California State University, Northridge

BEFORE-BEHIND SPATIAL RELATIONS
IN PRESCHOOL CHILDREN

A thesis submitted in partial satisfaction of the requirements for the degree of Master of Science in
Home Economics

by
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The thesis of Ellen Topkis Cale is approved.

Committee Chairman

California State University, Northridge
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To Douglas

For his constant support
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ABSTRACT

BEFORE-BEHIND SPATIAL RELATIONS
IN PRESCHOOL CHILDREN

by

Ellen Topkis Cale

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The primary purpose of this study was to clarify Jean Piaget's ages and stages of declining egocentrism in projective spatial relations by investigating the preschool child's knowledge of before-behind space. It was also sought to determine if different words used to describe these spatial relations have an effect on the preschool child's performance on the experimental tasks.

The subjects used in this investigation were 23 female and 21 male children attending the California State University, Northridge Preschool Laboratory.

Each subject was asked to perform a series of tasks which measure understanding of the before-behind projective relation. The tasks were fashioned after
those used or suggested by other authors to measure the decentration of projective space, particularly
with regard to the development of left-right concepts. Half the subjects tested were given task instructions
with the words "in front of" and "in back of." The other half of the subjects were exposed to the terms "before" and "behind."

This study demonstrated that the preschool child's ability to deal with before-behind projective relations
is not totally dominated by egocentric attitudes. It was also found that the age of the subject may be
an intervening variable in considering the effect of different spatial terms on task performance. Sex
differences in test performance were also explored.
CHAPTER I

INTRODUCTION

Spatial awareness pervades all aspects of human development. From infancy on, we must cope with space and spatial relations. As Barsch (1967) points out, objects and events must be located in space and responses must be made to directions given in terms of space.

The preschool years mark a vital stage in the evolution of spatial awareness and the concepts of space. Barsch depicts these years as being filled with such spatial exploits as sitting, standing, walking, climbing, running, throwing, drawing, and the resolution of spatial dilemmas. It is during this period of development that the child becomes aware of his body parts and their relationships which will serve as a reference point for his developing spatial orientation. Language acquisition, which occurs rapidly during this developmental period, enables the child to become more adept at organizing space and designating spatial relationships.

These achievements lay the foundation for cognitive and perceptual spatial sophistication. Spatial aware-
ness is thus a vital concept which the child must develop and refine if he is to function adequately in all areas of life.

Knowledge of the genetic psychology of spatial reasoning is of enormous value to the psychologist, teacher, and all those concerned with human development. Tolwer and Nelson (1967) contend that adequate spatial reasoning is a significant factor in the acquisition of such formal academic learnings as mathematics, geography, reading, and writing. Holloway (1967) maintains that in order to stimulate growth in these areas, it is necessary to understand the stages of cognitive growth so that appropriate learning experiences may be provided at each stage of development. In so doing, functioning in each developmental stage will be facilitated and transition to subsequent stages is ensured.

It has further been suggested that the tests and normative data generated by genetic studies of spatial reasoning might contribute valuable instruments to the field of psychodiagnosis (Meyer, 1940; Swanson and Benton, 1955). Meyer contends that genetic studies can provide valuable information in terms of general intellectual functioning. She goes on to state that in complicated and more sensitive reasoning processes such as those involved in spatial relations, "deviations
from normal mental activity may be suspected when solutions in tests of the kind employed (in genetic studies) differ from the established norm."

THEORETICAL FRAMEWORK

The Child's Conception of Space (Piaget and Inhelder, 1956) has made an enormous contribution to the knowledge of the genetic psychology of spatial reasoning. It is one of the many investigations carried out by Piaget and his co-workers on the various aspects of cognitive development. Such studies have served to document Piaget's theoretical framework of the developmental stages of cognitive growth.

According to Piaget, there are three major types of spatial relations: topological, projective, and euclidean. He asserts that topological relations are the most basic and the first to be mastered in the development of spatial concepts. Topological space is qualitative in nature and includes such concepts as neighborhoods, separations, ordinal relationships, and closure. Topological space deals exclusively with intrinsic relations of a single object and includes neither locating an object in relation to others nor points of view.

Projective and euclidean space coordinate partial topological spaces into total space. These two types
of relations derive directly from topological space. Projective relations include the concepts of left-right, before-behind, and above-below. Projective space deals with perspective and apparent changes in size, distance, and position. Euclidean space deals with measurements and the conservation of distances and dimensions.

Piaget characterizes the development of spatial awareness as proceeding along two levels at different developmental stages. He refers to these two levels as perceptual space, which is based on sensorimotor activity; and cognitive space, in which the primary mode of functioning is in the realm of representational or symbolic thought.

Perceptual space implies knowledge of objects from direct perceptual and motor contact. This level of spatial awareness begins at birth and develops during the first two years of childhood. Throughout this period, the child has experience with spatial relations and develops knowledge of them on a primitive perceptual and motoric level. In fact, by the end of the sensorimotor period, the child has perceptually and motorically explored all aspects of topological, projective, and euclidean relations.

By the end of the second year, the child's knowledge of objects is no longer bound to direct sensorimotor contact. He becomes capable of internal represen-
tation which allows him to evoke the image of objects in their absence. Although this achievement introduces the possibility of dealing with spatial relations cognitively, Piaget contends that the intellect does not simply elaborate on the perceptual spatial model. Instead, the child must re-encounter, on a symbolic level, the spatial relations already achieved on the perceptual level.

The evolution of representational space thus begins on the primitive topological level and develops, as the cognitive structures develop, to include the relations and measurements of projective and euclidean space.

A central tenet of Piaget's theoretical framework is that the development of representational space is bound by the egocentric and rigid mental structures of preoperational thought. In essence, the child initially lacks the cognitive capacities which will allow him to do more than restructure his own point of view. The child considers himself to be the privileged center of the universe. He judges all other objects to be a permanent and immutable static mass. Thus, in his spatial encounters, the child "centers" upon relationships between himself and the entire mass of objects. As the child begins to see himself in his spatial encounters as one object among many other distinct,
yet connected, objects; "decentration" results and egocentrism begins to wane. The cognitive structures gradually become reversible and capable of dealing with the transformations inherent in projective and euclidean relations.

Piaget has postulated three stages in the decentration of representational thought which are characterized by the following modes of cognitive functioning:

**Stage I: Total and Unconscious Egocentricity.** The child's own point of view is his only reference. He is entirely dependent on topological relations without referring to reference points outside of objects. In complex tasks, children at this stage are unable to follow the instructions or comprehend the task and are thus said to be pre-egocentric and are not tested.

**Stage II: Limited Decentration.** The child will sometimes give up his own point of view if the new perspective requires only a few simple transformations. For instance, the child at this stage is more likely to be able to adopt the point of view of a person facing him than a person seated at a 90° angle because the first transformation requires the reversal of only one projective relation whereas the second transformation requires translating one projective relation into another.

The child at this stage may persist in responding
in an egocentric manner. His behavior, however, may indicate that he is aware that other viewpoints exist but he is unable to make the necessary transformations in order to respond correctly. Such behavior results because objects are still considered to be permanent and immutable.

At this stage, the child is perceptually dominant and must often rely on external cues in order to make correct responses on certain tasks.

**Stage III: Objectification.** The child at this stage becomes aware of his own viewpoint and it thus serves as a reference point for coordinating relations. The child is able to reflectively foresee and anticipate spatial transformations and he is able to coordinate several transformations at once.

**STATEMENT OF THE PROBLEM**

Piaget and Inhelder devised a battery of spatial tasks in order to study the evolution of reasoning in representational space. Although Piaget's experimental procedures are oriented toward epistemological research (i.e. the study of the acquisition of knowledge) rather than normative research, he does make it clear on the basis of the results of his studies that the child does not begin to shed his egocentric attitudes until
the age of seven years.

From this evidence, it would seem reasonable to assume that the preschool child's means of dealing with spatial relations are purely pre-egocentric or egocentric and almost totally dominated by the static nature of topological relations. However, observation of the daily and routine behavior of preschool children seems to call into doubt the length of time that total egocentricity dominates the child's spatial behavior.

Response to spatial commands is perhaps the most notable example of behavior exhibited by preschool children which would suggest that decentering is taking place and the understanding of simple projective relations is at least beginning to emerge. Three year olds have the capacity for responding to such commands as: "Stand in front of me" or "Move the truck backwards." Four and five year olds can often carry out more complex spatial tasks.

Hence, the primary purpose of this study was to determine if preschool children demonstrate conceptual knowledge of before-behind projective relations in a series of experimental tasks. A secondary purpose was to gather normative data on the progressive decenteration of before-behind projective relations. These data were analyzed qualitatively in terms of Piaget's (1956) stages of decenteration. The final objective of this
investigation was to determine if different words used to describe spatial relations to preschool children have an effect on their performance on the experimental tasks.

**NULL HYPOTHESES**

1. There will be no significant difference among preschool children in the age at which egocentric attitudes in before-behind projective space begin to decrease.

2. There will be no significant difference in performance on experimental tasks between subjects who receive instructions with the words "before" and "behind" and subjects who receive instructions with the words "in front of" and "in back of."

**ASSUMPTIONS**

It was assumed in this study that the devised experimental tasks were valid measures of the conceptual knowledge of before-behind projective relations and that the sequence of tasks represents a graduated order of difficulty.

**LIMITATIONS**

The sample used in this study represents an intact preschool group from a white, middle-class community. The
results of this study are therefore only applicable to children of similar background and ages.

A further limitation is that since a major focus of this study was normative in nature, it would be desirable to study two year olds as well as children up to the ages of six or seven years. Such a wider sampling range might present a more complete picture of concept evolution. However, such subjects were unavailable to the author.

DEFINITIONS

_Centration_ is a term used by Piaget (1956) to refer to global exploration of objects which results in perceiving only one part of the object. Every such perception results in an over-emphasis on the one part perceived.

_Decentration_ occurs when passage from one centration to another results in an integration of perceptions and the construction of images. Every aspect of an object which is explored is at the same time considered distinct yet connected with every other aspect in terms of a fixed point of reference.

_Egocentricity_ has been postulated by Piaget (1970) as a characteristic of child thought. Piaget cites two aspects of egocentricity. The negative aspect is, in essence, a mental attitude which distorts reality
in the young child's reasoning. It implies difficulty in freeing oneself from one's own point of view and in coordinating one's own viewpoint with that of other observers. The child is thus unable to consider that other observers' viewpoints are different from his own.

Egocentricity also has a positive aspect in that it represents an attempt to understand new situations in terms of what is already known. The child is thus able to assimilate reality to his own actions. This, according to Piaget, constitutes the primary means of acquiring knowledge during the preoperational period of development.

Post-egocentrism is defined by Laurendeau and Pinard (1970) as the child's awareness of perspectives other than his own which leads to efforts of decentration.

Pre-egocentrism is another term used by Laurendeau and Pinard (1970) to refer to the child's inability to follow task instructions and his total dependence on topological relations without referring to a single reference point outside of objects.

Piaget (1969) refers to the stage of cognitive development between the ages of two and seven years as the preoperational period. During this stage, the child can process information directly in terms of subjective action or by internal representation of
objects and actions. The child's cognitive functioning is characterized by egocentric attitudes and other types of idiosyncratic thinking. The child is said to be preoperational because he has not yet developed the cognitive operations which will later allow him to logically handle transformations and relations.

The three major types of spatial relations are:

**Topological space** deals with the intrinsic relations of objects without concern for locating an object in relation to other objects. Topological space includes such concepts as neighborhood, proximity, separations, closures, and ordinal relationships.

**Projective space** concerns the relative positioning of objects in space in relation to a single observer. The concepts of left-right, before-behind, and above-below and their transformations with apparent changes in size, distance, and position are of major importance in projective space.

**Euclidean space** involves the coordination of objects in space. Euclidean space implies conservation of distance and dimension and it includes such metric concepts as parallelism, slope, angles, lines, similarity, and proportion.
CHAPTER II

REVIEW OF LITERATURE

To date, research dealing with the development of spatial concepts has not been extensive. And studies which deal directly with preschool children are even fewer. Until Piaget completed his work on spatial concepts, most studies dealt with limited aspects of spatial awareness. For instance, Ames and Learned (1948) investigated verbalized manifestations of space in children 18 to 48 months old. It was found that simple, one-dimensional space words are spontaneously verbalized by 18 months and by 2-6 years, most children can adequately answer questions dealing with various aspects of space. Development of verbalized space was found to follow a rather uniform age sequence.

These early normative-descriptive studies have the shortcoming of not being integrated into a theoretical framework which explains the mechanisms of age and stage developmental patterns. Piaget's work in cognitive development has provided the field with such a framework.

Piaget and Inhelder's (1956) study is based on
the observation of middle-class, Genevan children roughly between the ages of 2 and 13 years.\textsuperscript{1} The subjects were studied within the context of a series of tasks designed to elicit problem-solving behavior in the area of spatial relations. The areas covered in this work include topological space, projective space, and the transitions from projective to euclidean space.

The developmental stages which emerge from this study reflect cognitive growth from the end of the sensorimotor period to the beginning of the period of formal operations (11 to 12 years). Piaget sees no decline in egocentrism until middle childhood. However, the tasks which were devised for this study require the child to do a great deal of mental abstracting and they demand familiarity with such conventions as knot tying, shadow projection, and cross sections.

Piaget's task of Coordination of Perspectives is of particular relevance to the present study. This task deals with the positions of objects relative to one another and to various observers placed in different locations. Its primary purpose is to trace the child's developing awareness of his own point of view and its relation to the viewpoint of others. This is

\textsuperscript{1}Piaget's methodology is not rigorous, thus information on his subjects is not clearly stated.
the ultimate achievement in projective space which enables the child to objectively and reflectively coordinate relations.

In this task, the child is shown a model of three mountains. A doll is placed in a number of different positions around the model and the child is asked to first, reconstruct the scene that the doll sees using three pieces of shaped cardboard. Secondly, the child is asked to choose which of several pictures represent the view that the doll sees. In a third sub-test, the child is shown pictures of several different views of the mountains and is asked to place the doll in the positions from which each view can be seen.

Piaget found that stage I children (below four years) were unable to comprehend the task and therefore were not tested. Throughout stage II (four to seven years), the child distinguishes hardly, or not at all, between his own viewpoint and that of other observers. During the early part of this stage, the child's spatial imagination remains centered on a position corresponding to his own viewpoint which prevents him from making the necessary reversals of left-right and before-behind relations. In the latter part of this stage, the child's behavior may indicate that he is aware that other viewpoints exist but he is still unable to make the necessary transformations because objects
are still considered to be permanent and immutable masses. Hence, the child persists in responding in an egocentric manner.

The stage III child (seven to eight years on) becomes progressively aware of his own viewpoint which enables him to first coordinate single projective transformations and later, both transformations.

Thus, it is Piaget’s contention that the process of becoming aware of his own viewpoint is a deciding factor in the child’s decenteration in projective relations. In an earlier work, Piaget (1928) asserts that the child’s awareness of his own thought and reasoning processes, and thus his own viewpoint, is faint because he has no need to justify his thought. In fact, the need to verify thought processes and solutions does not arise until the child begins formal education, at about seven years. Hence, until this age, the child’s representation of reality is highly influenced and distorted by his egocentric attitudes. This, rather than the immaturity of child thought arising from ignorance, accounts for the child’s inability to deal with projective relations and problems of perspective.

Because of Piaget’s lack of empirical rigor and intentional disinterest in the normative aspects of mental development, several authors have sought to replicate Piaget’s studies in order to verify age
norms and the evolutionary development of spatial concepts.

In what has perhaps been the most extensive, systematic, and empirically rigorous replication to date, Laurendeau and Pinard (1970) confirm virtually all aspects of Piaget's findings.

In other replications, Lovell (1959) and Dodwell (1963) observed the same types of spatial behavior which Piaget describes as characteristic of various stages. However, both workers report variability in performance within age groups which would call into question the clarity of Piaget's stages. Dodwell further suggests that such factors as special interests and degree of training might disrupt Piaget's developmental pattern.

Other authors have cited further variables which might influence the results of performance on Piaget's spatial tasks. Eliot (1970) assessed Piaget's Coordination of Perspectives task in terms of photographic variables. He contends that two-dimensional pictures do not necessarily convey the same information as a three-dimensional display. Graphic representations require the viewer to possess knowledge of pictorial conventions, especially in judging depth.

Eliot further believes that task instructions might convey different meanings to children of different
ages. It is questionable if younger children would be able to interpret the meaning of "Find the place on the landscape which has the same view as the picture."

Shantz and Watson (1970) also assessed Piaget's findings in the Coordination of Perspectives task. These authors believe that performance on this task may be based less on egocentrism and more on the possibility that the child younger than seven years may be unable to express any knowledge he might have about change of perspective within a classical Piagetian situation. In order to assess the child's cognitive status and spatial egocentrism, and "expectancy violation" procedure was designed which holds in check verbal and photographic variables.

In this procedure, 48 preschool children between the ages of 3-0 and 5-2 years viewed a scene which could be seen at 0° and 180°. Each subject was exposed to the real condition of changed perspective resulting from the consequence of moving from the 0° position to the 180° position. In addition, each subject was exposed to a trick condition in which the display was surreptitiously rotated wither 90° or 180° as the subject changed positions.

A significant number of subjects of all ages differentiated between the natural and the trick conditions as judged by facial expressions and verbal-
zations of surprise and perplexity.

The authors conclude that preschool children have at least gross expectations regarding relations between their positions in space and the positions and appearances of objects. It is further contended that if decentration of the child's spatial concepts is broken down into two major steps: 1) construction of a system that coordinates transformations in spatial movement and transformations in perspective, and 2) application of that system to anticipate or symbolically represent moves in space; then it could be said on the basis of this study that an important period of decentration exists earlier in childhood than previous work would suggest.

Similar conclusions are implied in a study carried out prior to the publication of Piaget's study of spatial concepts, but after Piaget introduced his model of cognitive development. In this work, Meyer (1940) studied the comprehension of spatial concepts in preschool children within the Piagetian theoretical framework.

The experimental tasks used in this study are rather perceptually concrete although solution does require cognitive transformations. As a result, the author postulates three developmental stages which reflect the growth of the cognitive structures to handle
spatial relations. These stages are remarkably similar to the stages postulated later by Piaget, however the age of accession to each stage is well below Piaget's. In this study, objectivity is seen by four years.

Meyer contends that her stages reflect cognitive growth in the period between sensorimotor space and "reflective thought." She further states that a similar genetic sequence occurs at the sensorimotor level as well as at the level of reflective thought. Meyer's evidence thus suggests decenteration in spatial relations during the preschool years on simple, concrete tasks.

Another study which suggests at least limited decenteration during the preschool years was done by Holmes (1932). The intended purpose of this work was to determine what sizes, shapes, and positions are comprehended by young children. However, the experimental task devised for this study is somewhat revealing of the child's ability to adopt another viewpoint.

Forty preschool children were told a story about the adventures of a teddy bear. The story contained 25 words of size, shape, and position. Each child was given a toy teddy bear and after each critical word or phrase, the experimenter paused and asked the child to make the teddy bear perform the act.

It was determined that by 3-6 years, at least
80 percent of the subjects were able to respond to selected words of spatial position. The children were thus able to adopt the viewpoint of the teddy bear in responding to the spatial words in the study.

The three relations which must be mastered in projective space are left-right, before-behind, and above-below. Piaget's Coordination of Perspectives task studies the decentration and coordination of the left-right and before-behind relations. To date, studies which deal with the decentration of just one of these relations have been, for the most part, limited to the investigation of left-right discrimination.

Piaget (1928) traced the growth of relativity in projective relations in a study of left-right discrimination. This test was administered to 200 children between the ages of 4 and 12 years. Each child was asked to designate his own right and left body parts, the right and left body parts of the experimenter who was seated facing opposite the child, and the relative lateral positions of three objects on a table.

The test responses were analyzed in terms of three developmental stages:

Stage I: This stage is observed between the ages of five and eight years. Left and right are considered only from the child's point of view (egocentrism).

Stage II: The child between 8 and 11 years
considers right and left from another person's point of view (socialization).

**Stage III:** By 11 or 12 years, left and right are considered in relational terms, that is, from the point of view of the objects themselves (objectivity).

Swanson and Benton (1955) and Laurendeau and Pinard (1970) replicated Piaget's study and found analogous developmental patterns.

Laurendeau and Pinard (1970) have pointed out that there has been little or no systematic investigation of the other two projective relations (before-behind and above-below). Piaget (1956) points out that before-behind relations may be easier to comprehend than left-right relations. He bases this hypothesis on the fact that before-behind spatial positions are not equally accessible to the child as are left-right positions. Thus, the child is more readily able to recognize his own viewpoint in before-behind relations. It is therefore tenable to believe that decenteration in before-behind relations occurs at an earlier age than has been observed for left-right relations.
CHAPTER III

METHODS OF INVESTIGATION

SAMPLE SELECTION

The sample used in this study was composed of 23 female and 21 male children attending the California State University, Northridge Preschool Laboratory. The sample ranged in age from 3-0 to 4-11 years, with a mean age of 4-0 years.

The 44 subjects were drawn from a pool of 67 children enrolled in the California State University, Northridge Preschool program. Of the 23 children who were not tested, 12 were handicapped children who had been integrated into the program under the auspices of a Department of Health, Education, and Welfare Grant. These children were eliminated from the study at the outset in an attempt to obtain a homogeneous sample in terms of perceptual and mental abilities. Ten children refused to enter the testing situation. One child's protocol was eliminated because of evidence that it was invalid.
INSTRUMENTS

The subjects were tested over a four-week period beginning on February 23, 1972 and ending on March 15, 1972. Each subject was asked to perform a series of tasks which measure understanding of the before-behind projective relation. The tasks were fashioned after those used or suggested by other authors to measure the decenteration of projective space, particularly with regard to the development of left-right concepts (see, for example: Piaget, 1928; Swanson and Benton, 1955; and Laurendeau and Pinard, 1970).

The test materials and test protocol were pre-tested with three children from the Haidn House Preschool and three children who were enrolled in the California State University, Northridge Preschool Laboratory on the Federal Grant and were therefore excluded from the actual study.

The test materials consisted of two pieces of green felt, two small plastic animals, two paper trees, and one plastic farmer doll. Before each subject entered the examining room, the two pieces of felt were placed side by side on a table. One tree was put in the middle of each piece of felt. When the subject entered the room, he was seated in front of one of the felt pieces and the examiner was
seated beside the subject, in front of the other piece of felt. Once settled in the examining room, the subject was told that he was going to play a game about a farm.

The test protocol was divided into three major sections:

I Recognition of Before-Behind Spatial Positions in Relation to the Subject's Own Body.

II Recognition of Before-Behind Spatial Positions in Relation to an External Observer Situated Opposite the Subject.

III Comprehension of the Relativity of Before-Behind Spatial Positions.

Each test section was designed to reach one of the three major stages in the cognitive construction of projective spatial relations as postulated by Piaget (1956):

I Total and Unconscious Egocentrism.

II Limited Decentration.

III Objectification.

In addition, each section of the test protocol contained questions which measured comprehension of before-behind relations in body space as well as external space. The reasoning behind this is perhaps best described by Vreecken (1961) who points out: "'Behind the own body' is a relation which is very different from 'Put the yellow block behind the red
one,' because the yellow block is behind the red one but in front of the own body."

It was further determined necessary to include in the latter two sections of the test, tasks which would reduce perceptually concrete cues. Such tasks would require the subject to perform mental transformations which would be indicative of the child's ability to anticipate and mentally represent changes in perspective. Piaget (1956) regards this type of spatial knowledge to be more advanced than simple transformations of perceptual space.

Consequently, three tasks were included in each test section in order to ensure that each child's abilities to deal with body space, external space, and representational space were tapped.

Piaget's (1956) stages of decentration as they relate to the experimental tasks used in this study are as follows (see Appendix A for a detailed description of the experimental tasks):

Piagetian Stage I: Total and Unconscious Egocentrism

Piaget contends that at this stage, the child's own point of view is his only point of reference. The child, being unaware of his own viewpoint, is unable to conceive of any perspective but his own and therefore does not refer to reference points outside of objects. Spatial terms are absolutes in the child's thinking
since he has not yet developed the cognitive capacities which will permit him to mentally change and reverse the spatial positions dependent on another observer's positions.

**Test Section I: Recognition of Before-Behind Spatial Positions in Relation to the Subject's Own Body**

The three tasks which comprise this test section require the child to simply restructure his own point of view without referring to outside reference points. In the first task, the subject was asked to place the toy animal on his farm in various topological positions around the tree. This was designed as a non-verbal, baseline recognition of before-behind spatial positions and was accomplished by asking the child to place his animal on his farm in the same manner as demonstrated by the examiner.

The second task required the child to designate various parts of his own body - the front of his body, the back of his body, the front of his head, the back of his leg, and so on. In the final task of this section, the subject was asked to deal with external space by identifying which of two items on the farm was in front and which was in back.

It was thought that successes on all three tasks of this section with subsequent failure on the remaining tasks would indicate that the child had a
firm and invariable grasp of before-behind spatial positions with reference to his own body and point of view. Such a child would be classified in stage I.

**Piagetian Stage II: Limited Decentration**

Piaget describes the child in this stage as being able to give up his own viewpoint if the new perspective requires only a few simple transformations. Such a transformation would be adopting the viewpoint of an observer situated in $180^\circ$ opposition to the subject. Thus, the child at this stage is beginning to discover his own point of view which will in turn allow him to adopt simple perspectives of other observers.

The stage II child no longer considers spatial terms to be absolutes. He realizes that spatial positions change as the observer's positions change but he is not always able to make the necessary cognitive transformations. Thus external cues are often necessary in order for the still perceptually dominant child to make correct responses.

**Test Section II: Recognition of Before-Behind Spatial Positions in Relation to an External Observer Situated Opposite the Subject**

All of the tasks in this section of the test protocol require the child to adopt the viewpoint of an observer situated in $180^\circ$ opposition to the subject. In the first two tasks, the farmer figure was placed
on the farm in two successive positions opposite the subject. The child was asked to determine how the farmer, in each position, saw the items on the farm. These two tasks permitted the child full use of perceptually concrete cues as they were displayed on the farm scene.

Task three required the subject to stand beside the examiner, but facing in the opposite direction. The child was then asked to respond from memory to a series of questions concerning which of two designated room furnishings was in front of him, in back of him, in front of the examiner, and in back of the examiner (Is the door or the window in front of you?). This task greatly reduced the availability of perceptual cues and required the child to mentally represent to himself the spatial positions of the designated objects.

The child who successfully completed all of the tasks to this point in the test protocol would be demonstrating his understanding of the perspective changes incurred by positional transformation. Correct responses to these tasks could only be made if the child could successfully relinquish his own viewpoint in favor of another. This would indicate that the child's spatial imagination is no longer centered on a perspective corresponding with his own point of view. Such a child would be classified in stage II.

*Piagetian Stage III: Objectification*
Piaget describes the child at this stage as being fully aware of his own viewpoint which serves as a reference point for adopting the point of view of another observer with changes in perspective. The child is able to reflectively foresee and anticipate spatial transformations without the aid of external cues and he is able to coordinate several transformations at once. The child is further able to adopt the viewpoint of the objects themselves in designating their relative spatial positions.

Test Section III: Comprehension of the Relativity of Before-Behind Spatial Positions

The first two tasks of this section required the child to adopt the viewpoint of an observer situated at a 90° angle in relation to the subject. Although this test did not require the child to coordinate two projective relations at once, success in these tasks demanded that the subject translate the perceptual left-right into the relational before-behind.

In the first task, the child was asked to stand at a 90° angle in relation to the examiner. A series of questions on the spatial positions of designated room furnishings were then asked (Is the table or the wall in front of you?). As was the case in the last task in section II, this task reduced the availability of perceptual cues to the child. The subject had to
simultaneously mentally represent the before-behind of his body space while translating his own left and right into the before-behind of the examiner's body space.

The subject's attention was drawn back to the farm materials for the second task of this section. The farmer figure was placed at a $90^\circ$ angle in relation to the child. The subject was then asked to determine how the farmer saw the other items on the farm. Once again, perceptually concrete cues were available to the child.

In the final task of the series, the child was asked five questions concerning the relative spatial positions of the three items on the farm. This required the child to adopt the viewpoint of the objects themselves.

The child who successfully completed all of the tasks in the test protocol would be demonstrating his ability to coordinate spatial perspectives. Unlike the child in stage I who is largely structuring and restructuring perceptual data, or the stage II child who can only adopt the viewpoint of an observer situated at $180^\circ$ angle, the stage III child can mentally represent and anticipate more complex perspective changes involving translation of one spatial position into another. Such a child can deal objectively and effectively with the relational nature of before-behind projective space.
In order to determine the effect of different spatial words on performance in the various tasks, two test protocols were used. The two protocols were identical in every way except that the words "in front of" and "in back of" were substituted in appropriate places for the words "before" and "behind." The odd-numbered subjects tested were administered the "in front of-in back of" protocol. The even-numbered subjects were administered the "before-behind" protocol.

The experimental tasks were administered in a progressive sequence beginning with what was assumed to be the easiest task and ending with the most difficult. Therefore, in order to avoid frustration, failure on any two successive tasks was the basis for termination of the experimental procedure for any one subject.

Each subject's performance on each question was recorded as either plus, for success; or minus, for failure. The child's final answer was the one that was recorded. Thus, when the protocol contained probes, an initially incorrect response was disregarded if the child corrected himself (see Appendix B for sample score sheet).

To qualitatively assess each subject's performance in terms of Piaget's (1956) stages of deccentration, none of the tasks were considered passed unless all of the questions in it were correctly answered. As
Piaget (1928) points out, when there are only two possible responses to a question, the chances are two-to-one that a correct response will be made by chance. Furthermore, only one or two correctly answered questions within a task indicates that the subject does not have a firm and invariable grasp of the concept.

In pre-testing the materials, however, it was found that a subject who showed reasonable understanding of the concepts being tested might respond incorrectly to the first questions of a task. Thus, in order to ensure that such errors were not merely the result of transitional confusion, such responses were verified by repeating the missed questions verbatim upon the completion of the task.

**STATISTICAL TREATMENT OF THE DATA**

A chi square test and t tests were used to assess the significance of the data. It was determined that a .05 level of significance or better would be used to establish significance of relationships for the analyses in this study.
CHAPTER IV

RESULTS AND DISCUSSION

RELATIVE DIFFICULTY OF THE TASKS

In order to analyze the performances of the subjects on the experimental tasks, it is necessary to confirm the order of task difficulty which was predicted in the construction of the test protocol. The index of difficulty was derived by computing the percentage of subjects in each age group who successfully answered all of the questions in each task (see Table 1). For the observed frequencies and median ages upon which these computations were based, see Appendix C).

A global indication of the relative difficulty of the tasks is provided in Table 1 by a comparison of the ages of accession. The age of accession was determined to be the age at which 50 percent of the subjects successfully completed each task in the test protocol (Laurendeau and Pinard, 1970). The formula used for this computation is found in Appendix D.

With the exception of task G, Table 1 shows that the ages of accession become greater in moving from task A to task I. Disregarding task G for the moment,
TABLE 1
SUCCESES OF SUBJECTS
BY AGE LEVEL
(DATA IN PERCENTAGE)

<table>
<thead>
<tr>
<th>Age of access-</th>
<th>Below</th>
<th>Above</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-0</td>
<td>3-4</td>
<td>3-10</td>
</tr>
<tr>
<td>4-0</td>
<td>4-2</td>
<td>4-6</td>
</tr>
<tr>
<td>4-5</td>
<td>4-11</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tasks</th>
<th>N</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-6</td>
<td>15</td>
<td>93.3</td>
<td>86.7</td>
<td>60.0</td>
<td>86.7</td>
<td>86.7</td>
<td>73.3</td>
<td>53.3</td>
<td>53.3</td>
<td>26.7</td>
</tr>
<tr>
<td>4-0</td>
<td>8</td>
<td>75.0</td>
<td>62.5</td>
<td>62.5</td>
<td>62.5</td>
<td>50.0</td>
<td>37.5</td>
<td>12.5</td>
<td>37.5</td>
<td></td>
</tr>
<tr>
<td>3-6</td>
<td>9</td>
<td>88.9</td>
<td>55.6</td>
<td>33.3</td>
<td>22.2</td>
<td>22.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-0</td>
<td>12</td>
<td>58.3</td>
<td>41.7</td>
<td>33.3</td>
<td>16.7</td>
<td>8.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
the ages of accession indicate that each successive task is progressively more difficult.

However, if the sequence of tasks did represent a true graduated order of difficulty, the observed percentages of correct responses shown in Table 1 would become greater in going up each column from the youngest age group to the oldest age group. Similarly, the observed percentages would remain the same or become smaller in going across each row from task to task.

Table 1 indicates that such a graduated order of percentages occurs in all but three places: task A, task C, and task G.

In task A, the 4-0 to 4-5 year age group shows a decline in the number of subjects who successfully completed this task. The subjects were required in this task to place the animal in various spatial positions around the tree in a manner demonstrated by the examiner.

Analysis of the individual test protocols reveals that the two subjects in this age group who failed this task made what might be described as topological placements of the animal. That is, instead of placing the animal directly in front of or in back of the tree, these subjects placed the animal in proper spatial area (front or back) but somewhat to the left or right of the tree. Such a response, according to Piaget (1956), would be indicative of reliance on
qualitative topological spatial strategies which preclude the use of reference points outside of objects.

It should be mentioned that both of these subjects missed only one of the two questions in this task and they both went on to pass more difficult tasks in the protocol. In fact, analysis of all of the individual protocols reveals that of the nine subjects who made topological placements in this task, seven were able to complete more difficult tasks in the sequence. It therefore seems apparent that performance on this task is not necessarily predictive of performance on subsequent tasks. In many cases, the inability to successfully complete this task might be attributable to carelessness resulting from the ease with which many of the older subjects were able to carry it out. Thus, these errors are not necessarily related to the ability to understand the before-behind positions.

This task was included in the protocol only as a baseline measure of comprehension of spatial positions. Hence, for analytical purposes, performance on this task was weighed against each subject's successes on the other tasks of the measure.

The irregular percentages of successful completions of task C reveal the general confusion and misunderstanding exhibited by the subjects when confronted with this problem. The subjects were asked in this task
to designate the spatial positions of two items (We have a tree and an animal on the farm. Which is in front, or before? Which is in back, or behind?).

Of the 42 subjects who reached this task, 20 successfully responded to the two questions. Of the remaining 22 subjects who did not successfully complete task C, 7 made what might be termed as random responses. That is, when asked, "Which is in front?", they would point to the animal, which is the correct response. However, when asked, "Which is in back?", they again pointed to the animal. These subjects were clearly unable to differentiate between the before and behind spatial positions.

The remaining 15 subjects made systematic reversals in responding to the questions of this task. That is, when asked "Which is in front?", these subjects pointed to the animal; when asked "Which is in back?", they pointed to the tree.

The reasons for such a reversal are speculative since none of the subjects were able to explain why they gave the answers that they did. However, in responding to this task, many of the subjects seemed to have been thrown off guard by the absence of stated reference points on which to base their answers. A look at the aims of this task might therefore be revealing.
The purpose of the task was to measure ability to deal with absolute positions in external space. Thus, the reference point implied in this task would be the objects themselves. At this point in the test protocol, such an implication was perhaps too advanced and the expected answer may have required relational understanding of the concept. A more successful measurement of the ability to deal with absolute positions in external space might have been placement of the animal by the examiner in front and in back of the tree and asking the subject, "Is the animal in front of (before), or in back of (behind) the tree?" A task of this nature would provide the subject with the necessary external cues and would more readily establish comprehension of the before-behind positions in external space.

It would be reasonable to assume, however, that the subjects who made systematic reversals in their protocols were demonstrating a knowledge of the absolute before-behind spatial positions. In their 1955 study on the development of left-right concepts, Swanson and Benton attributed success to those subjects who systematically showed the left part of the body when asked to show the right and vice versa. The authors contend that it is obvious that subjects who consistently make such reversals are not responding randomly and therefore demonstrate the ability to discriminate between the two
spatial positions.

In view of the confusion apparently aroused by this task, performance in this area was analyzed with regard to each subject's total protocol. Only one of the subjects who gave random responses in this task went on to successfully complete more difficult tasks, whereas eight of the subjects making systematic reversals were successful in completing further tasks.

It might be worthwhile to note, however, that of those eight subjects who made systematic reversals and were able to successfully complete further tasks, the highest level of success for three of them was task D. This presents a further problem in protocol analysis since the correct answer to task D would be the same as the systematic reversal for task C. In other words, task D required the subject to designate how an observer standing opposite and facing the child saw the items on the farm. The aim of this task was to measure the child's ability to transform the spatial positions with a designated change in perspective. Thus, it is unknown whether a successful response in task D, in these cases, represented the ability to mentally transform spatial positions or if it was merely a perseveration of the response given in task C.

Rather than attribute success to a questionable response, in assessing the performances of these three
subjects, task D was not considered successfully passed.

In task G, neither the graduated percentages nor the age of accession are consistent with what would be expected if one could assume a progressive sequence of task difficulty. This task required the subject to stand at a 90° angle to the examiner and answer a series of questions on the spatial positions of room furnishings.

The percentages and the age of accession indicate that task G was more difficult than task H. This, in all probability, is the case since task G reduces perceptual cues and requires the child to do more mental transformation and representation than was required in task H.

Tasks G and H should have been reversed in their order of appearance on the protocol, thus explaining the irregularity in age of accession for these tasks. The order was not reversed at the outset in the interest of facilitating the administration of the test. Since task F required the subject to be standing, it was thought that task transition would be easier for the child if task G (which also requires the child to be standing) was the next in the sequence. Given these circumstances, task G was considered more difficult than task H for the purpose of protocol analysis.
NULL HYPOTHESIS 1

This hypothesis proposed that there would be no significant difference among preschool children in the age at which egocentric attitudes in before-behind projective space would begin to decrease.

Establishment of a Developmental Scale

In order to statistically analyze this hypothesis, a developmental scale must first be established based on Piaget's (1956) stages of decentration. Such a scale will permit qualitative assessment of each subject's performance on the test instrument in terms of declining egocentricity.

Piaget (1956) describes three broad stages of declining egocentrism: I) Total and unconscious egocentrism, II) Limited decentration, III) Objectification. Each subject's test protocol was analyzed accordingly.

The subjects who were able to complete at least one of the first three tasks in the discrimination of before-behind space were classified in stage I. The ability to successfully adopt the point of view of an observer in 180° opposition would put a subject in stage II. The minimal criterion for accession to stage III is the ability to adopt the viewpoint of an observer situated at a 90° angle. In addition, a
stage 0 was set up for those subjects who were unable to successfully complete any of the experimental tasks.

It is obvious that classification into these three broad stages is not discriminating enough when taking into account the length of the test and variability of performance and cognitive development among the subjects. For example, it is assumed that the child who can consistently and invariably designate the front and back parts of his own body shows a more advanced understanding of the before-behind concept than the child who can only make topological placements. In other instances, some subjects were able to successfully complete a stage III task but had previously failed a stage II task. Such performances do not necessarily show a straightforward ability to deal with objective space and need to be analyzed more discretely.

Hence, a series of substages fashioned after those used by Piaget (1956), Laurendeau and Pinard (1970), and other workers, have been delineated. These substages should more accurately reflect the decline of egocentric attitudes in the development of the before-behind spatial concept.

Detailed Description of Stages

Stage 0: Inability to Successfully Complete any Tasks
(Mean age: 3-3 years)
Two subjects were classified in this stage. In both instances, the subjects showed poor attention spans and a resistance to the test situation.

In task A, each subject made one topological placement error. These errors were marked by the fact that the animal was not placed in the correct spatial area. For example, one of the subjects put his animal directly to the right of the tree when the examiner's placement was behind the tree.

In task B, these subjects made at least one, but as many as five, reversals in designating their front and back body parts. Although these subjects demonstrated the knowledge that the spatial terms referred to different bodily positions, their responses were arbitrary and showed lack of a consistent and invariable understanding of the concept.

Stage I: Ability to Consistently Discriminate Before-Behind Space (Mean age: 3-8 years)

The subjects in this stage were able to successfully complete at least one, but as many as three tasks in the first section of the test protocol. Such successes clearly indicate the emergence of the before-behind spatial concept.

These subjects understood that "before" and "behind" or "front" and "back" were labels which referred to specific spatial localizations with regard to
their own body and point of view. However, stage I children were unable to deal with the relational aspects of the concept. When confronted with a change in perspective, these subjects responded arbitrarily without any awareness that such a change required them to give up their own point of view. Egocentricity is clearly the dominating cognitive characteristic of this stage.

**Substage IA:** The distinguishing characteristic of this substage was the subjects' success in locating before-behind space in either task A or task C. However, these subjects were unable to consistently identify the front and back parts of their own bodies in task B.

Of the 11 children classified in this substage, only 2 were successful in task C (see Table 2). Thus, it might even be said that these subjects were still unfamiliar with the exact meaning of the verbal referents for the spatial positions.

These subjects did, however, realize that the spatial labels referred to spatial locations but this realization was vague and inexact. Thus, all of the subjects gave responses in task B, but many of them were reversals. These children had yet to grasp the specificity of the spatial labels.

**Substage IB:** The number of successfully completed tasks was variable for the 11 subjects in this
### TABLE 2

NUMBER OF SUBJECTS WHO SUCCESSFULLY COMPLETED TASKS IN STAGE I

<table>
<thead>
<tr>
<th>Sub-stage</th>
<th>N</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E *</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
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<td>11</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IB</td>
<td>11</td>
<td>8</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

* No subject in this stage was able to complete a task beyond this point.
substage, but they all demonstrated a firm and invariable understanding of the before-behind spatial labels by successfully designating all of their front and back body parts (see Table 2).

There was only one subject classified in this substage who did not meet the criterion of successful completion of task B. This subject was successful in tasks A, C, and E but missed one question in task B. The fact that this subject was able to complete a task in section II of the protocol made her a questionable candidate for substage IA. Nevertheless, the error in task B disqualified her from stage II. Substage IB seemed to be the most appropriate classification for this subject who was apparently on the verge of an invariable and relational understanding of the concept.

It is interesting to note here that the three subjects in this substage who successfully completed task D made systematic reversals in task C. Additionally, task D was the highest level of success achieved by these three subjects.

It is clear, however, that the subjects in this substage had advanced a step ahead of those in substage IA by demonstrating their ability to appropriately respond to verbal spatial labels.

Stage II: Ability to Adopt the Viewpoint of an Observer in 180° Opposition (Mean age: 4-2 years)
In stage II, the concepts of before and behind assume new meaning for the child. The concept is no longer an absolute delineated by spatial labels. The stage II child realizes the relativity of before-behind space as it applies to changes in perspective.

The subject in this stage, however, does not yet have the cognitive capacities to deal successfully with complex perspective changes; but he is clearly capable of giving up his own viewpoint to designate the front and back space of an observer in 180° opposition. The primary characteristic of this stage is thus declining egocentrism, or limited decenteration.

Substage IIA: The six subjects in this substage showed the ability to assume the viewpoint of an observer in 180° opposition with the aid of perceptually concrete cues. Tasks D and E provide such cues, thus these subjects successfully completed at least one of these tasks but failed task F which requires the child to perform more rigorous mental transformations.

Two subjects in this substage scored unqualified successes in both tasks D and E (see Table 3). Three of the subjects scored apparent success in both of these tasks but a closer scrutiny of their protocols brings their performances on task D into question. These subjects responded to task C in test section I with systematic reversals. Thus performance on task D
TABLE 3
NUMBER OF SUBJECTS WHO SUCCESSFULLY COMPLETED TASKS IN STAGE II

<table>
<thead>
<tr>
<th>Sub-stage</th>
<th>N</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IIB</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
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</tr>
</tbody>
</table>
might be a chance success if the responses to this problem reflect a perseveration of the task C response rather than a true transformation of spatial position.

Nevertheless, these subjects, along with the one subject who successfully completed only task E, demonstrated the emerging ability to cope with the relational aspects of before-behind spatial positions.

**Substage IIIb:*** Accession to this substage is characterized by the ability to identify the before-behind spatial positions of an observer in 180° opposition without the aid of perceptually concrete cues. Thus, the criterion for placement at this level is successful completion of task F.

Of the two subjects in this substage, one successfully completed all three tasks (D, E, and F) of section II of the test protocol (see Table 3). Such a performance shows a firm and invariable grasp of the concepts involved in transforming spatial positions with a simple change in perspective.

The performance of the second subject in this substage was more variable. This subject successfully completed tasks D, F, and H. Failure in task E, but success in adopting the viewpoint of an observer situated at a 90° angle in task H, seems to indicate that this subject was in a transitional phase. She was apparently on the verge of cognitively consolidat-
ing all of the relational aspects of the before-behind spatial concept. If tested a month or two later, this subject's performance would probably be more consistent. At this point, however, failure on task E precluded placement in stage III.

Stage III: Ability to Deal with Objective Spatial Relations (Mean age: 4-9 years)

In stage III, the child exhibits a more advanced ability to deal with the relational aspects of before-behind space. Identifying the before-behind space of an observer situated at a 90° angle requires complex mental transformations involving the translation of left-right into before-behind.

In addition, the stage III child becomes capable of assuming the viewpoint of objects. Success in doing this reveals the child's ability to deal not only with coordinating potential perspectives, but also to cope with the unstable spatial relations of three objects in a row. Laurendeau and Pinard (1970) note that the former ability requires the child to merely discover that the viewpoint of an external observer is a potential viewpoint of his own. It then remains for the child to mentally put himself in that observer's position. Once that transformation has been made, the actual spatial positions in relation to the subject's body remain stable. The latter ability, on
the other hand, requires the child to mentally cope with the unstable internal relations of a series: object B in a series of A, B, C is at once both before C and behind A; object A is in front of both B and C. The solution of such a task requires the subject to deal with the objects of a problem and adopt perspectives which are not necessarily potential viewpoints of his own. The child who reaches this stage is truly dealing objectively with before-behind space.

Substage IIIA: The eight subjects in this substage demonstrated the ability to perform the appropriate mental transformations in adopting the viewpoint of an observer situated at a $90^\circ$ angle. Three of these subjects were only able to accomplish this with the aid of the perceptually concrete cues provided in task H (see Table 4). The capability of performing the mental transformation necessary in adopting such a viewpoint is apparently just emerging in these subjects.

A successful completion of task G demonstrates a more advanced and invariable grasp of the appropriate mental transformations since this task reduces the availability of perceptual cues. The three subjects who responded correctly to all of the questions in tasks G and H seem to have a tenacious understanding of the coordinations involved in perspective changes
<table>
<thead>
<tr>
<th>Sub-stage</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIIA</td>
<td>8 8 8 5 8 8 8 5 6 0</td>
</tr>
<tr>
<td>IIIIB</td>
<td>4 4 4 3 4 4 4 4 4 4</td>
</tr>
</tbody>
</table>

TABLE 4
NUMBER OF SUBJECTS WHO SUCCESSFULLY COMPLETED TASKS IN STAGE III
(see Table 4). They were aware of their own viewpoint and were therefore liberated from it for the purpose of adopting another's point of view.

The two subjects who responded correctly to the more complex task G, but were unsuccessful in task H, probably had a degree of understanding of the before-behind concept which would be akin to that of the subjects who scored successes in both of these tasks. The failures in these two cases were more likely attributable to fatigue at the end of a long test protocol than lack of understanding.

Substage IIIB: The subjects in this substage have reached the pinnacle in the developmental sequence of before-behind spatial reasoning at this stage of mental development. Their success in task I indicates the emergence of the ability to deal objectively with before-behind space. Furthermore, these children have demonstrated a versatile range of spatial cognition in dealing successfully with a variety of problem situations throughout the test protocol.

Three of the four subjects in this substage successfully completed all of the tasks on the test protocol (see Table 4). The fourth subject responded to task C with a systematic reversal. However, given the questionable status of this task and the child's perfect performance on the rest of the protocol, this
subject undoubtedly belonged in this substage.

It is necessary to note that accession to this substage does not constitute the conclusion of cognitive development in before-behind space. As the child advances to higher stages of mental development (Piaget's periods of concrete operations and formal operations) he will undergo similar developmental sequences. He will eventually become capable of dealing with spatial concepts on a more abstract and reflective level and he will develop more flexible and advanced cognitive operations to apply to the solution of spatial problems.

Statistical Analysis

The observed frequencies of subjects at the four age levels and seven substages were too small to be analyzed by a chi square test (see Table 5). The age-substage categories were therefore collapsed to allow the data to be statistically analyzed. A chi square test was run on the frequency data presented in Table 6. The test was significant at less than the .01 level.

This data is in accordance with Shantz and Watson's (1970) hypothesis that the child below the age of seven years realizes that spatial positions change with changes in perspective but he is unable to
### TABLE 5

**DISTRIBUTION OF SUBJECTS BY AGE LEVEL AND BY SUBSTAGES**

<table>
<thead>
<tr>
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<th>IB</th>
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<th>IIB</th>
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<tr>
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<td>0</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
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<td>3-6</td>
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<td>0</td>
<td>2</td>
<td>6</td>
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<td>0</td>
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</tr>
<tr>
<td>3-0</td>
<td>12</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

| Total | 44 | 2  | 11 | 11 | 6   | 2   | 8    | 6    |

| Mean Age | 3-3 | 3-5 | 3-7 | 4-1 | 4-4 | 4-8 | 4-10 |

---
Chi square is significant at less than the .01 level (chi square = 13.277, with 4 degrees of freedom).

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<tr>
<td>Total</td>
<td>44</td>
<td>24</td>
<td>8</td>
<td>12</td>
</tr>
</tbody>
</table>

**TABLE 6**

**DISTRIBUTION OF SUBJECTS BY AGE LEVEL AND BY STAGES**
express this knowledge within the classical Piagetian spatial task. Piaget's (1956) Coordination of Perspectives task which purports to measure this ability is a complex problem requiring the coordination of several projective relations. In determining the positions of three mountains as an external observer moves around the landscape, the child must deal with left-right and before-behind relations at one time.

The developmental age-stage analysis reported by Piaget on this task is clouded by two issues: 1) The directions for this task may be difficult for a preschool child to fully comprehend (see, for example, Eliot, 1970). 2) Piaget (1928) and other workers (see, for example: Laurendeau and Pinard, 1970; Swanson and Benton, 1955) have found that the decline of egocentric attitudes in the development of left-right concepts does not begin to occur until eight years of age. Piaget (1956) does speculate, however, that decenation may occur earlier in the other two projective relations (up-down, before-behind) because they are not equally accessible to the child's viewpoint. Thus, these contingencies must be taken into account when assessing the preschool child's spatial egocentrism.

The test instrument used in the present study eliminated these confounding factors by focusing on
the preschool child's ability to decenter his spatial perceptions with regard to a singular and apparently simple projective spatial relation. Furthermore, the instructions were concrete and easy for the young child to comprehend.

The data generated by the present study overwhelmingly suggest that the preschool child's ability to deal with projective space is not totally dominated by egocentric attitudes. By the fifth year, the young child becomes aware of his own viewpoint in before-behind space and is thus liberated from it. He realizes that these spatial positions change with changes in perspective and is able to demonstrate this knowledge in performing simple tasks. He is further able to anticipate and reflectively deal with such spatial transformations when perceptual cues are reduced.

The decline of egocentric attitudes found in this study reflects the genetic sequence of cognitive growth during the preoperational period of cognitive development. As Meyer (1940) suggests, it is likely that similar, though more advanced, developmental sequences occur at the levels of concrete and formal operations. Accordingly, Piaget's (1956) Coordination of Perspectives task, which requires the child to deal with two projective relations at once, and the various
development of left-right concepts tasks might be more appropriate indicators of the development of spatial reasoning during the period of concrete operations.

The data from the present study thus clarify previous findings in the development of spatial concepts in children by indicating that the preoperational child shows progressive decentralization between the ages of three and five years when dealing with simple before-behind projective relations. Piaget's (1956) Coordination of Perspectives task and the various studies investigating the development of left-right concepts reveal that decentralization in more complex and abstract aspects of projective space does not occur until the period of concrete operations (7 to 12 years).

On the basis of this data, Null Hypothesis 1 is rejected. There is a significant difference among preschool children in the age at which egocentric attitudes in before-behind projective relations begin to decrease.

NULL HYPOTHESIS 2

This hypothesis proposed that there would be no significant difference in performance on the experimental tasks between subjects who received instructions with the words "before" and "behind" and subjects who received instructions with the words "in front of"
and "in back of."

Each subject was assigned a score composed of the total number of successfully answered questions which were subject to the "before-behind," "in front of-in back of" differential (see Appendix B). The range of scores was from 0 to 23.

The subjects were then divided into two groups: group 1 included those subjects receiving the "in front of-in back of" protocol and group 2 consisted of those subjects receiving the "before-behind" protocol. A t test was run on these two sets of scores and it was found that the difference between the means (.87) was not significant (t = 2.021, with 42 degrees of freedom).

This hypothesis was formulated on the basis of the contentions of several authors (see, for example: Shantz and Watson, 1970; and Eliot, 1970) that such variables as wording may have a detrimental effect on the preschool child's performance on Piagetian type tasks. Thus, it seemed desirable to determine if the words "before" and "behind" and "in front" and "in back" carry the same connotations in a test measuring the ability to deal with before-behind space.

It was thought that perhaps the terms "before" and "behind" would be more difficult for young children
to interpret especially since the term "before" carries connotations of time as well as physical space. On the other hand, the terms "in front" and "in back" are conventionally used in the English language solely to identify physical spatial positions.

In the administration of the test, however, it was found that many of the subjects who received the "before-behind" protocol spontaneously translated these terms into "in front" and "in back." For example, the question: "Is the door or the window before you?" would often elicit the response: "The window is in front of me." This spontaneous translation occurred at all age levels. However, there were no cases in which the terms "in front" and "in back" were spontaneously translated into "before" and "behind."

It was further observed in the administration of the test that those subjects who seemed confused when confronted with the first "before-behind," "in front of-in back of" differential question would immediately grasp the meaning of the term "before" when it was linked with the term "behind." For instance, the first "before-behind" task was "Stretch your arms before you." If the child looked puzzled and gave no response, the examiner said: "Stretch your arms behind you." In most cases, the child was able to carry out this task and a verbatim repetition of the first command
usually elicited a successful response. This probe was justified by the criterion set forth that verbatim repetitions of questions would be used when the tasks required the subject to change his mental set. Up to this point in the protocol, only the terms "in front" and "in back" were used for all subjects.

The statistical finding for this hypothesis is not surprising given the observed reactions of the subjects to the term differential. It is interesting to note, however, that when the subjects were divided into three year old and four year old age groups and a t test was run for each of these sets of "before-behind," "in front of-in back of" scores, there was no significant difference found in the four year old group. On the other hand, there was a significant difference in the three year old group. The difference between the mean scores for this group was -7.50 points (t = 3.883, with 19 degrees of freedom, significant at less than the .001 level).

A look at the raw data indicates that those three year old subjects receiving the "before-behind" protocol scored higher (mean score = 5.00) than the three year olds receiving the "in front of-in back of" protocol (mean score = 3.80). The fact that the three year olds did so poorly in the "in front of-in back of" protocol is confounding. However, a logical explanation
for their surprisingly good performance on the "before-behind" protocol might be that the three year olds have not yet become thoroughly familiar with the diverse meanings of the word "before" and it is thus easier for them to cope with the interchangeable use of the term.

Hence, there are indications that the terms "before," "behind," "in front," and "in back" do not convey precisely the same meanings to all preschool age children. This is especially true of the term "before." Thus, indiscriminate interchange of the terms without the utilization of clarifying probes could adversely effect task performance.

On the basis of these data, Null Hypothesis 2 is partially rejected. Accordingly, this hypothesis should be restated to read: There is no significant difference in performance on the experimental tasks between preschool subjects of all ages who receive instructions with the words "before" and "behind" and subjects who receive instructions with the words "in front of" and "in back of."

**SEX DIFFERENCES**

Although it is popularly believed that males are more adept in the area of spatial relations than females, recent studies of young children have revealed
that sex differences are not a significant factor in spatial reasoning (see, for example, Davol and Hastings, 1967).

As one of the normative aspects of the present study, a t test was run to determine if there was a significant difference in test performance between males and females. Each subject was assigned a score composed of the total number of successfully answered question on his test protocol (see Appendix B). The score range was 4 to 31, with the lowest possible score being 0. The difference between the mean scores was 13.4 points ($t = 3.551$, with 42 degrees of freedom, significant at less than the .001 level). A look at the raw data reveals that females were more successful (mean score = 18.39) in carrying out the experimental tasks than males (mean score = 15.04).

From observations made in the administration of the test protocol, it seems likely that the differences in performance are attributable more to attitudinal factors than sex factors per se. The males tested in this study were decidedly more resistant to the testing situation than the females. More coaxing was needed to bring the males into the examining room and performance may have consequently been poorer.

Such attitudes toward the testing situation may be sex-linked, however, it seems doubtful that
actual cognitive abilities differ between the sexes.
CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

PURPOSE

The primary purpose of this study was to clarify Piaget's (1956) ages and stages of declining egocentrism in projective spatial relations by investigating the preschool child's knowledge of before-behind space. It was also sought to determine if different words used to describe these spatial relations have an effect on the preschool child's performance on the experimental tasks.

PROCEDURE OF INVESTIGATION

The subjects used in this study were 23 female and 21 male children attending the California State University, Northridge Preschool Laboratory. The sample ranged in age from 3-0 to 4-11 years, with a mean age of 4-0 years.

Each subject was asked to perform a series of tasks which measured understanding of the before-behind projective relation. The tasks were fashioned after those used or suggested by other authors to
measure the decentration of projective space, particularly with regard to the development of left-right concepts (see, for example: Piaget, 1928; Swanson and Benton, 1955; and Laurendeau and Pinard, 1970).

Half the subjects tested were given task instructions with the words "in front of" and "in back of." The other half of the subjects were exposed to the terms "before" and "behind."

CONCLUSIONS

Null Hypothesis 1: There will be no significant difference among preschool children in the age at which egocentric attitudes in before-behind projective space begin to decrease.

Each subject's test protocol was analyzed according to Piaget's (1956) developmental stages of declining egocentricity. The observed frequencies of subjects in each developmental stage and at each of two designated age levels were found to be significantly different. This being an indication that the preschool child's ability to deal with before-behind projective space is not totally dominated by egocentric attitudes, Null Hypothesis 1 was rejected.

Null Hypothesis 2: There will be no significant difference in performance on the experimental tasks between subjects who receive instructions with the
words "before" and "behind" and subjects who receive instructions with the words "in front of" and "in back of."

No significant difference was found between performance on the two test protocols when the entire sample was considered. A significant difference was found, however, between the three year olds who were administered the "before-behind" protocol and the three year olds who received the "in front of-in back of" protocol. The three year old group who received the "before-behind" protocol performed better. Hence, Null Hypothesis 2 was partially rejected since there is an age factor to be considered when evaluating the effect of spatial terms on task performance.

A significant difference was also found between the overall performances of the male and female subjects on the test protocol. The data revealed that females were more successful than males in test performance.

RECOMMENDATIONS

The results of this study would seem to justify further investigation of the degree of egocentricity exhibited in the preschool child's conception of projective spatial relations. Studies which trace the young child's developing realization that spatial positions change with changes of perspective would help to
clarify the preoperational child's cognitive status in spatial concept development and would broaden our knowledge of cognitive development with regard to the acquisition of all concepts.

In order to establish a broader developmental scale and to obtain more precise normative data, it is recommended that the test instrument used in this study be refined and administered to a larger sample consisting of a broader age and socioeconomic range of subjects. Further investigation of the effect of task wording on test performance would also seem to be justified in view of the data generated by this study.

Investigation of the young child's understanding of the above-below projective relation would further enhance the literature on the development of spatial concepts.
BIBLIOGRAPHY
BIBLIOGRAPHY


APPENDICES
APPENDIX A

TEST PROTOCOL

MATERIALS

1. Two pieces of green felt (9" x 12")

2. Toy items which might be associated with a farm:
   a. Two animals (1 1/2" x 1 1/2")
   b. Two trees (2 1/2" high)
   c. One doll to represent the farmer (2 3/4" high)

All of the toy items are small enough to be manipulated easily on a table but large enough so that each toy may be seen when all are lined up vertically.

Before the subject enters the examining room, the two pieces of felt are placed side by side on a table. One tree is put on each piece of felt, somewhere near the middle of the material.

When the subject enters the room, he is seated in front of one of the felt pieces and the examiner sits beside the subject, in front of the other piece of felt.

TEST SECTION I

Recognition of Before-Behind Spatial Positions in Relation to the Subject's Own Body

Task A

Explain materials and task to the child:

We are going to play a game about a farm. Since farms have lots of grass, I have put some grass in front of you and some grass in front of me. This is my farm and that is your farm. Each farm has a tree on it.
This is my tree and that is your tree. Now we are going to put some animals on our farms. We will put the animals the same way on both farms. See, I am putting my animal here. (E places animal about 2" to the left of the tree.) Now you should put your animal on your farm in the same place so that the two farms will look exactly alike.

Allow the child to place his animal. If he does not place the animal correctly or if he does not seem to understand the instructions, place his animal for him and explain:

See, your animal goes here. Now it is in the same place as mine and the farms look exactly alike. Do you understand?

Make sure the child understands. Repeat the example by moving the animal to the right of the tree.

Now I am going to move my animal to this spot. (E puts animal about 2" behind the tree.) Now you do as I am doing. Put your animal on your farm in the same place so that the two farms look exactly alike.

If the child does not place his animal in the corresponding position, ask:

Is your animal in the same place as my animal? Do the two farms look exactly alike?

Now let's move our animals. I am going to put mine right here. (E places animal about 2" in front of the tree.) Now you do the same thing; put your animal in the same place so that the farms look exactly alike.

Task B

Explain task to the child:

Now that we have put animals on our farms, let's stand up and play another game.

Examiner and subject stand up. Examiner asks:

1. Show me the front of your body?
2. Show me the back of your body?
FIGURE 1

DIAGRAMMATIC LAYOUT
OF TASK A

ANIMAL
(Placement 3)

ANIMAL TREE ANIMAL
(Placement 1) (Placement 2)

ANIMAL
(Placement 4)
If the child fails to respond correctly, the examiner says with appropriate gestures:

This is the front of my body, and this is the back of my body. Now show me the front of your body. Show me the back of your body.

The examiner continues:

3. Show me the front of your head.
4. Show me the back of your leg.
5. Show me the back of your head.
6. Show me the front of your leg.
7. Stretch your arms in front of (before) you.
8. Stretch your arms in back of (behind) you.

If the subjects in the "before-behind" group respond incorrectly, the examiner says:

I am going to stretch my arms before me, and now I am going to stretch my arms behind me. Now stretch your arms before you. Stretch them behind you.

Task C

Examiner explains:

Now let's go back to our farms. We only need one farm now. Shall we use your farm or my farm?

Allow the child to choose, then remove the other materials. Arrange the tree and animal on the remaining farm so that the animal is about 2" in front of the tree.

The examiner continues:

We still have a tree and an animal on our farm.

1. Point to the one that is in front (before).
2. Point to the one that is in back (behind).

TEST SECTION II

Recognition of Before-Behind Spatial Positions in Relation to an External Observer
FIGURE 2

DIAGRAMMATIC LAYOUT
OF TASK C

TREE

ANIMAL

FIGURE 3

DIAGRAMMATIC LAYOUT
OF TASK D

FARMER

* Arrow indicates line of sight.

TREE

ANIMAL
Task D

Examiner explains:

Now we need a farmer for our farm. I am going to put him right here.

Examiner places the farmer about 2' behind the tree and facing the animal and the tree. The examiner continues:

The farmer can see the animal and the tree from where he is standing.

1. From where the farmer is standing, does he see the tree or the animal in front (before)?

2. From where the farmer is standing, does he see the animal or the tree in back (behind)?

Task E

Examiner explains:

The farmer is going to take a walk and now he is turning around.

Examiner moves the farmer between the animal and the tree, facing the tree.

The farmer's head is turned this way (E makes appropriate pointing gesture).

1. Is the animal or the tree in front of (before) the farmer?

2. Is the tree or the animal in back of (behind) the farmer?

Task F

Examiner explains:

Now let's stand up again and play another game. I see that there are windows (or some other obvious object) on that wall of the room. And I see a door on this wall (i.e. the opposite wall). Do you see the
FIGURE 4

DIAGRAMMATIC LAYOUT
OF TASK E

TREE

FARMER

ANIMAL

FIGURE 5

DIAGRAMMATIC LAYOUT
OF TASK F

WINDOWS

E

S

DOOR
windows and the door? I am going to stand this way so that I can see the door. And you stand that way so that you can see the windows. You need to stand so that you can only see the windows; you must not turn your head, so listen carefully. (If appropriate, the examiner may put an arm around the child to prevent him from turning his body.)

The examiner and the subject are standing side by side and facing in opposite directions. The examiner asks:

1. Is the door or the window in front of (before) you?
2. Is the window or the door in front of (before) me?
3. Is the door or the window in back of (behind) you?
4. Is the window or the door in back of (behind) me?

**TEST SECTION III**

Comprehension of the Relativity of Before-Behind Spatial Positions

**Task G**

Examiner explains:

I see a table (or some other obvious room furnishing) over there. And I see the wall over there. Do you see the table and the wall? Turn your body so that you can see the table.

The examiner and the subject are standing at a 90° angle to each other. If the child does not change his positions correctly, the examiner should help him find the right place. The examiner continues:

If you turn this way, you can see the wall. And if you turn back this way, you can see the table again.
Now look where I am standing. I am going to stand right here where I was. If I turn this way, I can see the windows; and if I turn this way, I can see the door. I am going to stand so that I can see the door. You need to stand so that you can only see the table. You must not turn you head, so listen carefully. (If appropriate, the examiner may put an arm around the child to prevent him from turning his body.)

1. Is the table or the wall in front of (before) you?
2. Is the window or the door in front of (before) me?
3. Is the table or the wall in back of (behind) you?
4. Is the window or the door in back of (behind) me?

Task H

Examiner explains:

Now let's go back to the farm again. The farmer is going to take another walk and the animal is going to follow him.

The examiner places the objects horizontally from left to right: the farmer, the animal, and the tree. The farmer is facing the animal and the tree. The examiner continues:

The farmer can see the animal and the tree from where he is standing.

1. Does the farmer see the tree or the animal in front (before)?
2. Does the farmer see the animal or the tree in back (behind)?

Task I

Examiner explains:
FIGURE 6

DIAGRAMMATIC LAYOUT
OF TASK G

FIGURE 7

DIAGRAMMATIC LAYOUT
OF TASK H
FIGURE 8

DIAGRAMMATIC LAYOUT
OF TASK I

FARMER
TREE
ANIMAL
Let's move the farmer and the animal back to where they were.

The examiner places the objects from front to back: the animal, the tree, and the farmer. Examiner continues:

Now you can see the tree, the animal, and the farmer on the farm. Tell me how you see the things on the farm:

1. Do you see the animal? Is the animal in front of (before) or in back of (behind) the tree?
2. Do you see the farmer? Is the farmer in front of (before) or in back of (behind) the tree?
3. Is the tree in front of (before) or in back of (behind) the animal?
4. Is the animal in front of (before) or in back of (behind) the farmer?
5. Is the farmer in front of (before) or in back of (behind) the animal?
APPENDIX B

SAMPLE SCORE SHEET.

SUBJECT NUMBER: 15  AGE: 3-7  SEX: FEMALE

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<thead>
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<th>QUESTIONS</th>
<th>A</th>
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<th>D</th>
<th>E</th>
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COMMENTS: The experimental procedure in this actual test protocol was terminated at the completion of task C since this marks the point at which two successive tasks were failed.

The "before-behind," "in front of-in back of" score for this subject was 13. It includes all of the correctly answered questions subject to the "before-behind", "in front of-in back of" differential
(questions 7 and 8 in task B; questions 1 and 2 in task C; questions 1 and 2 in task D; questions 1, 2, and 3 in task F; and questions 1 and 3 in task G).

This subject's overall score used in the analysis of sex differences was 19. It includes all of the correctly answered questions in the protocol (excluding questions 1 and 2 in task A which were examples).
APPENDIX C

OBSERVED FREQUENCIES OF SUBJECTS
BY AGE LEVEL AND
BY SUCCESS ON EACH TASK

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<th>Age</th>
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Median Age

4-1  4-5  4-4  4-7  4-8  4-9  4-11  4-11  4-11
APPENDIX D

FORMULA USED IN THE COMPUTATION OF THE AGE OF ACCESSION

\[
x + \left( \frac{50 - n_1\%}{n_2\% - n_1\%} \right) (x - y)
\]

Where:

- \(x\) is the age below 50 percent.
- \(y\) is the age above 50 percent.
- \(n_1\) is the percent below 50 percent.
- \(n_2\) is the percent above 50 percent.