-Transition IIa-Transition I-No Concept	12 min.	2/22/73-3/19/73	2/26/73-3/27/73					ok

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TABLE 7

Descriptive Summary Tables for Complete Test Battery: Pretest Administered to Wave II, 1972

Test	Theoretical Range	Average Admin. Time	Dates of Administration		Range		Mean		Subjective Impression
			P_2	C_2	P_2	C_2	P_2	C_2	
PPVT	1-150 1-150	15 min.	9/20/73-10/22/72	9/22/72-10/26/72	12-68	20-56	40.44	44.10	ok
CPM	1-36 1-36	15 min.	9/25/72-10/24/72	9/29/72-11/2/72	4-16	4-14	10.28	9.60	Long & tedious; frustrating for children & examiner
CI	III-Has Concept II-Transition I-No Concept	3 min.	10/18/72-12/3/72	10/23/72-11/20/72	I-II-III	I-II-III			Children enjoyed
CC	III-Has Concept IIb-Transition IIa-Transition I-No Concept	5 min.	10/18/72-12/5/72	10/23/72-11/20/72	III I-IIa-IIb	I-IIb-III			Fun for children. They enjoyed blocks
Seri	III-Seriates IIc-Transition IIb-Transition IIa-Transition I-No Concept	12 min.	10/17/72-12/6/72	10/2/72-11/20/72	III I-IIa-IIb	IIc-III I-IIa-IIb			Frustrating for child and examiner.
DS	III-Has Concept IIc-Transition IIb-Transition IIa-Transition I-No Concept	5 min.	10/31/72-12/6/72	11/2/72-11/29/72	I-IIa-IIb	III I-IIa-IIb			Fun for both examiner and child.

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Cons. = Conservation
Dicho. = Dichotomies

TABLE 7 (Continued)

Test	Theoretical Range	Average Admin. Time	Dates of Administration		Range		Mean		Subjective Impression
			P_2	C_2	P_2	C_2	P_2	C_2	
Trans	III-Has Concept IIc-Transition IIb-Transition IIa-Transition I-No Concept	3 min.	10/3/72-12/6/72	11/2/72-11/29/72	III I-IIa-IIc	IIc-III I-IIa-IIb			ok
Meas.	III-Measures IIc-Transition IIb-Transition IIa-Transition I-No Concept	8 min.	10/3/72-12/4/72	10/4/72-12/4/72	III I-IIa-IIb	IIc-III I-IIa-IIb			fun
Cons	III-Conserves II-Transition I-No Concept	11 min.	11/6/72-11/22/73	11/7/72-11/29/72	I-II-III	I-II-III			Hard to hold attention
Dicho	III-Classifies IIb-Transition IIa-Transition I-No Concept	15 min.	10/10/72-12/5/72	10/19/72-11/17/72	I-IIa	I-IIa-IIb			Confusing at times

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Seri = Seriation

DS = Double Seriation
Trans. = Transitivity
Meas. = Measurement
Cons. = Conservation
Dicho. = Dichotomies

TABLE 8

Descriptive Summary Tables for Complete Test Battery: Posttest Administered to Wave II, 1974

Test	Theoretical Range	Average Admin. Time	Dates of Administration		Range		Mean		Subjective Impression
			P_2	C_2	P_2	C_2	P_2	C_2	
PPVT	0-150 0-150	9 min.	3/5/74-3/13/74	3/4/74-4/8/74	46-70	46-68	54.44	58.70	ok
CPM	1-36	8 min.	3/12/74-3/22/74	3/7/74-4/8/74	8-20	12-19	13.00	15.80	Post-ok, enjoyed giving to older children
CI	III-Has Concept II-Transition I-No Concept	3 min.	3/20/74-4/11/74	3/14/74-3/21/74	I-II	I-II			Varied media kept interest but some ques. were confusing
CC	III-Has Concept IIb-Transition IIa-Transition I-No Concept	5 min.	3/20/74-4/11/74	3/14/74-3/21/74	III I-IIa-IIb	III I-IIa-IIb			Children enjoyed the blocks
Seri	III-Seriates IIc-Transition IIb-Transition IIa-Transition I-No Concept	11 min.	3/19/74-4/11/74	3/7/74-4/17/74	IIc-III I-IIa-IIb	IIc-III IIa-IIb			Blocks were unique most children kept interest. Ok.
DS	III-Has Concept IIc-Transition IIb-Transition IIa-Transition I-No Concept	6 min.	3/21/74-4/11/74	3/7/74-4/17/74	III I-IIa-IIb	III I-IIa-IIb			Blocks were unique. Enjoyed giving this because children liked it. Fun.

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CPM = Raven
CI = Class Inclusion

CC = Cross Classification
Seri = Seriation
DS = Double Seriation
Trans = Transitivity

Meas = Measurement
Cons = Conservation
Dicho = Dichotomies

TABLE 8 (Continued)

Test	Theoretical Range	Average Admin. Time	Dates of Administration		Range		Mean		Subjective Impression
			P_2	C_2	P_2	C_2	P_2	C_2	
Trans	III-Has Concept IIc-Transition IIb-Transition IIa-Transition I-No Concept	3 min.	3/21/74-4/11/74	3/7/74-4/17/74	I-IIc-III	I-III			ok
Meas	III-Measures IIc-Transition IIb-Transition IIa-Transition I-No Concept	6 min.	3/4/74-4/11/74	3/7/74-4/22/74	IIc-III I-IIa-IIb	I-IIa-III			Interesting for children, attention held by varied media. ok
Cons	III-Conserves II-Transition I-No Concept	10 min.	3/15/74-4/23/74	3/8/74-4/9/74	I-II-III	III I-II			Some ques. were hard for child to understand. Liked play-dough the best
Dicho	III-Classified IIb-Transition IIa-Transition I-No Concept	12 min.	3/14/74-4/11/74	3/12/74-4/18/74	IIb I-IIa	III IIa-IIb			This was fun, and imaginative. I think children enjoyed for the most part. ok

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Trans = Transitivity
Meas = Measurement
Cons = Conservation
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over a period of six weeks for the pretest and for the posttest. The tasks were given in a game-like atmosphere in a room separate from the classroom. Each child received a task approximately every third school day over the testing period. (See Appendix B for a description of materials used, task administration, and scoring procedures for each task.)

5. Testers

Testers were chosen on the basis of their previous experience and their ability to establish rapport and work with young children. Each tester spent approximately 40 hours becoming familiar with the testing procedures and attended at least four group meetings to discuss testing requirements, approach, schedules, equipment, and specific task procedures. Before beginning actual testing, each tester received extensive practice in administering the tasks to both young children and adults, as well as in recording responses. Video tapes of testing sessions with children other than the core group members were used to familiarize testers with possible problems. Each tester was trained to administer all tasks and each worked in all classrooms.[8]

In order to become familiar with the subjects, as well as to help children become familiar with them, testers spent at least three days in each classroom before administering any tasks. During these visits, the testers and children read stories, played games, and explored the testing rooms together before testing began. As a result, the children appeared to be quite at ease in the testing situation and usually talked very freely. At the time of testing, tester-child combinations were usually determined by which tester the child seemed most responsive to on that particular day. Children were not taken to a testing room unless they indicated a readiness to go with a tester. Testers were encouraged to make each child as comfortable as possible.

Because of a semi-clinical orientation to the testing procedure, care was taken to see that the testers understood the purpose of each task so that they could add or delete words, as appropriate, for each individual child, without invalidating the results. During the initial training, each tester became familiar with evaluation guidelines suggested by Kamii (1971). Throughout the year testers met regularly with the researchers. Testers changed for each of the three years of the project necessitating that tester training be repeated yearly. For each testing period there were five testers. The consensus of subjective opinion of teachers, researchers, testers, and parents indicated that children greatly enjoyed the sessions and often requested extra turns.

6. Measures and Scoring

Two standardized measures, The Raven Colored Progressive Matrices Test and the Peabody Picture Vocabulary Test, were given to further characterize the experimental and control samples in terms of normative non-verbal and verbal intelligence respectively. The Raven CPM, devised in 1947, has been widely used with all ages from 6 to over 75 years to assess the capacity for intellectual activity relatively independent of previously acquired knowledge. In it the subject is asked to complete a matrix design with one of six choices shown below the test display. No verbalization is required of the subject and little is needed to explain the task.

Pilot work showed that children as young as three years old were able to understand the instructions. For the preschoolers in this study, the administration was altered slightly so that testing was stopped after three successive errors. It has been our experience that children become restless and inattentive when they find themselves very uncertain of their answers. Each child's responses were recorded whether or not they were correct so that an error analysis could be made in addition to the comparisons of numbers of correct responses. Furthermore, several researchers (Flavell & Wohlwill, 1969, among others) have indicated that the Raven CPM is an appropriate measure of multiple classification ability.

The PPVT was used as a counterpart to the Raven CPM. It is a standardized measure of verbal comprehension (receptive understanding) for young children in which children are asked to point to the one of four pictures which represents the word given by the experimenter. Standard procedure for this test is given in the Peabody Picture Vocabulary Testing Manual (Dunn, 1959).

The scoring procedure for the Piagetian tasks was determined by the interest in qualitative as well as quantitative change. The stage designations which were used are similar to those used for the original Piagetian experiments. For each task, a child who demonstrates no ability to perform a task is in Stage I. A child who is able to perform a task correctly is in Stage III. Stage II is used to designate the child who is clearly in transition at the time the task is administered. For some tasks, different levels of transitional thinking are indicated by the use of IIc, IIb, or IIa. For instance, within Stage II, the child receives more credit (Stage IIb) for demonstrating the correct manipulations of the materials (process) yet giving an incorrect response. The child who gives a correct response but throughout the tasks manipulates the materials inappropriately is given less credit (Stage IIa). (See Appendix B for a complete description of the stage designations employed.)

Classification Task Series

Dichotomous Sorting--The dichotomous sorting task was used to assess the flexibility of thought involved in the ability to sort consistently on a self-chosen criterion and in the ability to change to a new criterion with the same materials. It was adapted from evaluations developed by Kamii (1971) and Kamii and Peper (1969) for use in the Ypsilanti Preschool Project. The task used here involved a free sort of twenty-two blocks followed by three dichotomous sorting tasks in which subjects were asked to sort the same blocks into two boxes. (See Appendix B for a description of materials and task administration procedure.) Three dichotomous sorts were possible on the basis of size, shape, or color. Subjects were given stage scores of II, IIb, IIa, or I.

Cross Classification Matrix--A cross classification matrix taken from Mackay, Fraser, and Ross (1970) was used to assess the presence of early concrete operational abilities. This task involves a matrix of blocks, sorted into rows by shape (triangles, squares, and circles) and by color (yellow, red, and blue). After a warm-up consisting of simple replacement of one, two, and finally three blocks (along the matrix "diagonal"), the child is asked to reproduce the original matrix after all blocks have been removed. An additional task involves the reconstruction of the matrix when the blocks are removed (reproduction) and then one corner block is replaced so as to rotate the matrix by 90 degrees (transposition).

In both instances (simple reproduction and 90° rotation) the purpose is to assess the child's ability to classify on two criteria simultaneously rather than to test accuracy of memory. For this reason matrices were considered correct if whole rows were switched.

The stage designations given for reproduction and transposition were III, IIb, IIa, or I.

Class Inclusion--A class inclusion task was given as a further test of concrete operational ability. It was based on measures used by Brainerd and Kaszor (1974) and Kofsky (1966). The class inclusion task assesses the child's ability to use the complementary processes of joining subclasses to form a superordinate class (A + A') and dividing superordinate classes into constituent parts (B - A'). The subject must realize that combination and division are opposite processes before he is able to make quantitative comparisons of subclasses and larger groups. In the present task, the subject is presented with six male paper dolls and three female paper dolls. After counting the figures, the subject is queried as to whether there are the same number of boys as children; whether there are more boys than children; and whether there are more children than boys. The order of the three questions was randomly varied across all subjects. A brief warm-up (involving paper representations of cookies and the relational terms of "more" and "same") was given to each child before he was presented with the paper dolls.

The stage designations for the class inclusion task were III, II, or I.

Seriation Task Series

Unidimensional Seriation--The seriation tasks were based on protocols and recommended changes discussed by Burke (1971). These protocols were originally based on the work of Coxford (1964), Elkind (1964), and Whiteman (1964). They were included to assess developing abilities in ordering objects on a given dimension, in this case, size. This is an important aspect of operational number abilities. The tasks included in this battery and the range of possible responses by stages were as follows:

(a) absolute seriation--comparison between two sizes--III, II, I

(b) relative seriation--identification of the same object as bigger than one object yet smaller than another--III, IIb, IIa, I

(c) successive seriation--application of relative comparisons in a systematic fashion to a number of objects presented simultaneously--III, IIc, IIb, IIa, I

(d) additive seriation--arranging of objects in sequence and appropriate insertion of more objects into the original sequence--III, IIb, IIa, I

(e) serial correspondence--construction of one-to-one correspondence between two sequences of objects
question 1--III, IIc, IIb, IIa, I
questions 3 and 4 (combined)--III, IIb, IIa, I

Transitivity--The transitivity task was adapted from Brainerd (1972). It concerned the flexibility of the child's reasoning abilities in the area of transitivity of length. The child was asked to respond to a problem of transitive reasoning, e.g., if stick A is longer than stick B, and stick B is equal to stick C, then what is the relationship of stick A to stick C? This task also was used as a correlate indication of seriation, measurement and conservation abilities. It was scored with a Stage III, IIc, IIb, IIa, or I.

Double Seriation--A double seriation matrix based on the work of Mackay, Fraser, and Ross (1970) was used to assess the subject's ability to coordinate simultaneous change on two dimensions. It required the ordering of wooden cylinders on a matrix board according to two dimensions simultaneously, height and width. After a warm-up consisting of simple replacement of one, two, and three cylinders, the subjects were asked to reproduce the original matrix after E removed all the cylinders from the board (reproduction) and to reconstruct the original matrix when all cylinders were removed and one was replaced directly opposite its original position, as if the board had been rotated 90° (transposition). Stage designations were recorded separately for reproduction--III, IIb, IIa, I, and for transposition--III, IIb, IIa, I.

Measurement Task Series

Spontaneous Measurement--These tasks were based on procedures described in Wohlwill, Devoe, and Fusaro (1971). Five tasks were included to reveal the extent to which the child would engage in activities which served a measuring function and as indicators of developing conservation abilities. The task and the possible stage designations for each included:

(a) length comparison--identification of the longer object--III, IIb, IIa, I

(b) distance via reference length--equating two distances using a separate single unit--III, IIb, IIa, I

(c) distance via units--equating two distances with four equal sized units (quantity)--III, IIc, IIb, IIa, I

(d) height via reference length--equating height of different objects by using an item different than the objects themselves--III, IIb, IIa, I

(e) area via units--comparison of figures divided into unequal numbers of equal sized units--III, IIb, IIa, I

Conservation Task Series

Number Conservation--The number conservation task was taken from Rothenberg's (1969) adaptation of Piaget's original format. This task was included to assess the convergence of seriation and classification abilities in the form of operational number abilities. Two parallel rows of chips were spaced equally in the center of the table, making precise perceptual correspondence. One row was then manipulated by E to make it look perceptually different (collapsing it) though it was in fact still equal in number of chips. The child was asked whether the rows had equal number of chips, whether one row had more, and whether one row had less.

Conservation of Length--The conservation of length task, taken from Brainerd (1972), consisted of the similar changing by the experimenter of the configuration of one of two equal lengths of string. The child was then asked whether the two strings were of equal length, whether one was longer, and whether one was shorter.

Conservation of Substance--The conservation of substance task, adapted from Brainerd (1972), involved the deformation by the experimenter of one of two balls of equal amounts of clay into a "pancake" shape. The subject was then asked whether the two pieces had the same amount of clay, whether one had more, and whether one had less.

Each conservation task involved three parts. The first was the prediction of the relation between the two rows, amounts, or lengths if the conditions were changed. The second part involved the same questions posed in the face of actual transformations. The third part consisted of requests for justifications of the response to the questions about the actual transformations. Recording of Stage III responses was done with an -R- for a relevant justification or an -I- for an irrelevant justification so that an analysis could be carried out either with or without the justification response.

7. Modes of Analysis

Due to an emphasis on qualitative data, longitudinal assessment, and associated sample attrition, certain constraints were placed on the statistical analysis. Discrete categorical data for the Piagetian task battery necessitated the use of a nonparametric statistic. Goodman-Kruskal (1954, 1959, 1963) suggested the use of the gamma statistic for ordered data as a measure of the degree of association between multiple variables. Wohlwill (1973b) and Hubert (personal communications, 1973-74) also found this measure pertinent to developmental data of this nature. Intraindividual and interindividual analyses across Time 1 (pretest) and Time 2 (posttest) were carried out. A "change score" analyses as suggested by Wohlwill (1973b) and Wohlwill, Fusaro, and Devoe (1971) was included to ascertain developmental interrelationships between levels of response on one task at Time 1 and another task at Time 2. In principle, this technique is aimed at revealing the direction of causal linkages.

Initially examinations of sampling bias and sex differences were made. Cross-sectional analyses of the experimental and control subjects' pretest responses were carried out to determine subsequent comparability.

B. RESULTS AND DISCUSSION

The purpose of this research was to investigate the cognitive developmental changes occurring during a two year period of the preoperational substage for two groups of children aged three to five years. The research focused on the preoperational abilities in the areas of classification, seriation, double seriation, measurement, transitivity, and conservation. In addition, the differential effects of the variables in two preschool settings and related teacher education programs on the patterns of cognitive developmental change during the two year period were examined. It was hypothesized that the children who participated in the Piagetian Preschool Education Program (PPEP) would, as a by-product of their experience, exhibit overall higher levels of responses on various Piagetian tasks than the control group children who participated in a conventional nursery school program (CNSP). Furthermore, it was hypothesized that all the subjects, because they were within the age range suggested for the preoperational period, would show a relatively high degree of structural mix in their response patterns on both the pretest and posttest. Finally, it was hypothesized that the subjects would indicate a greater degree of developmental convergence within a concept domain than across concept domains.

I. Preliminary Considerations

The first major analysis dealt with whether the experimental groups and the control groups could be considered equivalent prior to their participation in either preschool program. Independent t-tests were carried out on the age variable and on the pretest scores for the standardized non-Piagetian measures, the PPVT and Raven CPM (see Table 24). The t-tests indicated that there were no significant differences on the age variable or on the PPVT scores. The t-test for the Raven CPM pretest scores revealed that the Wave 1 experimental group performed significantly better than the control group ($t = 2.4840$, d.f. 16, $p < .05$).

A comparison was made of the continuing longitudinal sample participants to the children who withdrew from either program prior to completion of two years. This was done in order to establish whether subsequent differences between the groups was due to differential sample attrition. Independent t-testsindicated no significant differences on the age variable, PPVT, or Raven CPM pretest scores (see Table 9). This is in contrast to expected sample attrition effects, and is surprising in view of typical longitudinal research findings (see Rigel, Rigel, & Meier, 1967 and Rigel & Meyer, 1972).

TABLE 9

Comparison of Continuing Longitudinal Sample (CORE) to Dropouts on Age and Two Standardized Measures: Pretest Scores

	Wave 1				Wave 2			
	P_1		C_1		P_2		C_2	
	CORE	Drop-outs	CORE	Drop-outs	CORE	Drop-outs	CORE	Drop-outs
Age								
N	12	8	8	12	18	4	10	7
Mean	40.41	38.87	41.75	43.83	40.78	40.25	40.50	42.43
S.D.	4.10	2.29	5.26	4.78	3.08	3.30	3.54	1.81
t	.9622		.9178		.3066		1.32	
d.f.	18		18		20		15	
PPVT								
N	12	8	8	12	18	4	10	7
Mean	40.00	33.50	48.13	46.42	40.44	40.0	44.10	53.71
S.D.	10.85	13.26	7.75	9.27	12.51	9.13	11.48	8.24
t	1.20		.4634		.0666		1.89	
d.f.	18		18		20		15	
Raven								
N	12	6+	Not Given		18	4	10	7
Mean	14.[illegible]3	13.17			10.28	13.25	9.60	9.57
S.D.	2.98	1.94			2.85	3.77	3.50	4.16
t	1.2353				1.7905		.0153	
d.f.	14				20		15	

Note: All t values are non-significant

+ Because Raven was given at beginning of second year, it was not given to children who had left the previous spring. This includes two dropouts in P_1 and all dropouts for C_1.

2. Primary Considerations

Normative Analyses--Normative data indicating typical age patterns for Piagetian task performances were established by determining the percentages of all subjects' responses, control and experimental groups combined, in each stage response category for each subtask for pretest and posttest administrations (see Appendix A for the complete raw score response by stage designations for each experimental and control group). The subjects were approximately three years old at the time of the pretest and approximately five years old at the time of the posttest. The percentages indicate an overall increase in subjects' responses in the higher response categories on the posttest. Unequal percentages of subjects at Stage III across all subtasks is indicative of differing degrees of difficulty within the task battery. Three measurement subtasks--distance via reference length, distance via units, and area via units, and the double seriation transposition subtask show a notably lower percentage of subjects at the higher stage categories on the posttest (see Tables 10, 11, 12, and 13).

Normative data on the scores for the standardized measures, PPVT and the Raven CPM, for the total group of subjects (N = 48) indicate that higher scores are more evident on the posttest. This would be anticipated from normal developmental change over a two year period. The fact that the lower limits of the range of scores for both tests moved up on the posttest while the upper limit stayed approximately the same (see Table 14) is unusual. A possible cause for this fact is measurement error in the unusually high scores on the pretest.

Cross-Sectional Analyses--Cross-sectional analyses compared the experimental and control group subjects on the pretest and the posttest for each wave. This analysis was carried out using the nonparametric statistic

TABLE 10

Percentages of All Children Tested (N = 48) at Various Stages on the Pretest and Posttest Administrations of the Seriation, Double Seriation, and Transitivity Tasks

		Percent at Stage:					
Task	Subtask	Test	I	IIa	IIb	IIc	III
Seriation	Absolute	Pre	16	--*	4	--	79
		Post	0	--	12	--	87
	Relative	Pre	20	56	14	--	8
		Post	37	33	22	--	6
	Successive	Pre	58	18	20	2	0
		Post	10	10	12	8	58
	Additive	Pre	45	29	18	--	6
		Post	2	27	14	--	56
	Serial Corresp. (1)	Pre**	25	25	21	7	18
		Post	4	10	25	4	56
	Serial Corresp. (3) & (4)	Pre	35	14	45	--	4
		Post	6	18	60	--	14
Double Seriation	Reproduction	Pre	92	3	0	--	3
		Post	25	16	4	--	54
	Transposition	Pre	85	10	3	--	0
		Post	41	14	33	--	10
Transitivity	Transitivity	Pre	42	14	3	25	14
		Post	16	0	0	10	72

* A dash in a Stage II category indicates that that particular division of Stage II was not used for this subtask. Where Stage II was not divided for a subtask, the response is listed under category IIb.

** N = 28, Pretest was not administered to P_1 or C_1. There was one no-response.

TABLE 11

Percentages of All Children Tested at Various Stages on the Pretest and Posttest Administrations of the Dichotomous Sorting, Class Inclusion, and Cross Classification Tasks (N=48).

Task	Subtask	Test	% at Stages: I	IIa	IIb	III
Dichotomous Sorting	---	Pre	43	50	6	0
		Post	2	31	39	27
Class Inclusion	---	Pre*	64	25	**	10
		Post	62	31	--	6
Cross Classification	Reproduction	Pre*	53	32	10	3
		Post	4	50	6	39
	Transposition	Pre*	67	12	10	0
		Post	20	37	18	22

* N = 28, P_1 and C_1 groups were not given the pretest on this task.

** Stage II was not subdivided for this task stage II responses are listed in the IIa column.

TABLE 12

Percentages of All Children Tested (N = 48) at Various Stages on the Pretest and Posttest Administration of the Measurement Task.

Task	Subtask	Test	% at Stage: I	IIa	IIb	IIc	III
Measurement	Length Comparison	Pre	64	8	4	-*	22
		Post	12	8	2	--	77
	Distance via Ref. Length	Pre	95	4	0	--	0
		Post	77	12	6	--	4
	Distance via Units	Pre	91	6	2	0	0
		Post	64	18	10	0	6
	Height via Ref. Length	Pre	18	20	2	--	58
		Post	0	2	4	--	93
	Area via Units	Pre	75	14	6	--	4
		Post	54	20	6	--	18

* A dash in a Stage II Category Indicates that that Particular Division was not used for this Subtask.

TABLE 13

Percentages of All Children Tested at Various Stages on the Pretest (n = 28) and Posttest (n = 48) Administrations of the Conservation Tasks

			% at Stage:		
Task	Subtask	Test	I	II	III
Conservation of Number	Prediction	Pre	85	7	7
		Post	52	18	29
	Deformation	Pre	78	21	0
		Post	68	4	27
Conservation of Length	Prediction	Pre	75	25	0
		Post	64	14	20
	Deformation	Pre	75	25	0
		Post	77	8	14
Conservation of Substance	Prediction	Pre	78	17	3
		Post	58	10	31
	Deformation	Pre	85	3	10
		Post	64	6	29

TABLE 14

Pretest and Posttest Normative Data: Mean, Range, and Standard Deviations on Standardized Non-Piagetian Measures for All Core Group Subjects

Task	Test	Mean	Range	S.D.
Peabody	Pre	42.37	12-68	11.17
	Post	55.25	40-68	6.83
Raven	Pre	11.54	4-19	3.44
	Post	14.02	8-20	3.05

"gamma" (Goodman-Kruskal, 1954, 1959, 1963).[9] It is essential for the reader to realize that gamma is a measure of association which indicates whether it is probable that untied responses would be in the same category on two ordered variables. When responses are in different categories for the two variables, the sign of the gamma value indicates which variable has the responses in a higher category. The significance level for gamma indicates how likely it would be for that pattern to occur by chance alone. In so doing, the significance level takes into consideration the marginal totals, not just the untied cases. For this reason, there can be two gamma values which are equal in strength but only one which is associated with a significant prediction.

Table 15 indicates that there are very few significant differences between the Wave 1 experimental and control group subjects on the Piagetian measures. Using a gamma value of .48 as a cutoff point, it is possible to indicate a number of interesting cases. Gamma values higher than .48 could be expected to show a fairly consistent pattern approaching the patternings of responses shown below in which the gamma value would be a $\pm$ 1.

Task B \ Task A	I	II	III
I	x		
II	x		
III	x	x	x

Task B \ Task A	I	II	III
I	x	x	x
II			x
III			x

Task B \ Task A	I	II	III
I			x
II		x	
III	x		

Task B \ Task A	I	II	III
I	x		
II		x	
III			x

For Wave 1 on the pretest scores for the measurement subtasks, the experimental group performed better on length comparison (γ = .50), distance via reference length (γ = -1), distance via units (γ = -1), and area via units (γ = -.50) though not significantly so. Wave 1 posttest comparisons indicate that the control group did better on transitivity (γ = .51) and distance via reference length (γ = .52) but not significantly better,

TABLE 15

Summary of Gamma Values for the Cross Sectional Analyses:

Wave 1, $P_1 \times C_1$, Pretest and Posttest and Wave 2, $P_2 \times C_2$, Pretest and Posttest

	Pretest				Posttest			
	Wave 1 $P_1 \times C_1$		Wave 2 $P_2 \times C_2$		Wave 1 $P_1 \times C_1$		Wave 2 $P_2 \times C_2$	
	γ Val.	Sign. Level	γ Val.	Sign. Level	γ Val.	Sign. Level	γ Val.	Sign. Level
Dichotomies	.75	p<.05	.65	p<.05	.21	n.s.	.75	p<.01
Class Inclusion	Not	Given	-.16	n.s.	.35	n.s.	.33	n.s.
Cross Class., Repro.	Not	Given	.33	n.s.	-.59	p<.05	.43	n.s.
Cross Class., Transpo.	Not	Given	.11	n.s.	-.13	n.s.	-.43	n.s.
Seriation								
Absolute	1	n.s.	-.24	n.s.	-.22	n.s.	1	p<.05
Relative	.35	n.s.	.44	n.s.	.23	n.s.	.64	p<.01
Successive	-.15	n.s.	.12	n.s.	.30	n.s.	.48	p<.05
Additive	-.34	n.s.	.15	n.s.	-.10	n.s.	.73	p<.01
Serial Cor. (1)	Not	Given	0	n.s.	.22	n.s.	.32	n.s.
Serial Cor. (3) & (4)	.19	n.s.	.28	n.s.	.33	n.s.	.25	n.s.
Double Ser., Repro.	Not	Given	1.0	p<.05	.09	n.s.	-.07	n.s.
Double Ser., Transpo.	Not	Given	.36	n.s.	-.03	n.s.	-.29	n.s.
Transitivity	Not	Given	.5	p<.05	.51	n.s.	.62	n.s.
Measurement								
Length Comp.	-.50	n.s.	-.11	n.s.	-.55	n.s.	0	n.s.
Dist. via Ref. Length	-1	n.s.	1.	n.s.	.52	n.s.	.27	n.s.
Dist. via Units	-1	n.s.	1.	n.s.	.09	n.s.	.21	n.s.
Ht. via Ref. Length	.25	n.s.	.04	n.s.	No	Diff.	1	n.s.
Area via Units	-.52	n.s.	.83	p<.01	-.04	n.s.	.35	n.s.
Conservation								
Number Pred.	Not	Given	.77	p<.05	-.44	n.s.	0	n.s.
Number Deform.	Not	Given	-.07	n.s.	-.14	n.s.	.30	n.s.
Number Adjusted	Not	Given	No	Diff.	-.06	n.s.	.63	n.s.
Length Pred.	Not	Given	-.21	n.s.	-.18	n.s.	-.04	n.s.
Length Deform.	Not	Given	-.21	n.s.	.13	n.s.	.09	n.s.
Length Adjusted	Not	Given	No	Diff.	.13	n.s.	.30	n.s.
Substance Pred.	Not	Given	.30	n.s.	-.19	n.s.	.22	n.s.
Substance Deform.	Not	Given	-.26	n.s.	.04	n.s.	.30	n.s.
Substance Adjusted	Not	Given	No	Diff.	-.11	n.s.	.37	n.s.

while the experimental group only maintained its pretest lead on length comparison ($\gamma = -.55$). For Wave 2, the control group did significantly better on the pretest for double seriation reproduction ($\gamma = 1.0$, $p<.05$), transitivity ($\gamma = .5$, $p<.05$), area via units ($\gamma = .83$, $p<.01$), and conservation of number, prediction ($\gamma = .77$, $p<.05$). On the posttest, the control group maintained its lead on transitivity ($\gamma = .62$) but it is no longer a significant difference. In addition, the control group was significantly better on absolute seriation ($\gamma = 1.0$, $p<.05$), relative seriation ($\gamma = .64$, $p<.01$), successive seriation ($\gamma = .48$, $p<.05$), additive seriation ($\gamma = .73$, $p<.01$), and nonsignificantly better on conservation of number, deformation-adjusted ($\gamma = .63$).

Comparisons of experimental and control groups on the classification measures show no significant differences in performance on either the class inclusion or cross-classification, transposition tasks. Both waves of the experimental group, however, performed significantly better on the pretest for dichotomous sorting than did the controls (Wave 1, $\gamma = .75$, $p<.05$; Wave 2, $\gamma = .65$, $p<.05$). Better performance was maintained on the posttest with the difference between groups significant for Wave 2 ($\gamma = .75$, $p<.01$) and nonsignificant for Wave 1 ($\gamma = .21$). Except for the posttest comparison in Wave 1, there were no significant comparisons between groups for the cross-classification, reproduction task. The first wave was not pretested on this task, but posttests showed a higher general performance level for the control group ($\gamma = -.59$, $p<.05$).

It is difficult to determine whether the better performance by the experimental groups on the dichotomies task can be attributed to a program effect. Classification abilities certainly were a major concern of the PPEP and a variety of activities involving choosing criteria and making sorts were included in the activities for children. The initial performance differences, however, prevent the assertion of a distinct cause-effect relationship.

The percentage of responses in each stage category on each task for Wave 1 and Wave 2 for the pretest and posttest administrations are presented in Tables 16-23. Relative seriation has a considerably smaller percentage of subjects in Stage III than the other seriation tasks at pretesting or posttesting for either the experimental or control group. Examination of the protocol for this task (see Appendix B) suggests that this result may be due to confusing language used by the tester. Siegel (1974) goes so far as to state that the verbal nature of the typical Piagetian measures may be a principal source of performance variance (perhaps leading to asynchrony) and that an exact determination of the young child's abilities awaits the development of more sophisticated and appropriate nonverbal techniques. The importance of this statement in terms of the assumption of accessibility to a young child's thought through language may well have had a bearing on the results on other Piagetian measures utilized in this research.

The control group for Wave 1 shows 100% of its subjects in the transitional Stage IIb on the posttest for serial correspondence (3) & (4). Percentages for the absolute seriation task indicate that in Wave 2, 77% of the experimental group and 100% of the control group were in Stage III on the posttest. This probably indicates a ceiling effect for this task.

Measurement subtasks of distance via reference length and distance via units indicate very little change in percentages at each stage in the experimental or control group from pretest to posttest. In the conservation battery, the percentages of prediction responses do not appear to be appreciably greater in the higher stage designations than the percentage of deformation responses. In most cases for the deformation response, there were no responses in Stage III on the pretest while by the posttest

TABLE 16

Percentages of Children at Various Stages on the Pretest and Posttest Administrations of Three Classification Tasks: Wave I, Experimental (n = 12) and Control (n = 8) Groups

Task	Subtask	Group	Test	% at Stage: I	IIa	IIb	III
Dichotomies	--	P_1	Pre	50	50	0	0
			Post	0	25	33	41
		C_1	Pre	12	87	0	0
			Post	0	12	37	50
Class Inclusion	--	P_1	Pre			**	
			Post	75	8	--	16
		C_1	Pre			--	
			Post	50	37	--	12
Cross Classification	Reproduction	P_1	Pre				
			Post	8	16	8	67
		C_1	Pre	0			
			Post	0	75	0	25
	Transposition	P_1	Pre				
			Post	25	16	8	50
		C_1	Pre				
			Post	0	37	50	12

** Stage II was not subdivided for this task. Stage II responses are listed in the IIa column.

TABLE 17

Percentage of Children at Various Stages on the Pretest and Posttest Administration of the Seriation, Double Seriation, and Transitivity Tasks: Wave 1, Experimental (n = 12) and Control Groups (n = 8).

Task	Subtask	Group	Test	% at Stage: I	IIa	IIb	IIc	III
Seriation	Absolute	P_1	Pre	8	-*	0	--	91
			Post	0	--	8	--	91
		C_1	Pre	0	--	0	--	100
			Post	0	--	12	--	87
	Relative	P_1	Pre	8	75	8	--	8
			Post	50	16	33	--	0
		C_1	Pre	0	75	12	--	12
			Post	62	25	0	--	12
	Successive	P_1	Pre	58	16	25	0	0
			Post	8	16	8	0	66
		C_1	Pre	62	25	12	0	0
			Post	0	0	25	0	62
	Additive	P_1	Pre	33	25	33	--	8
			Post	0	8	16	--	75
		C_1	Pre	50	37	0	--	12
			Post	0	16	0	--	75
	Serial Corresp. (1)	P_1	Pre	Not Administered				
			Post	16	8	8	0	66
		C_1	Pre	Not Administered				
			Post	0	25	0	0	75
	Serial Corresp. (3) & (4)	P_1	Pre	58	16	25	--	0
			Post	8	25	50	--	16
		C_1	Pre	50	12	37	--	0
			Post	0	0	100	--	0
Double Seriation	Reproduction	P_1	Pre	Not Administered				
			Post	25	8	0	--	66
		C_1	Pre	Not Administered				
			Post	0	37	0	--	62
	Transposition	P_1	Pre	Not Administered				
			Post	33	8	41	--	16
		C_1	Pre	Not Administered				
			Post	37	0	50	--	12
Transitivity	--	P_1	Pre	Not Administered				
			Post	25	0	0	8	66
		C_1	Pre	Not Administered				
			Post	12	0	0	0	87

* A dash in a Stage II subdivision indicates that that particular division was not used for the subtask. Where Stage II was not divided for a subtask, the response is listed under category IIb.

TABLE 18

Percentage of Children at Various Stages on the Pretest and Posttest Administration of the Measurement Tasks: Wave 1, Experimental (n = 12) and Control Groups (n = 8).

Task	Subtask	Group	Test	% at Stage: I	IIa	IIb	IIc	III
Measurement	Length Comparison	P_1	Pre	41	0	8	-*	50
			Post	0	16	0	--	83
		C_1	Pre	62	12	12	--	12
			Post	25	12	0	--	62
	Distance via Ref. Length	P_1	Pre	91	8	0	--	0
			Post	83	16	0	--	0
		C_1	Pre	100	0	0	--	0
			Post	62	25	12	--	0
	Distance via Units	P_1	Pre	75	25	0	0	0
			Post	50	25	[illegible]	0	8
		C_1	Pre	100	0	0	0	0
			Post	50	12	25	0	12
	Height via Ref. Length	P_1	Pre	25	16	0	--	58
			Post	0	0	0	--	100
		C_1	Pre	25	0	0	--	75
			Post	0	0	0	--	100
	Area via Units	P_1	Pre	58	33	0	--	8
			Post	41	25	0	--	33
		C_1	Pre	87	0	0	--	12
			Post	37	25	25	--	12

* A dash in Stage II subdivision indicates that that particular division was not used for the subtask. Where Stage II was not divided for a subtask, the response is listed under category IIb.

TABLE 19

Percentage of Children at Various Stages on the Posttest* Administration of the Conservation Tasks: Wave 1, Experimental (n = 12) and Control Groups (n = 8).

Task	Subtask	Group	Test	% at Stage: I	II	III
Conservation	Number Prediction	P_1	Post	50	8	41
		C_1	Post	75	0	25
	Number Deformation	P_1	Post	66	8	25
		C_1	Post	75	0	25
	Length Prediction	P_1	Post	66	16	16
		C_1	Post	75	12	12
	Length Deformation	P_1	Post	75	0	25
		C_1	Post	62	25	12
	Substance Prediction	P_1	Post	41	25	33
		C_1	Post	62	0	37
	Substance Deformation	P_1	Post	58	16	25
		C_1	Post	62	0	37

* No conservation pretest was administered to these children.

TABLE 20

Percentages of Children at Various Stages on the Pretest and Posttest Administration of Three Classification Tasks: Wave 2, Experimental (n = 18) and Control (n = 10) Groups

Task	Subtask	Group	Test	% at Stage: I	IIa	IIb	IIc	III
Dichotomies Sorting	--	P_2	Pre	61	38	0	--	0
			Post	5	50	44	--	0
		C_2	Pre	30	40	30	--	0
			Post	0	20	40	--	40
Class Inclusion	--	P_2	Pre	61	27	**	--	11
			Post	66	33	--	--	0
		C_2	Pre	70	20	--	--	10
			Post	50	50	--	--	0
Cross Classification	Reproduction	P_2	Pre	61	27	5	--	5
			Post	5	61	11	--	22
		C_2	Pre	40	40	20	--	0
			Post	0	50	0	--	50
	Transposition	P_2	Pre	72	11	16	--	0
			Post	22	38	16	--	22
		C_2	Pre	60	40	0	--	0
			Post	30	60	10	--	0
Double Seriation	Reproduction	P_2	Pre	100	0	0	--	0
			Post	33	11	5	--	50
		C_2	Pre	80	10	0	--	10
			Post	30	20	10	--	40
	Transposition	P_2	Pre	88	11	0	--	0
			Post	38	27	22	--	11
		C_2	Pre	80	10	10	--	0
			Post	60	10	30	--	0
Transitivity	--	P_2	Pre	55	11	0	27	5
			Post	16	0	0	22	61
		C_2	Pre	20	20	10	20	30
			Post	10	0	0	0	90

** Stage II was not subdivided for this task. Stage II responses are listed in the IIa column.

TABLE 21

Percentage of Children at Various Stages on the Pretest and Posttest Administration of the Seriation, Double Seriation, and Transitivity Tasks:

Wave 2, Experimental (n = 18) and Control (n = 10) Groups*

Task	Subtask	Group	Test	% at Stage: I	IIa	IIb	IIc	III
Seriation	Absolute	P_2	Pre	22	-*	5	--	72
			Post	0	--	22	--	77
		C_2	Pre	30	--	10	--	60
			Post	0	--	0	--	100
	Relative	P_2	Pre	44	33	16	--	5
			Post	38	38	16	--	5
		C_2	Pre	10	60	20	--	10
			Post	0	50	40	--	10
	Successive	P_2	Pre	61	11	27	0	0
			Post	22	16	11	5	44
		C_2	Pre	50	30	10	10	0
			Post	0	0	10	30	60
	Additive	P_2	Pre	55	22	16	--	5
			Post	5	44	27	--	22
		C_2	Pre	40	40	20	--	0
			Post	0	20	0	--	80
	Serial Corresp. (1)	P_2	Pre	27	22	22	11	16
			Post	0	5	50	5	338
		C_2	Pre**	20	30	20	0	20
			Post	0	10	20	10	60
	Serial Corresp. (3) & (4)	P_2	Pre	27	16	44	--	11
			Post	11	22	50	--	16
		C_2	Pre	10	10	80	--	0
			Post	0	20	60	--	20
Double Seriation	Reproduction	P_2	Pre	100	0	0	--	00
			Post	33	11	5	--	50
		C_2	Pre	80	10	0	--	10
			Post	30	20	10	--	40
	Transposition	P_2	Pre	88	11	0	--	0
			Post	38	27	22	--	11
		C_2	Pre	80	10	10	--	0
			Post	60	10	30	--	0
Transitivity	--	P_2	Pre	55	11	0	27	5
			Post	16	0	0	22	61
		C_2	Pre	20	20	10	20	30
			Post	10	0	0	0	90

* A dash in a Stage II category indicates that that particular division of Stage II was not used for this subtask. Where Stage II was not divided for a subtask, the response is listed under category IIb.

** One no-response.

TABLE 22

Percentage of Children at Various Stages on the Pretest and Posttest Administrations of the Measurement

Tasks: Wave 2, Experimental (n = 18) and Control (n = 10) Groups*

				% at Stage:				
Task	Subtask	Group	Test	I	IIa	IIb	IIc	III
Measurement	Length Comparison	P_2	Pre	72	16	0	-*	11
			Post	11	5	5	--	77
		C_2	Pre	80	0	0	--	20
			Post	20	0	0	--	80
	Distance via Length Ref.	P_2	Pre	100	0	0	--	0
			Post	83	0	11	--	5
		C_2	Pre	90	10	0	--	0
			Post	70	20	0	--	10
	Distance via Units	P_2	Pre	100	0	0	0	0
			Post	77	16	5	0	0
		C_2	Pre	90	0	10	0	0
			Post	70	20	0	0	10
	Height via Ref. Length	P_2	Pre	22	16	5	--	55
			Post	0	5	11	--	83
		C_2	Pre	0	50	0	--	50
			Post	0	0	0	--	100
	Area via Units	P_2	Pre	94	0	5	--	0
			Post	72	11	5	--	11
		C_2	Pre	50	30	20	--	0
			Post	50	30	0	--	20

* A dash in a Stage II category indicates that that particular division of Stage II was not used for this subtask. Where Stage II was not divided for a subtask, the response is listed under category IIb.

TABLE 23

Percentage of Children at Various Stages on the Pretest and Posttest

Administrations of the Conservation Tasks:

Wave 2, Experimental (n = 18) and Control (n = 10) Groups

Task	Subtask	Group	Test	% at Stage: I	II	III
Conservation	Number Prediction	P_2	Pre	94	5	0
			Post	44	33	22
		C_2	Pre	70	10	20
			Post	50	20	30
	Number Deformation	P_2	Pre	77	22	0
			Post	72	5	22
		C_2	Pre	80	20	0
			Post	60	0	40
	Length Prediction	P_2	Pre	72	27	0
			Post	61	11	27
		C_2	Pre	80	20	0
			Post	60	20	20
	Length Deformation	P_2	Pre	72	27	0
			Post	83	5	11
		C_2	Pre	80	20	0
			Post	80	10	10
	Substance Prediction	P_2	Pre	83	11	5
			Post	66	11	22
		C_2	Pre	70	30	0
			Post	60	0	40
	Substance Deformation	P_2	Pre	83	5	11
			Post	72	5	22
		C_2	Pre	90	0	10
			Post	60	0	40

there was 22%-40% in Stage III. The experimental group percentages are generally spread across all the stage designations on the conservation tasks. The Wave 1 and Wave 2 control group, however, had no responses in the transitional Stage II category on the posttest for the conservation tasks except for conservation of length prediction and deformation and for Wave 2 number prediction. The posttest Wave 2 control group responses for conservation of substance are the only instances of the theoretically expected bimodal distribution.

Performances on the classification tasks follow a general pre- to posttest trend out of Stage I and into the higher stages (see Tables 11, 16, and 20). An exception to this is the posttest performance of the Wave 2 experimental group on the class inclusion task. Most of the responses remained in the Stage I category with virtually no change from the pretest to the posttest. The control group showed the general trend of a movement out of Stage I on this task although a sizeable number (50%) also remained in that stage on the posttest. A comparison of responses on this task to those on the dichotomies task suggests that class inclusion abilities develop later, or perhaps slower, than abilities to sort dichotomously. In general, the groups show a much greater percentage of posttest responses in Stage III for the dichotomies task than for the class inclusion task. Group differences were apparent in the dichotomies task where the Wave 2 control group performed better (with 40% of their responses in Stage III compared to 0% for the Wave 2 experimental group) and in the cross-classification-transposition task where the Wave 2 experimental group had a larger percentage of Stage III responses than did the control group (22% and 0%, respectively).

Core group t-test comparisons were carried out on the age variable for the pretest and the PPVT and Raven CPM scores for the pretest and posttest for each wave (see Table 24). No significant differences were found for age or PPVT. A significant difference was found between the experimental and control groups for Wave 1 pretest on the Raven CPM ($t = 2.480$, d.f. 18, $p < .05$), which indicated the experimental group was superior. However, this difference no longer existed on the posttest Raven CPM comparison. For Wave 2, there was significant difference on the posttest Raven CPM comparison indicating that the control group was superior ($t = 2.2212$, d.f. 26, $p < .05$).

In short, there were few significant differences between the experimental and control core groups for either Wave of subjects and almost no differences were maintained from pre to posttesting. While the Wave 1 experimental group performed somewhat better on a few tasks on the pretest, it failed to maintain this lead, with the exception of the length comparison task, or to establish other leads on the posttest. The control group, while not surpassing the experimental group on the pretest on any task, did perform somewhat better on several tasks on the posttest. The Wave 2 control group performed significantly better than the experimental group on the pretest on five tasks but except for the dichotomies task did not maintain the significant lead on these tasks on the posttest. The control group did perform significantly better on four of the seriation tasks on the posttest -- absolute, relative, successive, and additive seriation. The t-test comparisons indicated no significant differences between the groups on age or PPVT. The significant difference between the experimental and control groups on the Raven CPM posttest in which the control group was superior is not traceable to a particular cause. However, a greater

TABLE 24

Core Group T-Test Comparisons of Age and Standardized Measures
for Wave 1 and Wave 2: Pretest and Posttest

	Wave 1				Wave 2			
	Pretest		Posttest		Pretest		Posttest	
	P_1	C_1	P_1	C_1	P_2	C_2	P_2	C_2
Age								
N	12	8			18	10		
Mean	40.41	41.75	Same		40.78	40.50	Same	
S.D.	4.10	5.26			3.08	3.54		
t	.64				.22			
d.f.	18							
PPVT								
N	12	8	12	8	18	10	18	10
Mean	40.00	48.13	53.17	55.87	40.44	44.10	54.44	58.70
S.D.	10.85	7.75	5.72	5.84	12.51	11.48	7.82	6.80
t	1.82		1.03		.76		1.44	
d.f.	18		18					
Raven								
N	12	8	12	8	18	10	18	10
Mean	14.83	11.88	13.83	14.37	10.28	9.60	13.00	15.80
S.D.	2.98	1.89	2.17	3.34	2.85	3.50	3.63	2.15
t	2.48*		.44		.56		2.22*	
d.f.	18		18					

* $p<.05$

use of puzzles and games with one correct solution in the CNSP may have contributed to the higher performance of the control group.

In retrospect, it is perhaps not unduly surprising that the first hypothesis concerning overall higher response levels by the experimental group was not supported by the results. The environment in the home and in the community outside of school has a large impact on development. This is particularly true for 3 and 4 year olds who spend only 2 1/2 hours in a school program. Both groups of preschool children in this study were drawn from the same population and therefore from the same general non-school environment. It seems likely that the following shared factors would be particularly influential on development: SES, community location, family structure, mobility, long and short term achievement expectations, and general attitudes toward child rearing. The effects of experiences common to both groups may well have overshadowed any effects differential schooling may have had. In addition, finer measures may be needed to distinguish between programs when the non-school environment is already meeting the basic needs for cognitive development. Sharper distinctions between programs might also have led to differences in performance. Original differences in approach in the present study diminished with time. Most notably, several members of the CNSP became interested in Piagetian theory and could not be denied the opportunity to participate in workshops offered to the public and run by PPEP personnel. Student teachers in both programs also had had similar training before their practicum experience so that particularly in the early weeks of each semester, much student-teacher-child interaction was similar for both programs. Since there were no major differences between the experimental and control groups for either Wave 1 or Wave 2, subsequent discussion will primarily focus on pre- to posttest comparison even when dealing with cross-sectional data.

The marked lack of difference in percentages between pre- and posttest on the distance via reference length and the distance via units measurement tasks is supported throughout the other statistical analyses carried out. These two tasks were particularly difficult for the 3-5 year old children. This is in contrast to results found by Wohlwill et al. (1971), who found that for kindergarteners and first graders the distance via reference length task and the length comparison task were the easiest of the measurement battery. The present research indicated that height via reference length and length comparison were the two least difficult tasks in the measurement battery. After personal communication with Wohlwill (1974), it was discovered that the height via reference length task was carried out with somewhat different instructions in the present research which made this task actually a height comparison task for many children. In the present research the child was not instructed to find a house of similar height without moving the house itself while in the Wohlwill et al. (1971) research this direction was used.

The percentages for the conservation tasks which indicate very little difference between the prediction and deformation responses is unexpected. Piaget (1952) suggested that conservation develops in three stages: Stage I, in which the child can neither predict nor conserve (in the deformation part of the task); Stage II, in which he can predict but not conserve; and Stage III in which he can do both equally well. It would be expected that the preoperational child would be more likely to be able to predict correctly before he could perform the deformation correctly. Piaget (1966) and Bruner, Olver, Greenfield et al. (1966) have found that preoperational subjects could correctly predict the empirical outcome of a transformation. Toniolo and Hooper (1974), in a study of observation of length and weight with young children, also found no difference between performances on prediction and deformation. It would also be expected that there would be more responses in the transitional Stage II designation than in the Stage III designation.

It may be that not enough children moved out of the Stage I designation during the two year period for these differences to be evident or that children are in the Stage II designation for such a short time that for some of those who moved to Stage III it was not assessed in the present research. The fact that the experimental group evidenced more Stage II responses on both the prediction and deformation components of the conservation tasks than did the control group may be a result of the emphasis placed on prediction in problem solving abilities in the PPEP which was not part of the CNSP. This may also be a result of the stress placed on operational integration within the PPEP which would be expected to facilitate structural transformation.

Longitudinal Analyses

The longitudinal analyses dealt with the gains made by each group from the pre- to the posttesting. The progress which is evident in the results from pre- to posttest indicates an increased ability in cognitive reasoning and understanding for all groups. Analyses using the gamma statistic compared the pretest to the posttest scores for each wave of the experimental and control groups. Table 25 presents a summary of the gamma values for the longitudinal analyses. Gamma values less than .50 are not considered in the following discussion of these results.

On the classification measures the Wave 1 experimental group made significant gains on the dichotomies task ($\gamma = 1.0$, $p < .001$). The Wave 2 experimental group also made significant gains on this task ($\gamma = .94$, $p < .001$) as well as on the two cross classification tasks (reproduction: $\gamma = .75$, $p < .001$ and transposition: $\gamma = .67$, $p < .01$). Patterns found for the control groups were similar to those in the experimental groups except that no statistically significant gains were made by the Wave 2 control group on

TABLE 25

Summary of Gamma Values for the Longitudinal Analyses: Wave 1 and Wave 2, Pretest to Posttest Comparisons for the Experimental and Control Groups

	Wave 1				Wave 2			
	P_1		C_1		P_2		C_2	
	γ Val.	Sign. Level	γ Val.	Sign. Level	γ Val.	Sign. Level	γ Val.	Sign. Level
Dichotomies	1.0	p<.001	1.0	p<.001	.94	p<.001	.85	p<.01
Class Inclusion	Not	Given			-.19	n.s.	.27	n.s.
Cross Class., Repro.	Not	Given			.75	p<.001	.75	p<.01
Cross Class., Transpo.	Not	Given			.67	p<.01	.59	n.s.
Seriation								
Absolute	.04	n.s.	-1.0	n.s.	.25	n.s.	1.0	p<.01
Relative	-.28	n.s.	-.73	p<.01	.06	n.s.	.38	n.s.
Successive	.83	p<.001	-1.0	p<.001	.67	p<.001	.98	p<.001
Additive	.89	p<.001	.92	p<.01	.66	p<.01	.91	p<.001
Serial Cor. (1)	Not	Given			.56	p<.01	.72	p<.01
Serial Cor. (3) & (4)	.75	p<.01	1.0	p<.01	.25	n.s.	.36	n.s.
Double Ser., Repro.	Not	Given			1.0	p<.001	.74	p<.01
Double Ser., Transpo.	Not	Given			.86	p<.001	.46	n.s.
Transitivity	Not	Given			.79	p<.001	.77	p<.01
Measurement								
Length Comp.	.67	p<.05	.67	p<.05	.90	p<.001	.88	p<.01
Dist. via Ref. Length	.38	n.s.	1.0	p<.05	1.0	p<.05	.60	n.s.
Dist. via Units	.56	n.s.	1.0	p<.01	1.0	p<.01	.51	n.s.
Ht. via Ref. Length	1.0	p<.01	[illegible]	n.s.	.63	p<.01	1.0	p<.01
Area via Units	.40	n.s.	.67	p<.05	.71	p<.05	.06	n.s.
Conservation								
Number Pred.	Not	Given			.91	p<.001	.33	n.s.
Number Deform.	Not	Given			.25	n.s.	.54	n.s.
Number Adjusted	Not	Given			1.0	n.s.	1.0	p<.05
Length Pred.	Not	Given			.36	n.s.	.50	n.s.
Length Deform.	Not	Given			-.21	n.s.	.06	n.s.
Length Adjusted	Not	Given			1.0	n.s.	1.0	n.s.
Substance Pred.	Not	Given			.44	n.s.	.38	n.s.
Substance Deform.	Not	Given			.32	n.s.	.71	n.s.
Substance Adjusted	Not	Given			1.0	n.s.	1.0	n.s.

the cross classification, transposition task. Neither group changed responses notably on the class inclusion task. This is not particularly surprising in view of recent discussions of class inclusion understanding (e.g. Brainerd, 1973 and Brainerd and Kaszor, 1974) which contend that these tasks may indeed involve formal operational reasoning.

An examination of the seriation measures indicates that the Wave 1 experimental group did significantly better on the posttest than on the pretest for successive seriation ($\gamma = .83$, $p < .001$), additive seriation ($\gamma = .87$, $p < .001$), and serial correspondence (3) & (4) ($\gamma = .75$, $p < .01$). The Wave 2 experimental group also made significant gains from the pretest to the posttest on successive seriation ($\gamma = .67$, $p < .001$), additive seriation ($\gamma = .66$, $p < .01$), and on serial correspondence (1) ($\gamma = .56$, $p < .01$). It should be noted that serial correspondence (1) is analogous to a successive seriation task (see Appendix B). In addition, the Wave 2 experimental group showed significant gains on double seriation, reproduction ($\gamma = 1.0$, $p < .001$) and transposition ($\gamma = .86$, $p < .001$), and transitivity ($\gamma = .79$, $p < .001$). The Wave 1 control group had significantly lower performance on the posttest on relative seriation ($\gamma = -.73$, $p < .01$) and successive seriation ($\gamma = -1.0$, $p < .001$). However, they made significant gains on additive seriation ($\gamma = .92$, $p < .01$) and serial correspondence (3) & (4) ($\gamma = 1.0$, $p < .001$). Table 25 indicates that they also had a significantly lower performance on absolute seriation ($\gamma = -1.0$); however, because there were so many ties, this gamma value took into account only two responses. Wave 2 control group subjects made significant gains on absolute seriation ($\gamma = 1.0$, $p < .01$), successive seriation ($\gamma = .98$, $p < .001$), additive seriation ($\gamma = .91$, $p < .001$), and serial correspondence (1) ($\gamma = .72$, $p < .01$). It should be pointed out that the Wave 2 experimental group also made significant gains on the latter three tasks. In addition, like the Wave 2 experimental group, the Wave 2 control group made significant gains on double seriation, reproduction (γ = .74, $p<.01$) and transitivity (γ = .77, $p<.01$).

Both waves of the experimental and control groups made significant gains generally on the seriation subtasks. This is a concept domain in which preoperational subjects typically make gains (see Bingham-Newman & Hooper, 1974). In addition, the Wave 2 experimental and control groups made significant gains on the more difficult double seriation and transitivity tasks. The differences in gains between Wave 1 and Wave 2 on serial correspondence (1) and serial correspondence (3) & (4) is indicative of a possible cohort and/or program effect. Moreover, the significant gains on the more difficult double seriation transposition and cross-classification transposition tasks for the experimental group only may be indicative of a program effect since the experimental program emphasized the kind of logical reasoning which these tasks require.

The longitudinal analyses of the measurement battery generally indicate gains on the posttest. The Wave 1 experimental group made significant gains on length comparison (γ = .67, $p<.05$) and height via reference length (γ = 1.0, $p<.01$) and nonsignificant gains on distance via units (γ = .56). Like the Wave 1 experimental group, the Wave 2 experimental group made significant gains on length comparison (γ = .90, $p<.001$). The Wave 2 experimental group also made significant gains on distance via reference length (γ = 1.0, $p<.05$), distance via units (γ = 1.0, $p<.01$), height via reference length (γ = .63, $p<.01$), and area via units (γ = .71, $p<.05$).

In comparison, the Wave 1 control group made significant gains on length comparison (γ = .67, $p<.05$), distance via reference length (γ = 1.0, $p<.05$), distance via units (γ = 1.0, $p<.05$), and area via units (γ = .67,

$p < .05$). Table 25 also indicates that the control group gained on height via reference length ($\gamma = 1.0$); however, because of ties, this gamma value is based on only two subjects' responses. Like the Wave 1 control group, the Wave 2 control group made significant gains on length comparison ($\gamma = .88$, $p < .01$). They also made significant gains on height via reference length ($\gamma = 1.0$, $p < .01$) and nonsignificant gains on distance via reference length ($\gamma = .60$), and distance via units ($\gamma = .51$).

In summary, the gamma values for the longitudinal measurement comparisons indicate that none of the groups performed worse on the posttest than on the pretest. Thus, regression effects would appear to have been negligible. Each of the control and experimental groups improved on length comparison, height via reference length, and distance via units. Each of the experimental and control groups made significant gains on the length comparison and height via reference length measurement tasks. As was mentioned previously, the height via reference length task, because of an error in the instructions, could be considered a height comparison task. Thus, it is appropriate for significant gains to be made on this task by groups who made significant gains on the length comparison task. The significant gains on the other more difficult measurement tasks are most probably due to some children moving out of the Stage I designation.

Longitudinal analyses of the conservation battery indicated that the Wave 2 experimental group did significantly better on the posttest on the conservation of number, prediction task ($\gamma = .91$, $p < .001$). Table 25 indicates that there were a number of other cases in which gamma is over .50 where the experimental group for Wave 2 performed better on the posttest; however, because of the number of ties in each case the gamma value is based on only a few cases. The gamma values for the conservation scores of the control group for Wave 2 indicate that they performed significantly better on the posttest on conservation of number, deformation-adjusted ($\gamma = 1.0$, $p < .05$). Furthermore, they made nonsignificant gains on conservation of number, deformation ($\gamma = .54$) and conservation of substance, deformation ($\gamma = .71$). Other gamma values which appear to indicate superior posttest performance for this group are again due to only a few cases because of ties.

Overall, for the conservation tasks all gamma values over .50 show that on the posttest the groups did better than on the pretest. Although many children remained in Stage I, there was a general increase in the number of children in Stage II or III across the conservation tasks. Interestingly, the Wave 2 experimental group did a great deal better on the posttest on conservation of number, prediction while the Wave 2 control group did better on conservation of number, deformation either adjusted or not adjusted. This again may be due to an emphasis on prediction experiences in the PPEP.

While the Piagetian tasks are sensitive to intellectual differences at early ages, it appears that further refinement could provide more information on what young children do know rather than what they don't know. Siegel's (1974) comments on the language components of the tasks is specdfically germane to this point. In addition, using a more clinical method and stimuli which are particularly relevant to young children may prove beneficial. For instance, in training testers for the Wave 2 posttesting for the present research, it was found that when scoops of ice cream were used for the conservation of substance task rather than clay balls, several three year olds who could not conserve with the clay balls could both predict and conserve substance. In the conservation of length task, when children were queried about whether one string was longer than the other after one was made into a circle they invariably said the straight string was longer. In actual measurement of the space occupied by the strings, the straight one was longer. From explanations given by the child, it was discerned that the question seemed to refer to actual length in space rather than the string itself. Miller, Grabowski, and Heldmeyer (1972) also cite the salience of the length dimension for preschoolers in the conservation of substance task.

Table 26 presents the t-test results for pre- to posttest change analyses on the standardized measures, PPVT, and Raven CPM, for each wave. The comparisons indicated that significant gains were made by all groups on the PPVT. However, only the Wave 2 experimental and control groups performed significantly better on the Raven CPM posttest. This is probably a reflection of the shorter time between pretest and posttest administrations of the Raven CPM for Wave 1 rather than an indication of cohort differences. The 4 1/2 month interval may not be long enough for age-related changes measurable with this task to occur— at least for the age range studied here.

The Wave 1 experimental group made significant gains on the PPVT ($t = 4.27$, d.f. 11, $p<.001$) but not, as mentioned above, on the Raven CPM. The Wave 1 control group likewise performed significantly better on the PPVT posttest ($t = 3.23$, d.f. 7, $p<.05$) but not on the Raven CPM. Although neither trend was significant, the mean score on the Raven CPM increased in the control group but decreased in the experimental group.

The Wave 2 experimental group performed significantly better on the PPVT posttest ($t = 6.13$, d.f. 17, $p<.001$) and on the Raven CPM posttest ($t = 2.87$, d.f. 17, $p<.05$). The control group for Wave 2 also performed significantly better on the PPVT posttest ($t = 3.33$, d.f. 9, $p<.01$) and on the Raven CPM posttest ($t = 4.06$, d.f. 9, $p<.01$). The similarities here suggest that measurement errors rather than program differences may have resulted in the directions of change noted on Raven CPM performances for Wave 1.

TABLE 26

Comparison of Pre to Posttest Changes on Standardized Measures for Experimental and Control Groups: Wave 1 and Wave 2

	Wave 1				Wave 2			
	P_1		C_1		P_2		C_2	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
PPVT								
N	12	12	8	8	18	18	10	10
Mean	40.00	53.17	48.13	55.87	40.44	54.44	44.10	58.70
S.D.	10.85	5.72	7.75	5.84	12.51	7.82	11.48	6.80
t	4.27***		3.23*		6.13***		3.33**	
df	11		7		17		9	
RAVEN								
N	12	12	8	8	18	18	10	10
Mean	14.83	13.83	11.88	14.37	10.28	13.00	9.60	15.80
S.D.	2.98	2.17	1.89	3.34	2.85	3.63	3.50	2.15
t	1.43		1.49		2.87*		4.06**	
df	11		7		17		9	

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

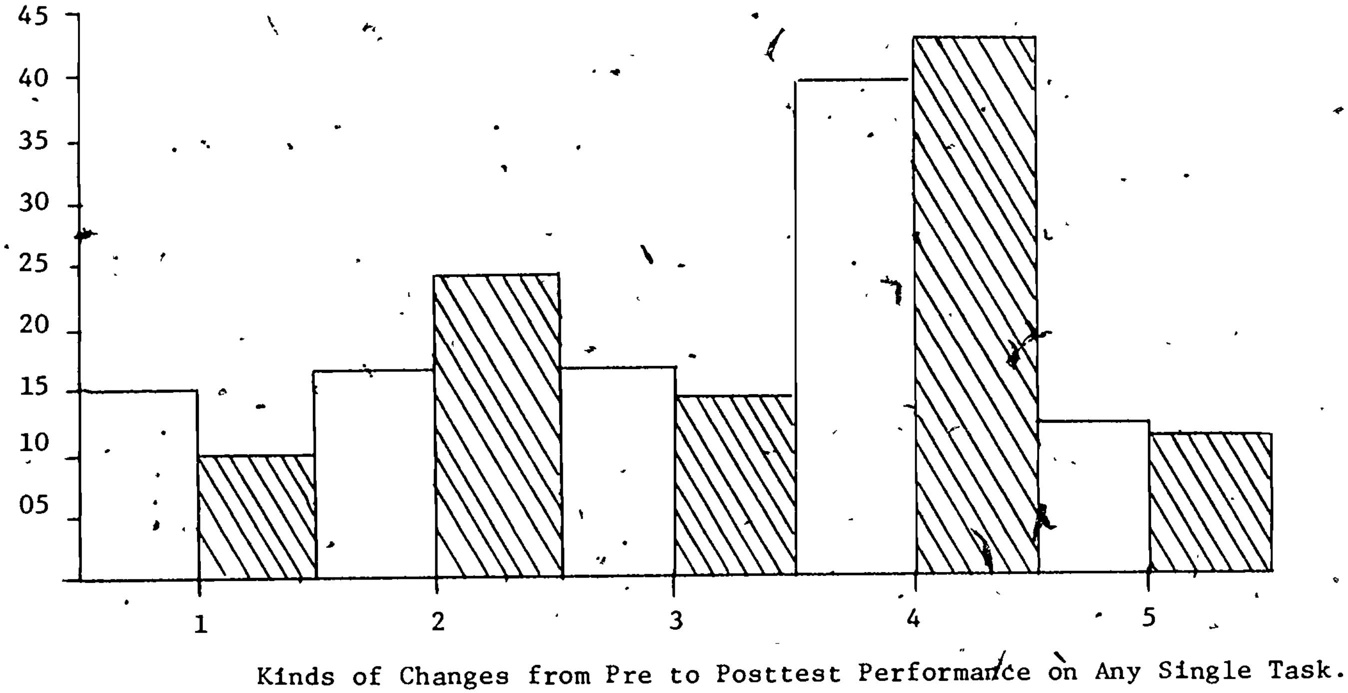
Percentages of several different types of pre- to posttest change patterns in stage category in each task summed over all tasks for Wave 1 are presented in Figure 1. Similar information for Wave 2 is shown in Figure 2. The experimental and control groups follow a strikingly similar pattern with the highest percentage of responses for each wave remaining in the transitional Stage II. Moreover, the figure indicates that the majority of all responses in each wave remained in the same stage category from pretest to posttest. Most of the responses which changed category for each wave followed the stage category sequence determined prior to scoring. Approximately 1/10 of the responses showed a backward shift from pretest to posttest. This small amount could be expected from normal statistical regression effects or measurement error. Not only were the experimental and control groups almost identical, but it is remarkable that the two waves of subjects also followed the same pattern.

It is significant to note that Figures 1 and 2 indicate that many subjects' responses, when all Piagetian tasks are considered, remain in the transitional Stage II designation. This again may be because of the relatively short period between measurement times (approximately 15 months) as well as the very young age of the subjects at the beginning of the research. A fifteen month period with 5 to 7 year olds would probably have resulted in considerably different outcomes. During the period from three to five years reorganization of operational structures may not have progressed enough to become apparent.

In addition, Kamii and DeVries (1974) suggest that Piagetian theory is even more relevant to the socioemotional area of development than the cognitive area of development. While a framework of operational abilities is essential in any interactions in the reality of objects, people, or events, it may be

FIGURE 1

Percentages of Pre/Posttest Changes in Stage Performance in Each Task Summed Over All Tasks: Wave I



1. Followed stage designations in order (No Skips)
2. Followed stage sequences with skips on substages
3. Went from stage I to stage III.
4. Remained in same stage or substages
5. Reversed order of stages

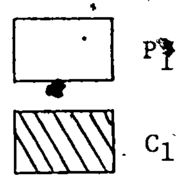
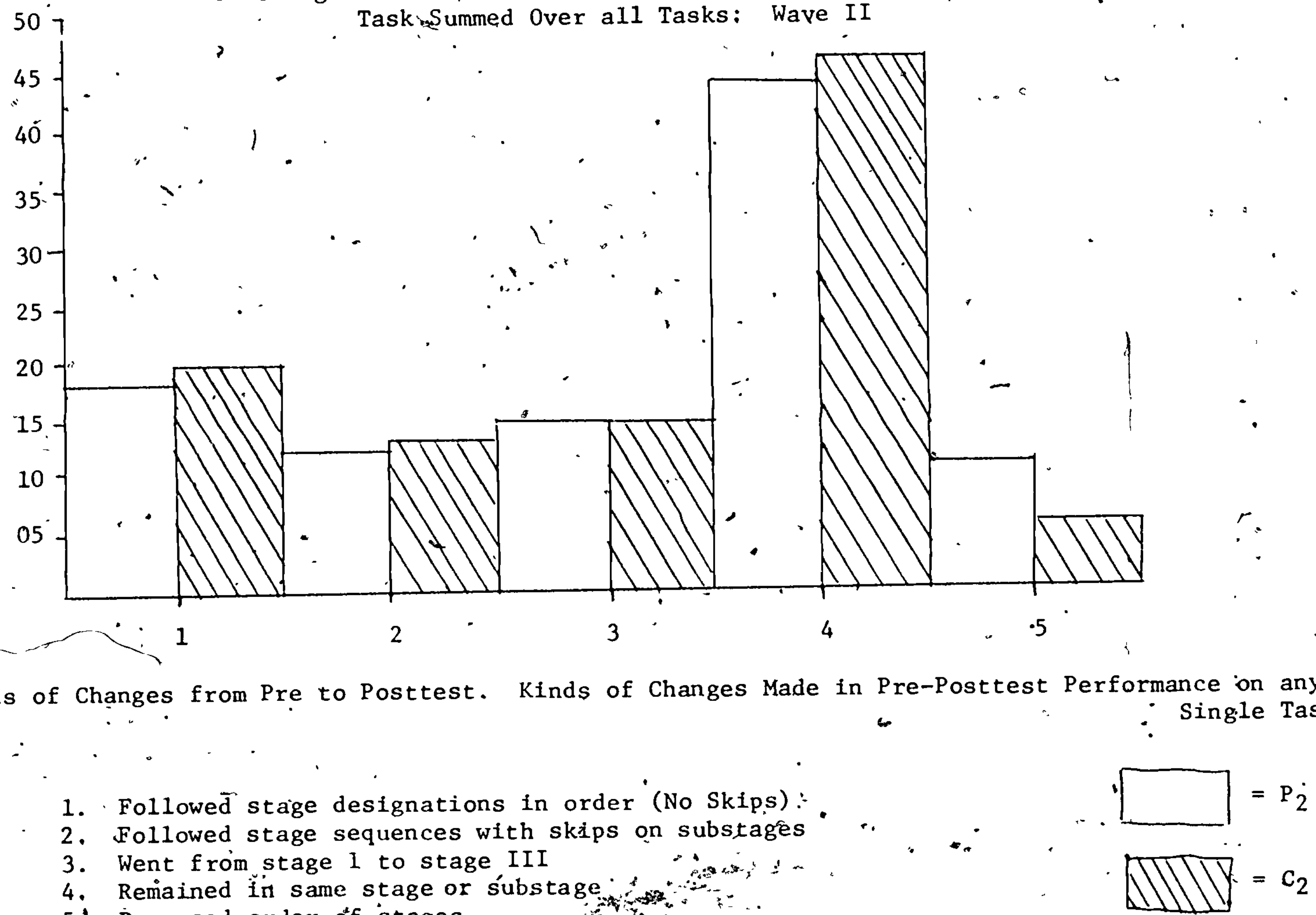


FIGURE 2

Percentages of Pre/Posttest Changes in Stage Performance in Each Task Summed Over all Tasks: Wave II



Kinds of Changes from Pre to Posttest. Kinds of Changes Made in Pre-Posttest Performance on any Single Task

1. Followed stage designations in order (No Skips)
2. Followed stage sequences with skips on substages
3. Went from stage 1 to stage III
4. Remained in same stage or substage
5. Reversed order of stages

that the present Piagetian measures do not tap the socioemotional aspects of development with which young children are struggling. Though Piaget emphasizes the integral aspects of socioemotional growth with cognitive growth, the present tasks do not appear to be designed to measure growth in this area.

Moreover, the processes of simple and reflective abstraction necessary for the child's building of physical and logico-mathematical knowledge through the continuous equilibrium mechanisms mentioned previously most likely take a longer period to transform cognitive structures than the period provided in this research. The differences between the experimental and control groups which are disappointingly absent from the present results might have shown up in future times of measurement. It is also possible that because the PPEP attempted to optimize and extend the use of structures already present rather than accelerate the functional and structural changes which occur developmentally, the use of the concrete operational tasks may not have been able to pick up this extension.

Another reason for finding many responses remaining in the Stage II category could be the phenomenon of spiral development suggested by Werner (1957) in which an individual's performance would be expected to regress before it progresses. From this theoretical viewpoint, it would be expected that children would move ahead and then back again before moving further ahead developmentally. If this were the case, it would be profitable to retest children at shorter intervals. However, attention would need to be given to establishing controls which would allow for measurement of the test-retest effects.

Wohlwill (1968) points out that the variables which are effective in concrete situations change. This results in differences in comprehension of an operation and expression of it at the level of performance. While the operational ability may be available, it may also be expressively retarded depending on the situational variables. This could account for the many instances of spontaneous operational performance witnessed by teachers in the PPEP which did not show up in the testing results. However, an observational study of the spontaneous classroom behaviors would be necessary to substantiate what the teachers saw happening. A study comparing the results of typical task assessment and naturalistic observation of the same subject could shed light on Wohlwill's (1970) suggestion that the very young child does not reveal his abilities fully in a testing situation. He suggests that the child often becomes stimulus bound by the directions of the task in an experimental situation rather than solving the problem creatively as he would in a natural situation.

3. Other Considerations[10]

Within Stage Correspondence Analyses--The data were rearrayed in frequency tables to determine within stage correspondence of the subjects' performances. Separate analyses were made for the pretest and the posttest. A representative sample of tasks was chosen prior to preparing the frequency tables which were used to examine synchrony within a concept domain as well as across concept domains. In preparing the tables for this analysis, the various Stage II subcategories were collapsed into a single Stage II category. In addition, the Wave 1 and Wave 2 experimental groups were combined for one analysis (Table 27) and the Wave 1 and Wave 2 control groups were combined for another analysis (Table 28).

The almost complete lack of synchrony found in the within stage correspondence analysis is particularly notable. Four types of tables which are representative examples of the typical patterns exhibited by the data are as follows:

TABLE 27

Summary of Selected Gamma Values for Within Stage Correspondence Comparisons on Piagetian Tasks: Total Experimental Groups, Pretest and Posttest.

	Dichotomies		Class Inclusion		Cross Class Repro		Cross Class Transpo		Serial Corresp 3 & 4		Double Seri Transpo		Transitivity		Distance Via Ref Length	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Class Inclusion	-.57	-.67														
Cross Class Repro	.59	.21	-.27	.12												
Cross Class Transpo	.54	.72*														
Serial Corresp (3 &4)	-.54*	.32			.29	.97***										
Double Seri Repro									—	.65*						
Double Seri Transpo	.25	.24			-.17	.56*	—	.32	.90	.12						
Transitivity	.07	.30			.32	.77**			-.32	.57	-1.00	.63**				
Distance Via Ref Length	-1.00	.62	—	-.35	—	.13	—	.12	-1.00	-.06	—	.49	—	.34		
Distance Via Units									-.57	.09	—	.05	—	.59*		
No. Prediction	1.00	.30			-1.00	.24			-1.00	.45	-1.00	.05	-1.00	.49*	—	.60*
No. Deformation	.29	.24			-.41	.45			-.14	-.20	-1.00	.07	-1.00*	.79*	—	.69*
Length Prediction	-1.00*	.00			.42	-.03			.33	-.56			.30	.29	—	.00
Length Deformation	-.55	.13			-.56	.12			.33	-.25			-.66	.63	—	.00
Substance Prediction	-.04	.58*			-.08	.62*			.86*	.14			-1.00*	.78**	—	.51
Substance Deformation	-.09	.68*			-.13	.37			.85	.13			-1.00*	.76*	—	.67**

Note: 1. Underlined values are for P_1 and P_2. All other values are for P_2 only.
2. A dash indicates a comparison which could not be calculated because all responses on one variable were in the Stage I category.
3. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

TABLE 28

Summary of Selected Gamma Values for Within Stage Correspondence Comparisons on Piagetian Tasks: Total Control Group, Pretest and Posttest

	Dichotomies		Class Inclusion		Cross Class Repro		Cross Class Transpo		Serial Corresp 3 & 4		Double Seri Transpo		Transitivity		Distance Via Ref Length	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Class Inclusion	-.27	-.09														
Cross Class Repro	-.20	.93**	-.27	-.64												
Cross Class Transpo	.20	-.03														
Serial Corresp (3 & 4)	1.00	-1.00			-1.00	-1.00										
Double Seri Repro									1.00	-.50						
Double Seri Transpo	-1.00**	-.09			1.00	-.29	.25	.94*	1.00	-.05						
Transitivity	.20	-.13			-.75	-.25			-1.00	1.00	-.20	-1.00*				
Distance Via Ref Length	1.00	.62	-1.00	.36	1.00	-.05	-1.00	.50	1.00	.29	-1.00	.64*	-1.00	-.52		
Distance Via Units									1.00	.11	-1.00	.69*	-1.00	-.42		
No. Prediction	1.00	.09			.09	.29			1.00	.37	-1.00	.47	-.13	-.33	1.00*	.90**
No. Deformation	1.00	.17			-.25	.33			-1.00*	.37	-1.00	.63*	1.00*	-.37	-1.00	.96***
Length Prediction	1.00	.07			1.00	.37			-1.00*	.16			-.08	1.00	1.00*	.41
Length Deformation	-.50	.05			1.00	.05			-1.00*	-1.00			.60	.33	-1.00	.58
Substance Prediction	-.11	-.05			-.67	.14			1.00	.25			.38	-1.00*	-1.00	.92**
Substance Deformation	1.00	-.05			-1.00	.14			1.00	.25			1.00	-1.00*	-1.00	.92**

Note: Underlined values are values for C1 and C2. All other values are for C2 only.

* p≤.05; ** p≤.01; *** p≤.001

Transitivity

Distance via reference length	I	II	III
I	5	5	15
II	1	0	3
III	0	0	1

Double Seriation-Transposition

Transitivity	I	II	III
I	0	1	1
II	0	0	0
III	9	7	0

Serial Correspondence (3) & (4)

Double Seriation, Reproduction	I	II	III
I	5	11	3
II	0	0	0
III	0	0	0

Dichotomies

Serial Correspondence (3) & (4)	I	II	III
I	4	7	0
II	12	4	0
III	1	1	0

These types of asynchrony suggest what Piaget describes, in what appears to be post-hoc fashion, as <u>horizontal décalage</u>, that is, differing levels of achievement involving similar mental operations. While Piaget hypothesized that many similar operations develop in synchrony, he also recognizes horizontal décalages as developmental phenomena. It may be that the shifting responses characteristic of the preoperational child resulted in some of the asynchrony findings. The results are supportive of the hypothesis based on the work of Wohlwill (1973), Flavell (1971), and Turiel (1969) that subjects in the transitional preoperational period would show a relatively high degree of structural mix in their response patterns across a battery of Piagetian tasks. In fact, more mix was evident on the posttest than on the pretest. The hypothesis concerning a greater degree of developmental convergence within a concept domain than across concept domains was not supported since the only significant convergence occurred in the pretest where there were many clusters of responses on both of the tasks in the Stage I category. Trends from pretest to posttest indicate that the subjects generally moved out of Stage I and patterns showed a wider spread across all stage categories. On the posttest for the control and the experimental groups there were few responses which fell into Stage I on both tasks. There were also more similarities in patterns between the control and experimental groups on the posttest than on the pretest. Tables 27 and 28 show within-stage correspondence data.

In sharp contrast to the present results which show few five year old children in the Stage I category, Gonchar (1974) in a cross-sectional study of classes, relations and numbers found kindergarten children clustering mainly in the Stage I category on similar tasks. This, of course, may be due to a somewhat different interpretation of the three stage scoring process. The present research made a determined effort to give the preoperational child credit for what he could do through detailed scoring procedures and by not giving global scores for a set of subtasks. To further compare the two research studies it would be necessary to have each use the same scoring procedures and analyses. It is also possible that the subject samples in the two studies differed considerably.

The clustering of responses in the Stage I designation for the present study was primarily on the pretests for measurement, conservation, and class inclusion. This suggests that these are among the more difficult tasks. It is notable that the serial correspondence (3) & (4) task and the dichotomous sorting task show evidence of significant development prior to the double seriation matrix task and several measurement and conservation subtasks for both groups on the pretest. The reader should recall that all groups performed significantly better on the seriation subtasks and the dichotomous sorting task in the longitudinal analyses while not evidencing such gains in other concept domains. The seriation subtasks are represented by serial correspondence (3) & (4) in the within-stage correspondence analysis. This result would indicate that seriation and sorting abilities are developmental precursors for the abilities represented by the more difficult measurement and conservation subtasks. Transitivity, which involves both seriation and measurement abilities, also shows significant development prior to several measurement subtasks. It was also found that double seriation-reproduction developed prior to the transposition portion of the task (though nonsignificantly so) which is in agreement with the findings of Mackay, Fraser, and Ross (1970), and Hooper <u>et al</u>. (1974).

It is evident that by the posttest transitivity shows considerable development prior to serial correspondence (3) & (4) and dichotomous sorting, as well as to the double seriation, transposition task, cross classification tasks, and conservation of substance, prediction and deformation tasks. This result is in contrast to results found by Piaget, Inhelder, and Szeminska (1960) that serial ordering was a prerequisite to transitive understanding. Murray and Youniss (1968) also found the same contrasting results though their transitivity task differed somewhat from the task used in the present research. The other seriation subtasks were not included in this analysis and these seriation abilities may develop prior to transitive abilities. However, the results confirm findings of Lovell and Ogilvie (1961) and Brainerd (1973) that transitivity precedes conservation which in turn precedes class inclusion. The results suggest that several of the measurement tasks--distance via reference length and distance via units, are more difficult than even the conservation tasks. This is in agreement with the findings of Wohlwill, Fusaro, and Devoe (1969) who found that conservation abilities changed prior to measurement abilities.

The order of difficulty of the subtasks which can be inferred from the results of the within stage correspondence analyses can be summarized as follows:

<u>Pretest</u>

(1) serial correspondence (3) & (4), dochotomies

(2) cross classification, class inclusion

(3) conservation, transitivity, distance via reference length, distance via units

<u>Posttest</u>

(1) transitivity

(2) serial correspondence (3) & (4), dichotomies

(3) conservation, cross classification

(4) distance via reference length,
distance via units, class inclusion

In addition, contrary to one interpretation of Piagetian theory which indicates that a bimodal distribution of performance can be expected on a given battery of tasks, this research found, overall, most responses falling into the Stage II transitional category on both the pre- and posttest. For a more detailed discussion of these results, see Bingham-Newman, 1974, and Saunders, 1975.

In general the within-stage correspondence analysis revealed that different children follow different paths to the same place. Not only is the route different for individual children but the pace is also different; the departure from synchrony is more random that systematic. Thus the data support Flavell's (1971) contention that while an integrated structure or "structure d'ensemble" may be characteristic during a final period of its development, this need not carry particular implications for the manner in which its components develop. As Wohlwill (1973) suggests, asynchrony appears to be undeniable, yet there is undoubtedly some degree of order and regularity in the forms which the interrelationship of developing components of a structure may take. The forms of interrelationships by which the components develop need further longitudinal investigation.

Sex Difference Analyses--Another type of analysis which was carried out was an analysis of sex differences in each wave combining the experimental and control groups. Using a cutoff point of $\gamma = .50$, Wave 1, pretest comparisons revealed that females performed significantly better on height via reference length ($\gamma = .68$, $p<.05$) and males performed significantly better on length comparison ($\gamma = -.66$, $p<.05$). The other task comparisons for Wave 1 which appear to be significant are due to only one or two cases because of the number of tied responses. Wave 1 posttest comparisons indicate that the females did significantly better on dichotomies ($\gamma = .63$, $p<.05$), successive seriation ($\gamma = 1$, $p<.01$), additive seriation ($\gamma = 1$, $p<.05$), double seriation, reproduction ($\gamma = .76$, $p<.05$), transitivity ($\gamma = 1$, $p<.05$), distance via reference length ($\gamma = .84$, $p<.01$), conservation of number, prediction ($\gamma = .82$, $p<.01$) and deformation ($\gamma = .69$, $p<.05$) and conservation of length, deformation ($\gamma = .65$, $p<.05$). In addition females performed better but not significantly so on serial correspondence (3) & (4) ($\gamma = .64$) and conservation of length, prediction ($\gamma = .62$). Males, on the other hand, performed significantly better only on absolute seriation ($\gamma = -1$, $p<.05$).

The Wave 2 pretest comparisons for sex differences indicated that females' performance was significantly superior on relative seriation ($\gamma = .59$, $p<.05$) and nonsignificantly better on conservation of number, deformation ($\gamma = .56$) and conservation of substance, deformation ($\gamma = .64$). Posttest comparisons for the same group indicate that males performed significantly better on conservation of number, prediction ($\gamma = -.61$, $p<.05$) and nonsignificantly better on height via reference length ($\gamma = -.51$). Females performed better, however, on the posttest task comparisons of class inclusion and cross classification, transposition.

The notable increase of female superiority in Wave 1 on the posttest as compared to Wave 2 posttest may be indicative of a cohort and/or program effect. However, the female performance leads on the pretest were not carried over to the posttest. Rather, an entirely different set of task comparisons showed female superiority on the posttest. The female leads in Wave 2 pretest comparisons were also not maintained on the posttest comparisons (see Table 29). Reexamination of the anecdotal records for

TABLE 29

Summary of Gamma Values for Sex Differences Analysis for the Pretest and Posttest:

Wave 1, Experimental and Control Groups Combined

Wave 2, Experimental and Control Groups Combined

	Pretest				Posttest			
	Wave 1 P_1 & C_1		Wave 2 P_2 & C_2		Wave 1 P_1 & C_1		Wave 2 P_2 & C_2	
	γ Val.	Sign. Level	γ Val.	Sign. Level	γ Val.	Sign. Level	γ Val.	Sign. Level
Dichotomies	-.09	n.s.	.41	n.s.	.63	.05	.29	n.s.
Class Inclusion	Not	Given	-.20	n.s.	.48	n.s.	.62	.05
Cross Class Repro.	Not	Given	.0	n.s.	.49	n.s.	-.29	n.s.
Cross Class, Transpo.	Not	Given	.11	n.s.	.45	n.s.	.68	.01
Seriation								
Absolute	-1.0	.001	-.03	n.s.	-1.0	.05	-.17	n.s.
Relative	-.08	n.s.	.59	.05	.03	n.s.	-.24	n.s.
Successive	0	n.s.	-.33	n.s.	1.0	.01	-.01	n.s.
Additive	-.21	n.s.	-.13	n.s.	1.0	.05	.24	n.s.
Serial Cor (1)	Not	Given	-.13	n.s.	.64	n.s.	.44	n.s.
Serial Cor (3) & (4)	.19	n.s.	.12	n.s.	.33	n.s.	.04	n.s.
Double Ser Repro.	Not	Given	.11	n.s.	.76	.05	-.21	n.s.
Double Ser Transpo.	Not	Given	-.45	n.s.	.25	n.s.	.39	n.s.
Transitivity	Not	Given	-.12	n.s.	1.0	.05	-.18	n.s.
Measurement								
Length Comp.	-.66	.05	.03	n.s.	-.03	n.s.	.28	n.s.
Dist. via Ref. Length	1.0	n.s.	1.0	n.s.	.84	.01	.46	n.s.
Dist. via Units	-.17	n.s.	1.0	n.s.	.30	n.s.	.41	n.s.
Ht. via Ref. Length	.68	.05	.06	n.s.	No	Diff.	-.51	n.s.
Area via Units	0	n.s.	-.31	n.s.	.16	n.s.	-.06	n.s.
Conservation								
Number Pred.	Not	Given	.16	n.s.	.82	.01	-.19	n.s.
Number Deform.	Not	Given	.56	n.s.	.69	.05	-.01	n.s.
Number Adjusted	Not	Given	No	Diff.	No	Diff.	No	Diff.
Length Pred.	Not	Given	.37	n.s.	.62	n.s.	-.61	.05
Length Deform.	Not	Given	0	n.s.	.65	.05	-.08	n.s.
Length Adjusted	Not	Given	No	Diff.	No	Diff.	No	Diff.
Substance Pred.	Not	Given	.22	n.s.	.20	n.s.	-.10	n.s.
Substance Deform.	Not	Given	.64	n.s.	.14	n.s.	.09	n.s.
Substance Adjusted	Not	Given	No	Diff.	No	Diff.	No	Diff.

the Wave 1 experimental group indicated that the males in this group spent a great deal of time in large motor and dramatic play activities which the girls were often hesitant to join. Theoretically, and from the orientation of the program, this should not have excluded the males from experiences which would utilize the Piagetian operational abilities since these abilities were considered a component of all activities. It is possible that a cohort effect brought about by an increased emphasis on women's liberation may have been in effect. Parents of the Wave 2 subjects became particularly aware of the movement during the two years they were in the program. The elimination of sex stereotyping in children's activities did become a particular concern of the teachers in the PPEP.

Core group t-test comparisons were carried out on the age variable and the standardized measures, PPVT and Raven CPM, to determine whether sex differences were apparent. (see Table 30). There were no significant differences on the Wave 1 pretest or posttest for either the experimental or control group. For Wave 2, the only significant difference was for the control group age variable which indicated that the girls were significantly older ($t = 3.65$, d.f. 8, $p<.01$). It is interesting to note that although the Wave 2 results indicated that females were significantly older than males in the control group, they did not perform better.

Time-Lag Analyses

The last analyses dealt with putative causal linkages in performances among the Piagetian tasks from pre- to posttesting. The data were rearrayed for the time-lag analysis so that each comparison looks at an individual's performance on one task at the pretest and performance on a different task at the posttest to see if there is any indication of a predicative causal

TABLE 30

Core Group Comparisons of Sex Differences for Wave 1 and Wave 2: Pretest and Posttest

	P_1				C_1				P_2				C_2			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Age																
N	8	4	8	4	4	4	4	4	10	8	10	8	6	4	6	4
Mean	41.00	39.25			42.25	41.25			41.20	40.25			38.33	43.75		
S.D.	4.69	2.75			4.99	6.23			2.74	3.57			2.50	1.89		
t	.67				.25				.63				3.65*			
Peabody																
N	8	4	8	4	4	4	4	4	10	8	10	8	6	4	6	4
Mean	36.87	46.25	53.25	53.00	48.25	48.00	58.50	53.25	44.90	34.87	55.00	52.62	39.50	51.00	58.33	59.25
S.D.	12.00	4.11	5.28	7.39	8.46	8.28	3.69	6.89	5.56	16.61	8.47	7.02	12.53	5.29	8.31	4.78
t	1.48		.06		.04		1.34		1.79		.87		1.70		.19	
Raven																
N	8	4	8	4	4	4	4	4	10	8	10	8	6	4	6	4
Mean	14.25	16.00	13.12	15.25	11.75	12.00	15.00	13.75	10.10	10.50	13.40	12.50	8.00	12.00	16.83	14.25
S.D.	3.28	2.16	2.29	.95	2.21	1.82	4.69	1.70	2.23	3.62	3.43	4.03	3.52	1.82	1.47	2.21
t	.95		1.74		.17		.50		.28		.51		2.06		2.23	

* p<.01

linkage involved. The waves for the experimental groups and the waves for the control groups were combined for a separate analysis (see Tables 31 and 32). The three distinct patterns which were apparent in the data are (1) high stage designations on the pretest task indicative of lower stage designations on the posttest task, (2) lower stage designations on the pretest task indicative of higher stage designations on the posttest task, and (3) most responses in Stage I.

An examination of the first type of pattern revealed that the majority of posttest task responses had remained in Stage I from the pretest. This may be a possible determinant of the lower posttest responses. The control group had ten comparisons in this type of pattern, while the experimental group had only three. This is supportive of the finding that the experimental groups evidenced a greater spread of responses across stage categories on the posttest than the control groups did, and suggests a possible program effect. The third type of pattern, mostly in Stage I on the pretest and posttest task, included area via units by conservation of number, deformation, and by conservation of substance, prediction for the experimental group. The control group comparisons for the same pattern type included successive seriation by double seriation, transposition, successive seriation by distance via units and successive seriation by area via units. In addition, most responses fell into the Stage I category for the control group comparisons of area via units by conservation of number, prediction and area via units by conservation of length, prediction.

The pattern type which is by far the most interesting is the second one in which a lower pretest stage category is indicative of a higher posttest stage category. The following are the cases which fit into this pattern for the experimental group:

TABLE 31

Summary of Gamma Values for Time Lag Data for Experimental Groups: Wave 1 and Wave 2 Combined

				Measurement					Conservation					
Pretest	Double Seriation Repro	Double Seriation Transpo	Transitivity	Length Comparison	Distance Via Reference Length	Distance Via Units	Height Via Reference Length	Area via Units	No. Conservation Prediction	No. Conservation Deformation	Length Conservation Prediction	Length Conservation Deformation	Substance Conservation Prediction	Substance Conservation Deformation
Absolute Seriation	.45	.28	.36	.26	-.05	1.0*	.43	.46	1.0**	.47	1.0*	1.0	1.0**	.41
Relative Seriation	.02	-.08	.23	.71	-.13	-.28	-.10	.04	-.04	.09	-.28	-.06	.04	.01
Successive Seriation	.09	.33	.39	-.23	-.13	.10	-.32	.49*	-.38	-.08	.07	-.03	.09	.28
Additive Seriation	-.10	-.17	-.09	-.10	-1.0**	-.44	.54	.12	.18	-.04	.31	.29	.24	-.05
Serial Corresp (1) +	.14	-.22	-.18	-.06	.21	-.06	-.25	-.11	.35	.45	-.08	.44	.63**	.38
Serial Corresp (3 & 4)+	-.24	.000	-.14	.32	-.42	-.73**	-.79*	-.16	-.27	.01	.11	.21	-.14	-.25
Double Seria Repro +	N.A.													
Double Seria Transpo +		.08												
Transitivity +			.33											
Length Comparison	.28	.18	.08	.07					.27	.40	.17	.42	.41	.49*
Distance Via Ref Length	1.0	1.0*	1.0		.79*				1.0	-1.0	-1.0	-1.0	-1.0	.48
Distance Via Units	1.0	.81*	1.0			.41			.48	.14	.02	.39	.33	.48
Height Via Ref Length	.58**	.40*	.84***				-.02		.23	.57*	.47	.44	.56**	.30
Area Via Units	.59	-.22	.46					.04	.21	.71**	.30	.46	.79**	.41

* $p<.05$; ** $p<.01$; *** $p<.001$; + P_2 only

TABLE 32

Summary of Gamma Values for Time Lag Comparisons for Control Groups: Wave 1 and Wave 2 Combined

				Measurement					Conservation					
Pretest	Double Seriation Repro	Double Seriation Transpo	Transitivity	Length Comparison	Distance Via Reference Length	Distance Via Units	Height Via Reference Length	Area Via Units	Number Prediction	Number Deformation	Length Prediction	Length Deformation	Substance Prediction	Substance Deformation
Absolute Seriation	.37*	.48**	-1.	-.15	1.	1*	N.A.	.68	-.11	.20	-.32	.12	--	.33
Relative Seriation	.03	-.02	-.37	-.32	-.16	-.18	N.A.	-.16	-.70*	-1.	-.28	-.45	-.65	-.65
Successive Seriation	-.31	-.35**	.05	-.20	-.43	-.63*	N.A.	-.77*	.18	-.26	.28	.22	.27	.27
Additive Seriation	-.40*	-.30	.26	-.13	-.68*	-.62*	N.A.	-.09	-.48	-.33	-.60	-.14	-.20	-.20
Serial Corresp (1)+	.18	.08	1.			-.38	N.A.	-.83**	.30	.33	.89**	.85*	.33	.33
Serial Corresp (3 & 4)+	-.17	.03	-1.	.35	-.25	-.51	N.A.	.54	.11	.05	.05	-.27	.22	.22
Double Seria Repro +	.57													
Double Seria Transpo +		-1.												
Transitivity			1.											
Length Comparison	.46	.80**	-1**	.39					.42		-.49	.30	.87**	.87**
Distance Via Ref Length	1.	.82	-1**		1.*				1.	1.	-1.	-1.	1.	1.
Distance Via Units	1.	.82	-1**			1.*			1.	1.	-1.	-1.	1.	1.
Height Via Ref Length	.45	.28	.13				N.A.		-.46	-.32	-.67*	-.41	-.14	-.14
Area Via Units	-.41	-.15	-.16					-.02	.67*	.52	.61*	.22	.38	.38

* $p < .05$; ** $p < .01$; + C_2 only

Pretest	Posttest
serial correspondence (3) & (4)	by height via reference length
distance via reference length	by double seriation, transposition
distance via units	by double seriation, transposition
dichotomous sorting	by cross classification, reproduction
dichotomous sorting	by cross classification, transposition
dichotomous sorting	by absolute seriation
dichotomous sorting	by successive seriation
dichotomous sorting	by additive seriation
dichotomous sorting	by serial correspondance (1)
dichotomous sorting	by serial correspondance (3) & (4)
dichotomous sorting	by double seriation, reproduction
dichotomous sorting	by transitivity
cross classification, reproduction	by relative seriation
cross classification, reproduction	by area via units
cross classification, transposition	by relative seriation

The control group comparisons which fit into the second time-lag pattern are:

Pretest	Posttest
additive seriation	by double seriation, reproduction
length comparison	by double seriation, transposition
length comparison	by transitivity
length comparison	by conservation of substance, prediction
length comparison	by conservation of substance, deformation

Pretest	Posttest
distance via reference length	by transitivity
distance via units	by transitivity
dichotomous sorting	by successive seriation
dichotomous sorting	by serial correspondance (1)
dichotomous sorting	by serial correspondance (3) & (4)
cross classification, reproduction	by cross classification, reproduction

The difference in the comparisons for the experimental and control groups in the time-lag analysis suggests a possible program effect. As mentioned above, the experimental group had only one third as many high to low comparison patterns as the control group had (10/3); moreover, the experimental group had fewer low to high comparison patterns than the control group did (11/15). In addition, the experimental group revealed a fourth pattern type which the control group did not. This was a pattern in which a Stage I on the pretest was indicative of a Stage I on the post-test but a Stage III on the pretest was indicative of anywhere from a III to a I on the posttest. This result may be evidence of a possible statistical regression or measurement error effect. There were four cases of this type:

absolute seriation by distance via units

absolute seriation by conservation of number, prediction

absolute seriation by conservation of length, prediction

absolute seriation by conservation of substance, prediction

There were many cases in the experimental and the control groups which indicated no particularly discernible type of pattern. Of all the time-lag comparisons, very few were significant in both groups simultaneously. Out of sixty three significant comparisons only eleven were shared by the two groups. Over all very different predictability patterns were found. Individual differences in pattern were as great as, if not greater than, group differences. Some children appear to spend a longer period in the transitional Stage II on some tasks while others move fairly quickly from Stage II to Stage III. It is not possible to discern whether the latter children are skipping the Stage II category entirely or whether the length of time between testings caused this stage to be missed. If children are actually skipping Stage II, this would contradict the theoretical assumption that stages of reasoning are invariant. To determine whether horizontal décalage-convergence (Wohlwill, 1973, Model II-A) is occurring, it would be necessary to have a third time of testing for comparison. It may turn out that different types of convergence or reciprocal interaction (Model III) occur for different individuals.

Neither the PPEP nor CNSP emphasized the conformity often required in later school experiences. The PPEP was specifically accepting of each child's individuality throughout all areas of the program. This factor may have had carry-over effects in the testing experience, allowing the children to be intellectually honest in these situations also. The care taken in making the testing situation for all subjects a comfortable and pleasant experience undoubtedly also contributed to the expression of individuality by subjects in both groups thus resulting in greater across-task variability.

4. Nonstatistical Consideration--Nontraditional evaluations included subjective impressions of parents, teachers, and testers, and anecdotal records kept by the teachers. Teacher evaluation of the general effectiveness of the PPEP were most positive. Teachers indicated that children's attitudes

towards problem solving, and approaches to unfamiliar materials, people or events changed markedly over the two year span. Anecdotal records on the spontaneous actions of children in the classroom indicated that children were making progress in terms of the Piagetian operations at issue. Many instances were recorded which revealed spontaneous seriation and measurement responses, as well as the beginnings of an awareness of conservation. Testers spontaneously stated that they felt the experimental group children were using a greater variety of approaches and solutions to the tasks than the control group children. The children's responsiveness to the general teaching framework was reflected in the positive reactions of the parents. Parents were eager to give accounts of experiences in the home and were curious about the activities which occurred at school. There was also general encouragement for extension and elaboration of the project into a kindergarten and first grade program.

V. CONCLUSIONS

In conclusion, the differential effectiveness of the PPEP was not established in the present research. While these results may be taken at face value, numerous other analyses provided information on a variety of changes occurring in early childhood. One of the most interesting findings was the wide variety of asynchronous patterns of developmental change. If the encouragement of individuality leads to asynchronous development, the increased use of programs such as the PPEP could result in changes in the developmental patterns found in previous research. The findings of synchrony and a universal sequence of development in previous research may be a reflection of the universal expectations of conformity by various societies. Although cultures differ, each society has generally expected its children to conform to its cultural patterns. Perhaps Piaget's universal findings, which heretofore have been thought to be relatively invariant across socio-cultural settings, could only apply to a relatively stable world where dependence on previously established cultural patterns is helpful. The present emphasis on preparation for constant and usually unpredictable change requires a break from such conformity. Divergence from old patterns is essential for continued adaptation to a rapidly changing society. Research findings of unsystematic asynchrony may reflect very real cohort differences rather than contradicting previous findings. It is paradoxical that programs, such as the British Infant Schools, open classrooms, or the PPEP, which are based on Piagetian theoretical assumptions and stress individuality may require adaptation of Piagetian theory in order to adequately describe future generations. Piaget (1970) spoke to this point when he said:

> If we desire, in answer to what is becoming an increasingly widely felt need, to form individuals capable of inventive thought and of helping the society of tomorrow to achieve progress, then it is clear that an education which is an active discovery of reality is superior to one that consists merely in providing the young with ready-made wills to will and ready-made truths to know with. (p. 26)

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Footnotes

1. This report is a summary of two copywrited dissertations by Ann Bingham-Newman and Ruth Saunders at the University of Wisconsin, Madison, Wisconsin, 1974. Any quotations or reproductions of this material must be arranged through the authors.

Ann Bingham-Newman
Coordinator, Child Development Program
California State University, L.A.
5151 State University Drive
Los Angeles, California 90032

Ruth Saunders
Child and Family Studies Program Area
School of Family Resources and Consumer Sciences
University of Wisconsin
1270 Linden Drive
Madison, Wisconsin 53706

2. Since a considerable number of recent reviews of the Piagetian training research literature are available (e.g., Beilin, 1971b; Brainerd, 1974; Brainerd & Allen, 1971; Glaser & Resnick, 1972; Hooper, Goldman, Storck, & Burke, 1971; Klausmeier & Hooper, 1974; and Wohlwill, 1970, 1973), references to these findings will be brief and given in the context of specific abilities. This is not to imply that controversy is nonexistent (cf. Brainerd, 1974, contrasted with Strauss, 1973), nor to question the role of such efforts in providing insight into developmental processes or theoretical constructs. The present study, however, is not to be confused with the standard training research paradigm. In contrast to such research, in which very specific procedures are used in teaching particular concepts, this program represents an attempt to incorporate general theoretically-derived principles into all aspects of a preschool program. A minimum of teacher-directed structure in the preschool program and the incorporation of theory into cognitive, socio-emotional, and psycho-motor domains distinguish this program as well from other endeavors to apply Piagetian theory to the classroom environment (e.g., Kamii, 1974; Furth & Wachs, 1974; Lavatelli, 1970, 1971; Sprigle, 1969; Weikart, 1971; and Willis, 1973).

3. The researchers would like to acknowledge the influence of the early work of Constance Kamii at the Perry Preschool in helping them to better understand some of the implications of Piagetian theory for early education.

4. Fifteen graduate nurses, sixty summer workshop participants, and twenty four student teachers have been involved in the teacher education program at various times in the course of the project. Their ideas, enthusiasm, and cooperation are greatly appreciated.

5. The teacher education program is more thoroughly described and discussed in Saunders (1975), dissertation in preparation.

6. It should be noted by the reader that the analyses reported in the Interim Progress Report, 1973, were not used in the present report. It was decided that the use of parametric statistics was inappropriate for this data and all previous analyses were discarded. Therefore, a comparison should not be attempted between data discussed in the Interim Report and data discussed in the present report.

7. Two measures of cognitive style, the Kagan Matching Familiar Figures Test and Maccoby's (1965) Walk-a-Line/Draw-a-Line Test of impulse control were initially included in the testing battery to determine the influence of the impulsivity-reflectivity dimension on subjects' problem solving abilities. Since a variety of analyses indicated a notable absence of statistically significant relationships in the results, these tests were dropped from the battery and replaced with items of more pertinent interest to the research. The lack of significant results was based on Kagan's impulsivity-reflectivity categories which employed no stage criteria.

8. Due to the nature of the present research which required two locations for subjects, it was not possible to function with "blind" testers who were unaware of which were the experimental or control groups.

9. The reader should note that a gamma value of ±1 is often indicative of inflation due to zero cell frequencies in the data. Since gamma deals only with untied pairs, the value becomes distorted more easily with a small sample. The gamma values of ±1 which are due to this type of distortion are labeled as such in the text.

10. Matrix analyses and correlational analyses between the classification tasks and the standardized measures are not included here, but can be found in Saunders, 1974.