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An Investigation of the Effects of Vestibular Stimulation on Object Permanence in Infants with Sensorimotor Dysfunction

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AN INVESTIGATION OF THE EFFECTS OF VESTIBULAR STIMULATION ON OBJECT PERMANENCE IN INFANTS WITH SENSORIMOTOR DYSFUNCTION

by

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VITA

The author, Sandra Benzies Levine, is the daughter of William Benzies, Jr. and Margaret (Marling) Benzies. She was born on March 9, 1933, in Madison, Wisconsin.

She graduated from Baraboo High School in Baraboo, Wisconsin in 1950. In September, 1950 she entered Smith College in Northampton, Massachusetts. In September, 1951 she entered the University of Wisconsin in Madison, Wisconsin, and in June, 1954 received the degree of Bachelor of Science with a major in occupational therapy. In 1962 she entered the physical therapy program at Stanford University, Palo Alto, California. She received a Certificate in Physical Therapy in October, 1963, and in January, 1966 was awarded a Master of Arts in physical therapy.

She practiced occupational therapy from 1955 to 1962 in Illinois and California. From 1965 to 1971 she directed the Department of Occupational and Physical Therapy at the Illinois State Pediatric Institute in Chicago, Illinois. From 1967 to 1971 she was a Lecturer in the physical therapy program at Northwestern University. In 1971 she joined the faculty of the Department of Physical Therapy, School of Associated Medical Sciences at the University of Illinois at the Medical Center. At present she is an Associate Professor and Assistant Department Head of the Physical Therapy Department, College of Associated Health Professions, University of Illinois at Chicago, Health Sciences Center.

She co-authored an article with Muriel H. Bagshaw titled "Multiple Measures of the Orienting Reaction and Their Dissociation after Amygdalectomy in Monkeys" which was published in Experimental Neurology in 1968.

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CHAPTER I

INTRODUCTION

With the advent of early intervention programs more professionals have become involved in the education of handicapped infants and children under three years of age. Many of these programs are based on Piagetian theory which states that early sensorimotor experiences are essential to the development of cognition. Many curricula appear to have been developed on a very generalized, theoretical base (Campbell, 1974). Often these programs emphasize visual and auditory stimulation. Some programs include vestibular stimulation and sensorimotor experiences. The sensorimotor experiences included in these programs are likely to be based on schedules of development, or acquisition of landmark activities. The sensorimotor abilities or experiences which may be the specific antecedents of cognitive concepts have not yet been identified. Identification of specific sensorimotor abilities or experiences related to the development of object permanence would enable professionals to plan educational programs better suited to the individual needs of the handicapped infant and to the achievement of this basic cognitive concept.

Theoretical Background

Inherent in Piaget's theory is the importance of the infant's interaction with the environment. Piaget (1952) states that the earliest schemata, such as sucking, vision, hearing, and grasping are used by the infant to interact with the environment. Primitive

sensorimotor and postural reactions which are inherent in the hereditary behavioral responses of the normal infant are refined and elaborated through experience and through active manipulation of the environment. The sucking schema, for example, is used by the infant not only for nurturance, but also as a means of learning about self and environment. The infant sucks fingers, clothes, blankets, toys, and anything else that enters the infant's mouth. A schema such as sucking can be seen to change and to develop as a result of practice and as a result of its application to new objects. The infant learns quite early which objects when sucked give food and which don't, and the pattern of sucking is observed to change. A different sucking pattern is developed which is used for play and exploration than the one used for taking in nutrition. Later the infant combines these schemata, in pairs or in larger combinations, while interacting with the environment, thus further extending the infant's knowledge of the environment. It is not until the sucking schema is combined with the grasping schema that the infant will bring a grasped object to the mouth in order to suck on it. Further, the infant is unable to look at an object, grasp it, and bring it to the mouth until all three schemata are combined. It is this sort of physical interaction with the environment that is deemed necessary for the development of cognitive constructs during the sensorimotor period. Physically handicapped infants are infrequently unable to interact with their environment in such a manner.

In addition to Piaget, other workers in the field (Bower, 1971; White, 1975) have emphasized the role of experience. Although Held and Hein studied kittens rather than human infants, their famous

experiment (1963) revealed that a kitten passively moved through the environment on a gondola by a littermate, was unable, at the end of the experimental treatment, to respond as the active littermate did, to visual stimuli. White (1975) and Wachs (1976) state that freedom from physical restraint is related to the development of cognition.

It is generally accepted that Piaget's theory is invariant in sequence and hierarchical in nature. These conditions have been supported by Corman and Escalona (1969), Decarie (1965), Kopp, Sigman, and Parmalee (1973), and Hunt (1976). Achievement of each stage of development is necessary for the mastery of the next stage. The infant who has not exercised the grasping schema should not be able to combine grasp with sucking or with vision. Presumably the infant who has not exercised and combined these early reflexive schemata should not be able to develop the concept of object permanence.

The schema of the object, object construct, or object permanence is achieved during the sensorimotor period, the earliest of four periods of cognitive development described by Piaget (1952). It is said to be the most important achievement of the sensorimotor period which covers the period of infancy (birth to two years of age). It is also considered by Piaget as the period of conservation of objects, and as such precedes the development of conservation of weight, conservation of volume, and conservation of number. When the infant has achieved object permanence the infant is said to know that objects still exist when outside of the perceptual field. Until this time the child cannot relate to people or objects as they exist, or relate them to each other spatially, temporally, or causally. Until six months of

age for most infants "out of sight is out of mind". At the highest level of object permanence an infant will search and find an interesting hidden object which has been moved through a series of invisible displacements.

Statement of the Problem

Infants who have incurred brain damage before, during, or after birth, often display abnormal postural tone and abnormal or primitive patterns of movement. These infants, who may either be hypertonic (abnormally stiff) or hypotonic (abnormally floppy) are often prevented from moving and interacting with their environment. Very early they may have difficulties with sucking and later may demonstrate an inability to follow objects with their eyes, to reach, and to grasp. These children, though unable to develop and combine schemata in the normal fashion during infancy, develop object permanence (Tessier, 1969; Fetters, 1976).

Although object permanence has been investigated in normal infants and in older handicapped children, no one has attempted to evaluate the motorically-at-risk infant between the ages of six and 24 months. Investigators have found that vestibular stimulation, such as rocking or spinning, improves visual functioning and motor responses. The effects of vestibular stimulation on the development of object permanence has not been investigated.

Purpose of the Study

One of the purposes of this study is to learn whether or not it is possible to determine the level of object concept development in handicapped infants. The second purpose is to determine whether the

development of motor abilities is related to the development of object permanence. It is also of interest to determine if object concept develops within the normal age ranges. It is the intent of this study to determine if vestibular stimulation has an effect on object permanence development and/or sensorimotor development.

The questions to be answered are:

1) Are motor abilities correlated with object concept development in infants between six and 24 months of age who have a sensorimotor handicap?
2) Does object concept develop within normal ranges in infants between six and 24 months of age who have a sensorimotor handicap?
3) Does vestibular stimulation increase the rate of object concept development in infants between six and 24 months of age who have a sensorimotor handicap?
4) Does vestibular stimulation increase the rate of development of motor abilities in infants between six and 24 months of age who have a sensorimotor handicap?

Method

The subjects of this study were infants with sensorimotor handicaps who were between six and 24 months of age. The infants were screened to exclude those with severe uncorrected visual defects, auditory defects, recurrent seizures, and/or severe or profound mental retardation.

All of the infants were assessed for object permanence using Scale I: The Development of Visual Pursuit and the Permanence of

Objects of the Infant Psychological Development Scales developed by Uzgiris and Hunt (1975). Motor abilities were evaluated by using The Motor Behavior Checklist devised by the author. Vestibular stimulation in the form of rocking was administered to each of the infants during one phase of the two-phase experiment. Descriptive and nonparametric statistics were used to evaluate the data gathered in this study.

Limitations

It was anticipated that obtaining appropriate infants under one year of age might be a problem. Many of these infants are not identified by physicians early unless their sensorimotor handicaps are severe. It was also expected that these infants might fatigue, or refuse to cooperate, during the testing sessions, thus prolonging the time necessary to complete each of the three phases of assessment of motor and cognitive skills. As the infants in the study were drawn from an out-patient treatment center, it was also anticipated that normal family problems, such as illness of the infant, parent or siblings could interfere with the scheduled testing sessions. Due to the nature of the infants' handicaps it was believed that some of the infants would be unable to manipulate some of the objects sufficiently well enough to complete the object permanence test items. It was further expected that many parents might not be able to administer the amount and kind of vestibular stimulation specified. It was believed that some infants might refuse to cooperate with or tolerate the vestibular stimulation. It was also anticipated that unexpected circumstances, or demands, on the parents might limit their ability to provide the specified rocking.

Need for Study

No systematic investigations of object permanence and its relationship to vestibular stimulation in infants with motor handicaps caused by central nervous systems dysfunction have been reported in the literature to date. A few investigations of object permanence have included a small number of subjects under 24 months of age (Tessier, 1969; Fetters, 1976; Young, 1977).

Studies of vestibular stimulation have not used object permanence as a measure. There has been no reported attempt to correlate motor abilities, except manual manipulation (Fetters, 1976) with object concept development. There are no reports of the effect of vestibular stimulation on the development of a cognitive concept, such as object permanence. In addition, the majority of the reported studies on vestibular stimulation include stronger stimulation that is applied in controlled clinical situations, rather than administered by the parents in the home.

Present infant stimulation programs for handicapped infants include emphasis on increasing physical interaction with the environment. Some of these programs include vestibular stimulation. The present study examined the effect of rocking on the development of motor and cognitive abilities.

Definition of Terms

a. Sensori-motor impaired infants, or infants-at-risk due to central nervous sytem dysfunction. Infants displaying abnormal postural tone and abnormal patterns of movement.

b. Object Permanence or Concept. The emergence of behaviors which

reflect the sensorimotor adaptation to the fact that objects exist independently of the infant. Object permanence is measured by a stage score for each subject (Uzgiris and Hunt, 1975). An infant obtains the stage score for the highest stage successfully reached.

c. Motor ability. Any process used by an infant to interact with his environment, including visual, locomotive (rolling, crawling, creeping, walking), and/or manipulative ability (reaching, grasping, transferring). Components of these activities, such as primitive reflexes, righting and equilibrium reactions are also included to indicate levels of development.

Summary

The purpose of this study is to investigate the effect of vestibular stimulation on the development of object permanence and sensorimotor behavior of infants with sensorimotor dysfunction. The investigation also examines the relationship between object concept development and motor development, and between object concept development in normal infants compared with infants with a sensorimotor handicap. Infants between six and 24 months of age who display abnormal postural tone and abnormal or primitive patterns of movement will serve as subjects. Infants with severe, uncorrected visual or auditory problems, or severe or profound mental retardation will be excluded from the study.

The parents of the infants will provide the vestibular stimulation by rocking the child in each of four different positions, for a total of 30 minutes daily for four weeks. The period of vestibular stimulation will be either preceded by or followed by a period of no

vestibular stimulation. Thus each child serves as his own control.

Each infant's performance on a test of object permanence and on a test of motor behavior will be measured before and after the first phase of the study and at the conclusion of the study. Object permanence will be measured using Scale I: The Development of Visual Pursuit and the Permanence of Objects, from the Infant Psychological Development Scales devised by Uzgiris and Hunt (1975). Sensorimotor development will be assessed using the Motor Behavior Checklist constructed by the author. Descriptive and nonparametric statistics will be used to evaluate the data.

In the succeeding chapters of this study, the following content is covered:

1) In Chapter Two, a detailed review of the literature is presented including object permanence in normal infants, object permanence in children with defects, eye pointing, and vestibular stimulation,

2) In Chapter Three the method is discussed including selection of subjects, materials and procedures used,

3) In Chapter Four an analysis of the data is presented, and the results of this investigation in relation to object permanence and sensorimotor abilities of infants, and

4) Chapter Five contains a discussion of the results of this investigation.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

The studies presented in this chapter have been grouped into five sections. Each section is related to the theoretical and practical rationale underlying the present investigation.

In the first section Piaget's theory of development during the sensorimotor period is reviewed. The stages of object permanence development and their characteristics are presented. In the second section more recent research on the development of object permanence in normal infants is discussed. The third section includes a review of the literature concerning object concept development in infants who are handicapped due to central nervous system dysfunction. The fourth section covers a method of measuring cognition in children who are only able to communicate through the technique of eye-pointing. The final section presents the theoretical neurological bases of vestibular stimulation and the contribution of such stimulation to the development of cognition as conceptualized by Ayres. This section also includes a review of the literature regarding the effects of providing vestibular stimulation to normal and handicapped individuals.

Piaget's Theory of Object Permanence

Jean Piaget was more interested in the process of intellectual development than in schedules of development. Intelligence is said by Piaget (1952) to be achieved through a process of adaptation and organization. Adaptation can be defined as the equilibrium achieved

between the individual and the environment. Organization is a structural concept which involves the schema, or a repeatable unit of intelligent action. Adaptation includes the processes of assimilation and accomodation. Assimilation is the incorporation of the environment into the current cognitive structures or schemata. Accomodation is the process of changing cognitive structures or schemata to adjust to new information. Accomodation occurs as a result of disequilibrium between existing cognitive structures and the environment. In order to remove the disequilibrium the individual attempts to make the environment fit into his already existing schema (assimilation). If this is unsuccessful, he alters his existing schema or develops a new schema (accomodation).

In Piaget's theory of development the individual passes through four periods of cognitive growth which are hierarchical and sequential. Attainment of the highest level is dependent on successfully passing through each of the previous three stages in order. The four periods are: the sensorimotor period, the preoperational period, the period of concrete operations, and the period of formal operations (Piaget, 1952).

The first period, the sensorimotor period, is the period in which object permanence is achieved. It covers the first two years of life, or infancy, and consists of six stages (Piaget, 1952). Stage I, the reflex stage is characterized by the use and extension of neonatal reflexes, e.g. sucking and grasping, and covers the first month of life. From one to four months of age the infant applies these reflexes to objects in the environment, and begins to alter them and to combine them. This is the second stage, or the stage of primary circular reactions. In stage III, the secondary circular reactions, the infant

repeats movement in order to cause an effect on his environment. In this stage, from four to eight months of age, the infant's movements become purposeful for the first time. Stage IV, (coordination of secondary schema) is characterized by the infant's ability to combine two schemas. This eight to twelve month old infant uses the first schema as the means to achieve the second schema or goal. From twelve to eighteen months the infant in stage V, or the stage of tertiary circular reactions, experiments with the environment and is led to discover new means of interacting with his environment. In stage VI, from eighteen months on, the infant invents new means of interaction with the environment by mental processes. Simple mental representations are used to achieve solutions to problems without using overt trial and error behavior.

As the infant progresses through these stages of sensorimotor period, object permanence is developing. The term object permanence is used in the literature to refer to the development of a concept of permanence of persons or objects or both. Object permanence is usually said to appear somewhere between six to eight months, and some authors state that infants acquire a concept of permanence of people before that of objects. This disparity of time of acquisition may be related to testing methods, or may relate to a more basic problem, that is, a difference between the levels of competence (maturation) of the visual system and the motor system. In any case, acquisition of object concept is a prerequisite for mental operations. Without it neither normal nor handicapped infants would be able to think about objects or people, or relate them to each other.

Piaget identifies the characteristics of object concept at each of six stages of development. The approximate age ranges stated for each stage of sensorimotor development correspond with the age ranges stated for object concept development with the exception of the first two stages. (Stage I of sensorimotor development occurs between birth and one month and stage II occurs between one and four months. Stage I of object concept development occurs between birth and two months, while stage II covers the period between two and four months of age). In stages I and II of object concept development there is no real response to a vanished object, although in stage II, infants are described as accurately tracking objects visually, and continuing to look at the spot where the object disappeared from view. Piaget also describes infants as continuing to listen and to grasp after the stimulus has left the perceptual field. In stage III (four to eight months) infants are more active in their attempts to maintain contact with objects. They not only track objects with their eyes but will turn and lean to follow the object as it moves out of sight. The infant will also search for a partially hidden object, but ceases to look for an object which is totally covered or which is covered prior to or during his attempts to grasp it. Piaget states that it is as if objects are made and unmade as they appear and disappear. From eight to twelve months, stage IV, is the time when an active search will occur for a totally hidden object. However, at this time if an object is hidden in one place, and then moved to another in the infant's view, the infant will continue to search for it in the place where it first disappeared. The stage V infant (twelve to eighteen months) no longer

makes this mistake, he accurately searches for objects that he sees moved from one place to another. However, if the infant is unable to see the object moved from one location to another he is unsuccessful in locating the hidden object. Finally in stage VI, or from about eighteen months on, the infant searches for the object no matter where or how it is hidden. A recent study by Ramsay and Campos (1978) supports Piaget's claim that only during this stage do infants begin to demonstrate some capacity for representation.

Piaget's theory can be interpreted as implicating movement and physical interaction with the environment as prerequisites for the development of object permanence. Active movement itself leads to changes in the infant's activity which permits the infant to transform schemata and organize object permanence.

Object Permanence in Normal Infants

In this section the literature reviewed expands and modifies the concept of object permanence presented by Piaget. Researchers have attempted to identify additional variables contributing to the development of object concept. Some of the research reviewed supports Piaget's position, and other research conflicts with that of Piaget, with respect to two variables: 1) the age of acquisition of object permanence, and 2) the issue of the relative importance of visual experience versus motor activity in the development of object permanence. The conflicting results in some instances, e.g. the work of Bower and associates, may be due to differing methodology.

Stage IV has attracted much attention recently, perhaps because it is considered by some to be the stage that marks the transition

between permanence and lack of permanence objects. Studies have been conducted to determine why the infant continues to search in the place where the object first disappeared (A) when he saw the object moved to a new location (B). This has been referred to as a "place error", or the "$A\overline{B}$ error". Piaget explains this error by stating that the infant thinks that certain objects belong to particular places. Therefore, an object usually found hidden at A is not looked for at B even though the infant has seen it moved there, because the object is a thing-that-is-found-at-A.

Variables such as the number of active search trials, the length of time of the active search, the length of the delay before search, and the characteristics of the screen have been investigated in stage IV. Landers (1971) and Gratch and Landers (1971) observed that active search at one location (A) influenced later trials when the object was hidden at B, causing persistent search (and error) at location A. It was stated by the authors that these results supported Piaget's opinion that action and motor response are more important to the development of object concept than visual experience alone.

Willatts (1979) observed that the infants in his study persisted to reach and attempt to manipulate an object at the empty place previously occupied by the object when they were four months of age. However, when they were retested at five months the same infants demonstrated no signs of persistence of manipulation at the object's original space. The author stated that the results still leave two alternative explanations. Four month old infants may not have learned that an object can exist in two locations, or they may have lacked the ability

to inhibit a previously successful motor pattern.

The character of the screen has been investigated by Gratch (1972), Bower and Wishart (1972), and Rader, Spiro, and Firestone (1979). Gratch observed that it was easier for six month old infants to obtain an object hidden by a transparent screen than by an opaque screen. Similar results were found by Bower and Wishart. The 16 infants, 21 weeks old, in this study secured an object more easily if it was hidden under a transparent cup than under an opaque cup. Six of the 10 infants in the study conducted by Rader, et.al. succeeded in obtaining an object covered with a small felt card cover, but failed with the standard cloth cover. The authors advise caution in concluding that infants have object permanence until it is clear that neither other perceptual concepts, such as "behind" or "inside" nor motor inabilities have affected performance.

Attention to the task has also been explored. Gratch, Appel, Evans, LeCompte, and Wright (1974) concentrated on the variables of memory and attentiveness while studying stage IV error. Forty-eight normal nine month old infants, male and female, from low socioeconomic Black families and middle class White families were allowed to search after 0, 1, 3, or 7 second delays. Infants in the 1, 3 and 7 second conditions made more errors than the infants in the no delay condition. Infants in the delay groups were found to be less attentive to the task; the direction of their gaze was found to be related to the direction of their search. Gazing away from the task thus led to errors in their search for the hidden object.

Lewis reported findings on attentive behavior in his preface to

Origins of Intelligence (1976). He found that infants under two years of age demonstrated no relationships between their attentive behavior and their object permanence scores. Not only were these measures not correlated with each other, but he found little stability in any of these measures between three and 18 months.

Although the work of Bower and his associates has a Piagetian orientation, the methodology used in some of their experiments differ from that of Piaget resulting in different conclusions. In 1967 Bower observed 12 infants between eight and 12 weeks of age while attempting to startle them with the disappearance and reappearance of a visual stimulus. The infants indicated by their sucking responses that they anticipated the reappearance of the stimulus.

Bower, Broughton and Moore (1970) observed 80 infants between six days and six months to determine if vision, or touch, was dominant during the development of the object concept. The infants' grasping responses indicated that there is an early dominance of vision over touch. The five month old infants did not close their hands over the virtual objects as the younger infants did. The authors stated that this indicated that tactile feedback was beginning to control the grasp response in the older infants.

These same authors (Bower, Broughton and Moore) studied infants tracking an object in a series of experiments described in 1971. The object was programmed to do two things; to move behind a screen and stop, and to move toward a screen but to stop short of the screen. Six infants, eight weeks old, were observed to continue to track the movement of the object in both conditions. The authors concluded that this

was due to poor head control and eye movement. A second experiment ruled out this possibility. Tangential movements were not observed which would have indicated problems with head and eye control. A third experiment was then presented to two infants in order to determine if infants who respond to moving objects respond to movement per se, rather than to the movement of an object. These infants were presented with two possible situations, and two highly improbable situations, e.g. a different object emerged from behind the screen, and the same object emerged too quickly. The infants were upset with the apparent change in speed of the moving object, but were not at all concerned when a different object emerged from behind the screen. The second and third experiments were replicated with 24 infants of 12, 16 and 20 weeks of age. The results were consistent with those of the previous experiments. The authors found evidence that there is a change of object concept development between eight and 20 weeks, as the 16 and 20 week old infants were capable of understanding that one object could move and stop and move even to an invisible place and return.

In 1971 Bower reported an experiment which was concerned with determining if infants thought that stationary objects that moved were, in effect, two separate objects. An unstated number of three month old subjects observed an object that moved from location A to B and back 10 times, and then from A to C. The infants failed to follow the object to C. Bower concluded that the infants thought that moving objects were different from stationary objects.

The question as to whether successful visual tracking of an object is part of the same process as the motoric search for an object

was raised by Bower and Paterson in 1972. A stage IV problem was presented to 66 infants in matched experimental and control groups. The experimental group was given weekly training in visual tracking from 12 to 16 weeks of age. The infants were brought in later for object permanence testing at stages IV and V. The stage V problem was to find the object under one of two cloths which had been transposed. The experimental group successfully passed stage IV and stage V tests, nine to 16 weeks earlier, respectively, than did the control group. The data were interpreted as indicating that the visual tracking and manual search are part of the same developmental process. The authors suggested that success in a visual object concept problem and failure in a search problem may indicate lack of transfer from one system to another.

In another experiment concerning tracking behavior intended to control for the effects of the screen, Bower and Paterson (1973) tested 48 infants of 12, 14, 16, 18, 20, and 23 weeks of age. The object tracked in this experiment moved and stopped, and infants' eye movements were observed. All of the infants stopped tracking when the object stopped moving, but a pattern of resuming tracking was observed in the younger infants of 12 to 18 weeks of age. After 18 weeks this pattern decreased markedly, and the infants continued to look at the stationary object. The results confirmed an earlier hypothesis: that infants of 20 weeks think that an object that both moves and also stops and remains stationary, is two different objects.

In 1974 Bower pointed out that some of the apparently conflicting results obtained in object permanence studies are due to the nature of

the transition from in sight to out of sight. Bower stated that the change to out of sight behind a screen is different from out of sight under a cloth, which is different from out of sight inside a container. He suggested that objects which are inside of another, or under another object may be perceived by the infant as occupying the same space, which is impossible for an infant of less than five months to comprehend.

Moore, Borton and Darby (1978) attempted to resolve the conflict between differing explanations of anticipatory tracking behavior. Forty-eight infants participated in the study. Half the infants were five months old, and half were nine months old. The infants were randomly assigned to each of the three violation-nonviolation tasks. In the permanence violation task, a moving object disappeared behind the first of two separated screens and failed to appear between them before emerging from behind the second screen. In the trajectory violation task the object reappeared from behind a screen much faster than would be appropriate for the object's speed before and after occlusion. In the violation of the feature task, an object disappeared behind a screen, and a different object emerged. In the nonviolation conditions, normal disappearance and reappearance of the object were observed by the infants. Disrupted tracking was displayed by the five month olds during the trajectory and feature tasks, but not in the permanence task. The nine month olds demonstrated disrupted tracking during all of the violation tasks. The authors concluded that the five month old infants had object identity, but not object permanence.

The variables of sex and socioeconomic background have been dealt with by several authors. Gratch, et.al. (1974) found that sex was not associated with task performance on object concept items, nor was social class. Golden and Birns (1968) assessed 192 Black infants from 12 to 18 months of age with a Piagetian object scale and the Cattell Infant Intelligence Scale. Three socioeconomic groups were represented in their sample. They found no difference between the three groups, but did find that the lowest socioeconomic group of infants was the most difficult to test. Gottfried and Brody (1975), who used Piagetian scales and psychometric scales, found that socio-environmental variables accounted for only a negligible portion of the variance in sensorimotor development. King and Seegmiller (1973) who studied cognitive development of 27 infants (14, 18, and 22 months of age) using the Bayley Scales and the Infant Psychological Development Scales of Uzgiris and Hunt, concluded that socioeconomic status was not a major factor influencing cognitive development before the age of 15 to 18 months.

Experience as a variable influencing infant cognition has been reviewed extensively by both Hunt and Uzgiris. Hunt (1961) identified five main themes in Piaget's theory and related four of them to the need for experience. First, he states that the change of cognitive structures is dependent on the opportunity to exercise schemata; secondly, that successive structures make their appearance during development because of stimulation and use. Piaget clearly states this in 1971; that experience is necessary for the formation of new structures. Thirdly, Hunt stated that accomodative modifications

depend not only on experience, but on a proper match between existing schemata and objects experienced. And finally, the greater the variety of situations that the child must accomodate his existing cognitive structures to, the more differentiated and mobile they become, thus allowing them to become transitive, associative, and reversible.

Corman and Escalona (1969) found that all but the most extremely deprived infants were successful in sensorimotor development, which included object permanence, but found that the richness of an infant's environment did affect the rate of progress through the stages. Wachs (1976) and Wachs, Uzgiris, and Hunt (1971) found the predictability of the environment, the amount, and the degree of visual and tactile stimulation to be important. In 1971 Wachs, et.al. studying children from different environmental backgrounds, observed that disadvantaged children achieved object permanence, but required more trials. The number of toys in the home which gave auditory-visual feedback, and the amount of human stimulation were found to be related to cognitive development.

In Wachs' longitudinal study reported in 1976, 39 infants were observed at home twice a month between 12 and 24 months. These observations were correlated with measures of object permanence using the Infant Psychological Development Scales of Uzgiris and Hunt at 15, 18, 21, and 24 months. The characteristics of the home environment correlating to the development of object permanence were the predictability of regularity of the environment, and the adequacy of stimulation, i.e. lack of physical restraint or "floor freedom", and toys that gave feedback. The highest correlation obtained ($r = .71$) was

that found between object permanence at 24 months and the amount of "floor freedom" the infant had in the previous three months.

Yarrow, Rubenstein, and Pedersen (1972) observed 41 Black infants five to six months of age, and administered the Bayley Infant Development Scales. They found that increased kinesthetic stimulation was positively correlated with higher performance, and that appropriateness of the available play materials in the home correlated positively with the object permanence items. White reports a longitudinal study in which 25 children whom the investigators thought would develop very well were compared with 14 children who they thought would develop poorly (1975). These one and two year old infants were observed for five years. He related his results to the caretakers of the infant; the most effective caretakers provided the child with maximum access to the living areas. Furth (1969) states that the infant learns about object permanence in the course of mastering physical displacements and movements of his own body. Gottfried and Brody correlated activity and object permanence as measured by the Corman-Escalona scales (1975). Observers scored the distance the infants traversed, and their interaction with toys during a ten minute free play session. Low positive correlations were found between activity and object permanence in this group of 207 Black infants between 10 and 17 months of age. Movement on the floor was correlated more highly with object permanence than was interaction with toys.

Uzgiris (1977) reviews the role of experience and organizes much of the literature by identifying four ways in which the effect of the environment can be measured. The results of many confusing and

conflicting studies become more understandable with these conceptions in mind. First, Uzgiris suggests that the environment may be viewed as a background and many different environments may meet the infant's needs. This can be thought of as a threshold factor; if a certain level is met, there is no further effect of the environment on cognitive development. The second concept is that the environment modifies the rate of development. Certain environments are seen as providing opportunity for certain kinds of activities which enhance development. Thirdly, the environment is seen as capable of modifying the pattern of development. Finally, the last concept, which appears to have the most empirical support, is that of the environment as a selective modifier. Differences in environmental conditions are seen as having different impacts at different times during development.

A recurring theme found throughout Uzgiris' review of the literature investigating the effects of experience is that kinesthetic stimulation is related to improved cognitive functioning during the sensorimotor period. Uzgiris concludes that 1) the data in these studies argue against a threshold effect, 2) there is insufficient empirical support to conclude that the environment can change the pattern of development, and 3) the bulk of the data tend to support the fourth concept, i.e. that different environmental opportunities are important at different periods of development.

In summary, the literature reviewed generally supports Piaget's theory that changes in cognitive structures are dependent on the infant's opportunities to exercise schemata actively during the appropriate stage of development. "Floor freedom", plus auditory,

visual, tactile, and proprioceptive stimulation have been identified as important to the infant during object concept development. Although Bower and his associates find object permanence present at an early age using visual methodology only, the data from Bower and Paterson's 1972 experiment suggest that manual search is a later expression of a developmental process that is based on an earlier visual object concept.

Object Permanence in Handicapped Infants

In the previous section, various authors presented findings which indicate that motor activity and sensory stimulation are important to the development of object permanence in normal infants. In this section the literature concerning object permanence in infants with sensorimotor deficits is reviewed. These infants may be given access to living areas, or "floor freedom", but may be unable to utilize the opportunity to move about on the floor because of their abnormal postural tone. For the same reason they may be prevented from interacting with toys that give feedback. Human stimulation may also be decreased for this group of infants. Parents may give these infants less tactile and kinesthetic stimulation because of fear of harming the child, or because the feedback the parents receive from the infants is also abnormal.

Four studies have been reported in the literature concerning the development of object permanence in infants with motor impairment due to central nervous system dysfunction. One of the purposes of the study conducted by Tessier (1969) was to determine whether object permanence developed normally in infants with central nervous system dysfunction, specifically in children with cerebral palsy. Tessier

assessed object permanence in 20 children with cerebral palsy, ten retarded and ten non-retarded, all between the ages of 18 and 36 months. She developed her own sensorimotor scale based on the work of Uzgiris and Hunt. She found that the non-retarded children passed through the stages of object concept development as expected, while the retarded cerebral palsied children were delayed in their acquisition of object permanence levels. This study, which confirms the fact that cerebral palsied children ultimately achieve object permanence, suffered from two major flaws. First of all Tessier eliminated any child from the study who did not possess good head control and use of arms and hands. Secondly, the age of the children presents a problem; they were all close to, or beyond the normal age of object concept development. (The final stage of object permanence is achieved between 18 and 21-24 months). As might be expected, all of the children, except the retarded, achieved all of the object permanence levels and ceilinged the test.

Fetters (1976) attempted to compare motorically impaired infants who were classified as manipulators with those who were classified as non-manipulators. Manipulators were defined as infants who were able to perform complex motor schemes such as holding, turning, and manipulating an object while inspecting it visually. She observed 12 subjects ranging in age from 13 to 29 months on visual tracking tests of object permanence based on the procedures developed by Bower, et.al. (1971). Handicapped infants were observed tracking objects across a puppet stage. Objects passed behind a screen and reversed direction, disappeared, changed speed, or emerged changed into a different object.

Visual and facial responses were recorded along with heart rate. She found no difference in object concept development between manipulators and non-manipulators, and concluded that visual interaction with the environment was more important than being able to manipulate objects. Many of the subjects in this experiment also ceilinged on the test items.

Young (1977) studied cognitive development in children with cerebral palsy. He examined 13 children in the youngest age group, 13 to 26 months old, using the instruments devised by Tessier (1969) and Corman and Escalona (1969). Object concept development, sensorimotor intelligence, and motor performance were measured. It was found that scores obtained on these instruments were highly dependent on motor abilities.

Wachs and DeRemer (1978) compared the performance of 25 developmentally disabled infants and preschool children on Piagetian scales with their adaptive behavior as reported by their mothers. Of the 25, only seven children were under the age of 24 months, and three of the 25 showed severe mental retardation. The disabilities of the children were not described, however children with severe motor impairment were excluded from the study. Moderate but significant correlations were reported between the object permanence subscale and physical, self-help, social, and academic development.

In summary, it is apparent from the studies reviewed that children with sensorimotor deficits do achieve object permanence. Conflicting evidence was presented in two of the studies with respect to the importance of the ability to manually manipulate objects. A

third study reported object concept development to be highly dependent on motor abilities. The last study reviewed found object permanence and motor abilities to be moderately correlated. None of the research reviewed dealt with the concept of "floor freedom" or any form of sensory stimulation. All of the studies reviewed in this section included very few infants under the age of 24 months.

Eye Pointing

Some infants with motor impairment due to central nervous system dysfunction are unable to manually interact with test materials. In this case, examiners have adapted testing procedures so that these infants can respond to test items by eye-pointing. The infants are then able to indicate their responses by looking at one of the two or more choices offered by the examiner.

A search of the literature revealed only one reference to the use of eye-pointing (Fieber, 1977). She suggested that eye-pointing be taught to those non-verbal children who were unable to point clearly thus enabling them to use an alternate method of communication.

A further review of the literature disclosed the use of visual fixation and visual pursuit (tracking) as measures of infant responses. Fixation time has been widely used as an indicator of infants' preferences. In some cases the methodology used is very simple; an observer times the infant's fixations while observing their eyes. In other studies sophisticated filming or videotaping procedures have been used to record corneal reflections. Fantz (1963) recorded fixation time of infants from ten hours to five days of age to determine presence of patterned vision. Preference for patterned targets

and unfamiliar targets was observed using fixation time by Salapatek and Kessen (1966) and Fantz (1964), respectively.

Tracking or visual pursuit has been studied in neonates and has been found to be a stable measure (Barten, Birns and Ronch, 1971; Dayton, Jones, Aiu, et.al., 1964; Nelson, 1968). In older infants tracking has been used as a dependent variable while measuring cognitive concepts. Nelson (1971) studied 80 infants, three to nine months of age, while they tracked a train moving around a track and disappearing in a tunnel. Similar methodology has been used in object permanence studies of normal infants by Bower, Broughton and Moore (1971) and Bower and Paterson (1972 and 1973). Fetters (1976) also used the same procedures in evaluating object permanence of older infants with cerebral palsy.

The development of pointing by infants themselves as a means of communication was studied by Murphy (1978) and Lempers (1976). Most of the infants in Lemper's study, who were nine, 12 and 14 months old, were able to point out where an object was located, and a few of these were only nine months old. Similar results were found by Murphy. Other authors, cited in Lempers, Flavell and Flavell (1977) have described pointing as occurring as early as 40 weeks.

It would appear from the review of the limited literature available that the use of eye-pointing as an alternate method of communication during testing of object permanence would not be unprecedented since visual fixation, tracking, visual attention, and manual pointing have been used to assess cognitive abilities.

Vestibular Stimulation

The role of visual attentiveness and of kinesthetic stimulation in the development of object permanence has been discussed earlier in this paper. Vestibular stimulation, which normal children receive through such activities as rocking, spinning, or twirling has been identified as a necessary prerequisite for sensory integration of the developing nervous system (Ayres, 1972). It has also been suggested that vestibular stimulation may reinforce cerebral specialization of the nondominant (right) hemisphere which is said to mediate visual-spatial activities. Lack of vestibular stimulation has been implicated in disorders of motor and cognitive development.

The vestibular system is a proprioceptive system and thus contributes to the sense of kinesthesia. The receptors of this system are located in the inner ear. They are the semicircular canals, and the otolith system (the saccule and the utricle); these receptors are sensitive to movement and gravity. Although there is some interaction between these two sets of structures, the semicircular canals are primarily responsive to motion, while the utricle and saccule are more affected by the forces of gravity. The receptors, plus the vestibular tracts and nuclei, which compose this system, have multiple connections with the other parts of the brain. Through its influence on muscle tone and on the visual system, the vestibular system functions to maintain equilibrium and to coordinate the direction of gaze and maintenance of the plane of vision in relationship to the position of the head in space. These basic functions are thought to provide the foundation for symbolic functions and for complex cognitive functioning

(Ayres, 1972; deQuiros, 1976; Weeks, 1979a, 1979b).

The current use of vestibular stimulation as a treatment modality is largely due to the work of Ayres (1972). Ayres hypothesizes that vestibular input may function to unify and coordinate all sensory input. She states that the normally functioning vestibular system helps the infant to know if sensory input is based on body movement or is a function of the external environment. She believes that the vestibular system has a strong influence on the development of body scheme, or the inner concept one has of one's own body, and on visual perception. The vestibular system has the potential to perform these functions through its connections with the cerebellum and, therefore the sensorimotor system. She states that some kinds of inadequate form and space perception may reflect poorly organized brain stem structures; and she states also that the vestibular system, especially the otolith organs may be important in the development of the normal integrative functions of the brain.

The effects of vestibular stimulation have been studied in normal humans from birth through adulthood. Neal (1967) studied the effects of vestibular stimulation on the development of premature infants of 28 to 32 weeks gestational age. The 31 infants in the experimental group achieved significantly greater motor responses, and greater visual and auditory responses than did the 31 control infants. The experimental group received vestibular stimulation three times daily to the total age of 36 weeks (gestational plus chronological age).

Two other studies have been reported on the effects that vestibular stimulation creates on the visual responses of infants.

Gregg, Haffner, and Korner (1976) studied visual pursuit responses of 48 neonates. They found that the infants who were rocked in a mechanical apparatus for four 15 second trials demonstrated enhanced tracking scores when compared with their controls. White and Castle (1964) also studied visual responses after rocking 10 normal institutionalized infants. The infants in the experimental group were rocked in an upright position for 20 minutes every day for 30 days. The increased visual responses of these infants, compared with 18 control group infants, were maintained for one and one half months.

Body rocking, head banging, and head rolling were investigated by Sallustro and Atwell (1978) in 525 normal children between three months and six years of age. Children who were body rockers and head bangers were found to be more developmentally advanced than the normals who did not engage in these forms of self-stimulation.

The amplitude and frequency of vestibular stimulation were studied by Pedersen and Ter Vrugt (1973) in a series of three experiments. A total of 134 two month old infants were rocked in a mechanical apparatus for 15 minutes; changes in activity levels were observed. The results of these studies indicated that the effectiveness of rocking is determined by maximal acceleration. In addition, the authors reported that the optimal frequency was about 60 cycles per minute. It should be noted that this frequency is similar to that of normal rhythmical patterns of movement, such as walking.

Vestibular stimulation has been provided to infants in experimental studies in several ways. In the studies reported above, the infants were either placed in a mechanical rocking apparatus, or were held in

the examiner's arms as the examiner rocked them in a rocking chair. The 13 normal infants who participated in the experimental group of another study were held in the examiner's lap while the examiner and the infant were spun in a chair (Clark, Kruetzberg, and Chee, 1977). These infants were spun in 16 sessions for a total of 10 minutes per session. Each spin lasted one minute and for each spin the head position and the direction of the spin were alternated. Six infants in one control group were held in the same position for the same amount of time without spinning; seven infants in another control group had no contact with the examiners between pre-test and post-test. Motor development was assessed by measuring reflexes and motor skills. The infants in the treatment group demonstrated the highest gains on both tests of motor development. Weeks (1979a) has cautioned against the use of strong vestibular stimulation, such as spinning, of infants. She suggested that rocking appears to be well established as a safe means of providing vestibular input.

The studies of DeGangi, Berk, and Larsen (1980) and Angelo (1980) were concerned with vestibular stimulation of pre-school and college students respectively. In both studies programs of vestibular stimulation increased visual-spatial skills and academic achievement.

Vestibular disorders and the effects of vestibular stimulation have also been reported in non-normal infants and children. deQuiros (1976) reported research in which he conducted a longitudinal study of infants with vestibular disorders. He identified a syndrome, present after birth, which predisposed these infants to later learning disabilities. He hypothesized that normal vestibular function is a

necessary prerequisite for the development of learning.

Three normal infants between six and nine months, and four infants with Down's syndrome between six and 24 months of age were divided into experimental and control groups in a study by Kanter, Clark, Allen, and Chase (1976). Infants in the experimental group were held by an examiner while being spun in a rotary chair for a total of 10 minutes each day for 10 days. The results indicated an increase in motor performance, including maturational effects, over that of the control group.

The effects of vestibular stimulation on children with motor deficits due to central nervous system dysfunction have been reported in three studies. The first study, reported in 1975 by Norton, concerned three multiply-handicapped mentally retarded children, three to four years old. These children were placed on home treatment programs which included, but were not limited to, vestibular stimulation. The author stated that after eight months on this program, trends toward higher developmental levels were observed.

Chee, Kreutzberg, and Clark (1978) also found improvement in cerebral palsied children after vestibular stimulation. Twenty-three preambulatory cerebral palsied children between two and six years were studied. All children were pre-tested for gross motor skills and postural reflexes, and then assigned to equated treatment and control groups. The control group was further divided into a handled subgroup and a non-handled subgroup. The 12 children in the treatment group were held in the examiner's lap while both the examiner and the child were spun in the chair. Head position of the child and the direction

of the spin were varied in order to stimulate paired semicircular canals. The children were spun in 16 sessions for a total of 10 minutes per session with each spin lasting one minute. A highly significant improvement in motor skills and postural reflexes was found in the treated group. No significant changes were found in the control groups.

The third study reported results which conflict with the findings of Norton (1975) and Chee, et.al. (1978). Sellick and Over (1980) studied 20 cerebral palsied children from eight to 56 months of age. These children were assigned to matched treatment and control groups based on age, diagnosis, and scores on the Bayley Infant Development Scales. The ten children in the treatment group were held in an examiner's lap while being spun. The method employed was the same as reported by Chee, et.al. (1978). In this study the control group was handled for the same length of time per session as the treated group. Post-test scores revealed some gains for both the treatment and the control groups; however, none of the gains could be attributed to the vestibular stimulation. The authors suggested that possible sources of error could have been related to difficulties with matching and to lack of control of therapy history.

The majority of the literature reviewed in this section reported that infants and children exposed to a regimen of vestibular stimulation demonstrated significant gains in motor abilities and in visual responses. In addition, vestibular stimulation was found to enhance auditory responses, visual-spatial skills, and academic achievement.

Summary

Piaget's theory of the process of intellectual development, in which the individual uses adaptation and organization to construct cognitive structures or schemata, provides the theoretical background for the development of object permanence. Object permanence, a cognitive structure is achieved in normal infants through six stages during the sensorimotor period, which covers the first two years of life. When the infant achieves object permanence he understands that an object still exists when it is out of sight. Object permanence, thus, appears to be a prerequisite concept for more advanced mental operations. Movement and physical interaction with the environment are implicated as prerequisites for the development of object permanence.

The more recent literature reviewed in this chapter supports the importance of physical interaction with the environment in the development of object concept. Other variables, such as sex, socioeconomic background, attention, method of hiding the object, and auditory, tactile, and proprioceptive stimulation or experiences have been explored. Bower and his associates report object permanence at an earlier age, using visual methodology, than Piaget. There is general agreement in the literature that the development of object permanence in normal infants is influenced by environmental factors. Sensory stimulation and the opportunity to interact with the environment have been identified as important to the development of object concept.

The literature in regard to the development of object permanence in infants with sensorimotor handicaps is limited, but indicates that

children with these handicaps do achieve object permanence. There is no evidence, however, that they achieve this concept at normal age levels. Some of the literature reviewed reported positive correlations between motor abilities and object permanence. These studies have been limited to older infants; the youngest of the infants was 13 months. The literature on object permanence in infants with sensorimotor handicaps does not conflict with Piaget's concept that movement and physical interaction with the environment are necessary for the development of this schema.

The literature relating to eye-pointing is virtually nonexistent. In 1977 Fieber suggested that eye-pointing could be taught to children whose central nervous system impairment prevented other forms of communication. Visual fixation, visual pursuit or tracking, and manual pointing have been used frequently as methods of measuring the cognitive abilities of infants and young children. On the basis of these findings it was concluded that eye-pointing could be used as a method of measuring object permanence in infants whose sensorimotor dysfunction would prevent them from manually searching for the hidden object.

Vestibular stimulation has been identified as a necessary prerequisite for sensory integration of the developing nervous system by Ayres (1972). Lack of vestibular stimulation, such as rocking, spinning, or twirling, has been associated with disorders of motor and cognitive development. Ayres' theories have been largely supported by the literature. Studies involving vestibular stimulation of individuals ranging in age from infancy to adulthood, indicate that this form of

stimulation greatly increases motor, visual, and auditory responsiveness, visuo-spatial skills, and academic achievement. Studies of infants with central nervous dysfunction generally report increases in motor and cognitive abilities after a period of vestibular stimulation.

In conclusion, the literature reviewed indicates that object permanence is a cognitive concept which develops sequentially during the first two years of life. By the age of two years, normal infants understand that objects continue to exist when they are out of sight. Movement and physical interaction with the environment have been identified as two factors which are related to the development of this concept. The few studies which have been reported on object permanence in infants with sensorimotor handicaps indicate that 1) these children do achieve object permanence eventually, 2) there is no evidence that they achieve object permanence at normal age levels, and 3) there is a positive relationship between object permanence and motor abilities. Eye-pointing, which is used by handicapped children to communicate, has not been reported as a method of measuring cognition in either normal or handicapped infants. However, visual fixation, which is not unlike eye-pointing, has been used to study the cognitive abilities of normal infants. Visual pursuit, or tracking, has been used in studies of both normal and handicapped infants. Vestibular stimulation such as rocking, spinning, or twirling, has been hypothesized to be important in the development of the normal central nervous system. Lack of vestibular stimulation has been related to disorders of sensorimotor and cognitive development. In addition, the literature reviewed indicates that

vestibular stimulation causes increased gains in cognitive and motor skills in both normal and handicapped children.

CHAPTER III

METHOD

It was the basic intent of this study to investigate the development of object permanence in young infants with a sensorimotor handicap. The primary purpose of this investigation was to determine the effect of vestibular stimulation on object permanence development and on motor development. It was also of interest to compare the relationship between levels of object permanence development and levels of motor development. Furthermore, this study was designed with the intent of comparing object permanence development in normal infants with that of infants with a sensorimotor handicap.

Infants between six and 24 months of age who displayed abnormal postural tone and abnormal or primitive patterns of movement served as subjects. The investigation was divided into two phases. During the first phase, each infant received either vestibular stimulation or no vestibular stimulation. In the second phase of the study those infants receiving vestibular stimulation in the first phase of the study received no vestibular stimulation, while those infants not receiving vestibular stimulation in the first phase of the study received vestibular stimulation. The parents of the infants rocked the infants in each of four different positions, thus providing the vestibular stimulation.

Each infant's performance on a test of object permanence and on a test of motor behavior was measured before and after the first phase

of the study, and at the end of the second phase of the investigation. Scale I: The Development of Visual Pursuit and the Permanence of Objects from the Infant Psychological Development Scales of Uzgiris and Hunt (1975) was used to measure object permanence. Sensorimotor development was assessed using the Motor Behavior Checklist constructed by the author.

Hypotheses

The following hypotheses were proposed for sensorimotor impaired infants between six and 24 months of age:

1) There is no significant relationship between motor behavior scores and object permanence scores.
2) Object permanence scores of these infants are not significantly different from object permanence scores of normal infants of the same age.
3) There is no significant difference between the rate of increase of object permanence scores after a period of vestibular stimulation and the rate of increase of object permanence scores after a period without vestibular stimulation. That is to say, the gain scores on the object permanence scale are no different after a period of vestibular stimulation than after a period of no vestibular stimulation.
4) There is no significant difference between the rate of increase of motor behavior scores after a period of vestibular stimulation and the rate of increase of motor behavior scores after a period without vestibular stimulation. That is to say, the gain scores on the motor behavior scale are no different after

a period of vestibular stimulation than after a period of no vestibular stimulation.

Subjects

The subjects were selected from a population of infants with sensorimotor handicaps who were between six and 24 months of age, and who were receiving therapy at a suburban out-patient treatment facility. Infants who had a sensorimotor handicap were defined as those infants displaying abnormal postural tone, and abnormal, limited, stereotyped patterns of movement. Infants with severe visual or auditory deficits, recurrent seizures, and/or severe or profound mental retardation were excluded from the study. Infants from severely deprived homes were also excluded from the study. The severity of the sensorimotor handicap was not a condition which warranted exclusion of an infant from the study.

Twenty-one infants, whose parents volunteered to participate, were selected for the study. Sixteen infants completed both phases of the investigation. The chronological ages of the infants ranged from seven to 21 months. Eight of the infants had been delivered prematurely (see Table I for details). Nine of the infants were male, and seven were female. All of the infants were Caucasian. Eight of the infants were hypotonic (i.e., floppy) and eight displayed hypertonia (i.e., stiff or spastic). Table II presents a numerical description of the subjects according to the diagnoses and severity of the sensorimotor handicap.

All of the infants were receiving physical, occupational, and/or speech therapy. None of the infants who participated in the study were

Table I

Age and Sex of Subjects (at Pre-Test)

Sex	Chronological Age	Adjusted Age (for Prematurity)
Male	7 mo. 3 wks.	-
	10 mo.	-
	10 mo. 2 wks.	8 mo. 2 wks.
	11 mo. 3 wks.	9 mo. 3 wks
	12 mo. 1 wk.	-
	16 mo.	13 mo.
	17 mo. 3 wks.	-
	18 mo.	15 mo.
	19 mo.	17 mo.
Female	12 mo. 3 wks.	-
	13 mo. 2 wks.	11 mo. 2 wks.
	14 mo. 1 wk.	-
	18 mo.	-
	19 mo. 1 wk.	16 mo. 1 wk.
	21 mo. 3 wks.	20 mo. 1 wk.
	21 mo. 3 wks.	-

Table II

Number of Infants Displaying Different Types and Severity of Sensorimotor Handicap

	DIAGNOSIS				
Severity	Hypotonic	Athetoid	Spastic Diplegia	Spastic Hemiplegia	Spastic Quadriplegia
Mild	4	0	2	0	0
Mild-Moderate	0	0	0	0	0
Moderate	4	0	0	1	1
Moderate-Severe	0	1	1	1	1
Severe	0	0	0	0	0

receiving vestibular stimulation, per se, as a part of their regular therapy program and no major changes were made in any infant's therapy program during the course of the investigation.

Treatment of the participants in the study was in accordance with and approved by the Institutional Review Board for Protection of Human Subjects of Loyola University of Chicago, and by the out-patient treatment facility. No monetary or other rewards were offered for participation in the study.

Experimental Design

A cross-over design, in which each subject served as his own control, was selected for this study. This design was chosen since the investigator believed that the maximum amount of cooperation from the parents of the infants participating in this study would be achieved. Since the parents of this group of infants often confided in and sought support from one another, it was believed it was not possible to assign the infants to either the treatment or the control group only. Therefore, each infant was assigned to either the treatment or the no treatment group during the first phase of the experiment, and to the opposite condition during the second phase of the experiment. Assignment to the treatment condition during the first or second phase of the experiment was determined either by parental preference or by random assignment. This procedure was designed to accomodate changes in family schedules due to work, school or vacation plans.

The independent variable, vestibular stimulation in the form of rocking, was provided by the parents. The regimen of vestibular

stimulation consisted of approximately 30 minutes of rocking each day for four weeks. Rocking was to be performed four times daily for seven to eight minutes in each of four positions, prone, upright or vertical, sidelying on the right, and sidelying on the left. These positions were selected to optimize the stimulation received by each pair of semicircular canals.

The dependent variables were the infant's scores on a scale of object permanence, and on a scale of motor behavior. Each infant was assessed using both of these scales at the start of the experiment (pre-test), after the first phase of the experiment (post-test one), and after the second phase of the experiment (post-test two). The object permanence scale was administered solely by the investigator, while the motor behavior scale was completed by the investigator and, whenever possible, by the infant's physical therapist.

Instrumentation

Object Permanence Scale

The first scale of the Infant Psychological Development Scales, The Development of Visual Pursuit and the Permanence of Objects (Uzgiris and Hunt, 1975) was selected for use in this study. In selecting an object permanence scale for this investigation, three major scales of sensorimotor development based on Piagetian theory and philosophy were reviewed. All three of those scales contain items which measure object permanence. The Infant Psychological Development Scales (IPDS) was first developed around 1966, and was published in final form in 1975. The Albert Einstein Scales of Early Cognitive Development were first used around 1969 by their developers, Corman and Escalona. The

The Casati-Lezine scale, Stages of Sensorimotor Intelligence in the Child, was apparently first used about 1968 in France. The UCLA version of this scale has been used in this country since 1972, primarily by Kopp and Parmelee in Los Angeles.

The Infant Psychological Development Scales developed by Uzgiris and Hunt (1975) appear to be the most frequently used and the most researched of the three sensorimotor development scales. The IPDS contains 15 object permanence items in Scale I: The Development of Visual Pursuit and the Permanence of Objects. The first two items of the scale are visual pursuit items. The next five items involve search for partially hidden objects, and fully covered objects hidden under one screen or under one of three screens. Items eight and nine require the infant to search after successive visible displacements. Items 10 through 13 call upon the infant to search after invisible displacements. The last two items present situations in which the infant must search for the object after successive invisible displacements.

Validity and reliability studies have been performed on the IPDS. Uzgiris and Hunt (1975) report inter-observer agreement ranging from .87 to 1.0 on Scale I. Test-retest reliability over 48 hours is reported to range from .43 to 1.0 for the entire IPDS, with items on Scale I ranging from .74 to .94. The authors state that considering the plasticity of the nervous system in infancy, they find it doubtful that further standardization would be of value (1975).

The IPDS has also been demonstrated to be ordinal in nature by the authors. Eighty-two infants were administered Scale I of the IPDS

in order to perform a scalogram analysis on the resulting data. Using Green's Index of Consistency (I) for a scalogram analysis, it was determined that 14 of the items were sequential in nature with a very high coefficient of reproducibility corrected for chance (I = .97). These 14 items are referred to as scale scores. In addition to the scalogram analysis, scale scores were correlated with the age of the infants. The Pearson product-moment for Scale I was also very high (r = .94).

The Casati-Lezine has been characterized as being comprehensive and easy to administer and to score (Parmelee, Kopp, and Sigman, 1976). Its ordinality was demonstrated by Kopp, Sigman and Parmelee (1973), however there is no evidence that reliability or validity studies were done. This scale contains only seven items that related to the development of object permanence.

The Albert Einstein Scales, or the Corman-Escalona, as it is more frequently referred to, has been subjected to reliability studies, and cross-sectional and longitudinal validation studies (Corman and Escalona, 1969). Reliability was found to be .94 on the object permanence scale which consists of 18 items. These scales have also been demonstrated to be ordinal in nature.

The Scale I of the IPDS was selected for use in this study. It appeared to be the most frequently used test for studies of object permanence in infants, and also appeared to be the most standardized of the three available scales.

Motor Development Scales

The motor development scale, The Motor Behavior Checklist, devised

by the author (see Appendix A for details) was based on her clinical experience, and developed in consultation with six other physical therapists knowledgeable in the development of normal infants and infants with sensorimotor handicaps. The items included in this scale were selected because it was believed that they reflected the infant's ability to interact with, and move about within the environment. The scale included 32 items. These items measured visual tracking, hand use, prone activities such as crawling and creeping, and activities leading to and including independent sitting, standing, and walking. In addition, the scale contained items indicating the quality of normal postural reactions (i.e., equilibrium reactions). The items on the test were generally arranged in order, progressing from those which appear early in development to those which appear later. Each item was scored as either present, partially present, or absent. A maximum score on the scale was 64. The form also included documentation of the type and distribution of postural tone, and the amount of floor space within which the infant moved during the testing. The Motor Behavior Checklist was validated during the course of the study (see Chapter 4 for details).

Four other motor behavior scales were reviewed before devising the Motor Behavior Checklist. These included the Gesell Developmental Schedule (Gesell, 1949), the Motor Scale of the Bayley Scales of Infant Development (Bayley, 1969), the Denver Developmental (Frankenberg and Dodds, 1967), and the Milani-Comparetti (Milani-Comparetti and Gidoni, 1967). Although the first three of these scales have been standardized, they were not selected for use in this study as none of these scales

contained all of the developmental activities and postural reactions included in the Motor Behavior Checklist. The Milani-Comparetti does contain postural reactions, but contains an insufficient number of items measuring developmental activities.

Procedure

The physical therapists at the out-patient treatment facility were asked to identify infants who met the criteria for inclusion in this investigation. After the infants who were eligible to participate in this study were identified, a letter was given to the parent of each selected child by the infant's physical therapist. The letter explained the general purpose of the study and the basic procedures that would be followed during the course of the investigation (see Appendix B). If the parents agreed to participate, they were asked to write on the form the days and hours that were most convenient for them for initial testing.

Most of the testing was done in the treatment center in a room containing testing materials and equipment (appropriate toys, seating benches, chairs, and tables) in a setting devoid of extraneous distractions. A few of the post-tests were performed in the infants' homes because of the inability of the parent to bring the infant to the treatment center for testing.

Standard procedures and materials employed in Scale I of the IPDS as described by Uzgiris and Hunt (1975) were used in this study with one exception. Infants, who were unable to remove the standard 18 inch square screens used to cover the objects, were presented with a screen measuring approximately nine square inches. All of the infants

in the study were able to manage either the larger or the smaller screens, therefore it was unnecessary to instruct any of the infants in eye-pointing or to alter the method of presentation of any of the items.

The Pre-test

Each infant was brought into the testing room by the investigator, and the nature of the testing procedure was explained to the parent accompanying the infant. During the initial stage of getting acquainted with the infant, the investigator talked to the parent, offered toys to the infant, and recorded the infant's motor behaviors. When it appeared that the infant was comfortable in the testing environment, the investigator began administering items from Scale I of the IPDS. If at any time the investigator determined that the infant's lack of interest or uncooperative behavior was interfering with formal testing, the testing was discontinued, and the infant was given the opportunity to play freely. During this play period the investigator again observed the infant and completed the rating of the Motor Behavior Checklist. After this period of play, either testing of object permanence was begun again, or abandoned for the day, and an appointment was made to continue testing at a later date.

Assignment to Treatment Condition and Parent Instruction

Infants were assigned to treatment or no treatment conditions after the initial testing was completed. Determination of whether the infant would be placed in the treatment or no treatment condition during the first phase of the study was made after consulting with the parent. The parent was given more specific information about the vestibular stimulation to be provided to the infant for four weeks.

Then the parent was asked if she preferred to perform the vestibular stimulation during the first phase of the study, or during the second phase. If the parent had no preference, the investigator randomly assigned the infant to either the treatment condition or the no treatment condition for the first phase of the study.

During the treatment phase of the study parents were requested to rock their infant for 30 minutes each day for four weeks. They were instructed to rock the infant for approximately seven to eight minutes in each of four positions; upright, prone, sidelying on the left, and sidelying on the right. The investigator demonstrated the rocking in all four positions for each parent. The parents were asked to rock their child when the infant was awake, alert, and not crying. Each parent was given a notebook in which to record the date, the amount of time they spent rocking the infant, and any problems which they encountered while trying to fulfill the requested stimulation. The parents were informed that it was very important to record the amount of stimulation and the problems encountered while administering the treatment. They were told that the investigator was interested in determining the feasibility of providing vestibular stimulation at home rather than at a treatment center. In this way the investigator hoped to be able to determine how much time was actually spent each day rocking the infant. The parents of the infants in the no treatment condition were given no instructions at that time. The parents were then informed by the investigator that they would be contacted by telephone to make an appointment for the next testing session.

Post-testing

All of the infants were re-tested after the first phase of the study (post-test one). Both the Motor Behavior Checklist and the Scale I of the IPDS were administered again by the investigator. Most of the infants were also re-tested with the Motor Behavior Checklist during the same week by their physical therapist. The procedures followed during post-testing were identical to those used in the pre-test situation. After the testing was completed for post-test one, the infants who were assigned to the no treatment condition during the first phase of the study, were then assigned to the treatment condition, and vice versa. The parents of the infants assigned to the treatment condition during the second phase of the study were then given the rocking instructions. At the end of the second phase of the investigation all of the infants were re-tested again (post-test two) using the same procedures as for the pre-test and post-test one.

Method of Analysis of Data

The Motor Behavior Checklist was validated by comparing the ratings assigned to the infants motor behaviors by the author and the ratings assigned by the infant's physical therapist. A percentage of agreement score was determined by comparing ratings on each individual item of the checklist.

The correlation between the motor behavior scores and object permanence scores was obtained by determining the agreement between the infant's ranking on each scale using the Kendall Tau Coefficient (Hays, 1973). The statistical significance of the relationships was obtained from a table of critical values for correlation coefficients (Siegel,

1956).

A Student's "t" test was performed to determine whether there was a difference between the object permanence scores of the infants in this study and normal infants of the same age. The data reporting the average scores of normal infants were obtained from Uzgiris and Hunt (1975). Critical values of "t" were obtained from Hays (1973).

The difference in the rate of increase of object permanence scores and motor behavior scores after a period of vestibular stimulation, and after a period without vestibular stimulation was determined by use of the Mann-Whitney U test. The values obtained were compared with tabled values to determine statistical significance (Siegel, 1956).

Summary

The major goal of this study was to investigate object permanence development in infants with sensorimotor dysfunction. One of the main purposes of the experiment was to determine the effect of vestibular stimulation on object permanence and on motor behavior. Another purpose was to determine the relationship between object permanence and motor behavior in these infants. In addition, it was of interest to compare object concept development in normal infants with that of infants with a sensorimotor handicap.

Sixteen infants between seven and 21 months of age were studied. These infants displayed abnormal postural tone and abnormal or primitive patterns of movement. None of the infants had severe visual or auditory deficits, recurrent seizures, or severe or profound mental retardation.

A two phase design was selected in which each infant received a period of vestibular stimulation and a period of no vestibular stimulation. During the first phase of the experiment each infant received either vestibular stimulation or no vestibular stimulation, and during the second phase of the study each infant received the opposite treatment condition. Assignment to the treatment (vestibular stimulation) or the no treatment condition (no vestibular stimulation) was determined by parental preference or random assignment.

Each infant's performance on a test of object permanence and on a motor behavior test was measured before and after the first phase of the study, and after the second phase of the study. The object permanence test selected for use in this study was Scale I: The Development of Visual Pursuit and the Permanence of Objects from the Infant Psychological Development Scales of Uzgiris and Hunt (1975). The Motor Behavior Checklist devised by the author was used to measure motor performance of the infants.

The parents of the infants were requested to provide their infant with vestibular stimulation in the form of rocking for 30 minutes each day for four weeks in four different positions which were selected in order to maximally stimulate each pair of semi-circular canals.

The gains in object permanence and motor behavior during each phase of the experiment (vestibular stimulation and no vestibular stimulation) were compared by the use of the Mann-Whitney U test. The relationship between object permanence scores and motor behavior scores was determined using the Kendall Tau Coefficient. A Student's "t" test was used to compare the age of achievement of object permanence

stages of the infants in this study with those of normal infants.

CHAPTER IV

RESULTS

The goal of this investigation was to study object permanence in infants with sensorimotor dysfunction. The first purpose of the investigation was to study the relationship between object permanence and motor behavior in infants with a sensorimotor handicap. The second purpose was to compare the object permanence scores of these infants with the object permanence scores of normal infants of the same age. The third purpose was to examine the effects of vestibular stimulation on object permanence in this group of infants. The fourth, and last purpose was to study the effects of vestibular stimulation on the motor behavior of infants with sensorimotor dysfunction.

The results of the study are divided into three major sections. The first section contains the data concerning the interscorer agreement on the Motor Behavior Checklist, the data related to the age of the infants, the data concerning the amount of vestibular stimulation actually provided by the parents, and the length of time between testing sessions. In the second section the data gathered which is relevant to the specific hypotheses of this investigation is systematically presented. This section includes 1) the comparison of object permanence and sensorimotor development, 2) a comparison of the object permanence development of the subjects in this study with that of normal infants, and 3) the effects of vestibular stimulation on object permanence and motor behavior. Additional findings related to the study are presented in the third section of this chapter.

Background Data

In this section data is presented supporting the reliability of the instrument used to measure the infants' motor behavior (the Motor Behavior Checklist). The descriptive statistics related to the age of the infants at the time of each testing session is also presented. In addition, this section includes the data related to the amount of vestibular stimulation the infants received from their parents, and the length of time that elapsed between testing sessions.

Interscorer Agreement on the Motor Behavior Checklist

Scoring of the Motor Behavior Checklist was completed by the primary investigator and five assistants (five physical therapists who treated the infant weekly). The data on interscorer agreement was collected during the course of the investigation in order to provide information regarding the reliability of the instrument. Sixty-nine percent of the motor behavior tests were administered by both the primary investigator and one other assistant. Interscorer agreement was determined by comparing the ratings of the infant's behavior on each item of the Motor Behavior Checklist. The average percentage of agreement was 88.99 percent, indicating that there was a high degree of inter-rater reliability.

Age of Infants

The chronological age of the infants ranged from seven to 21 months at the time the first testing session was completed (pre-test). Eight of the infants in the study had been delivered prematurely, therefore, the ages were adjusted for prematurity. The adjusted age of each infant who was born prematurely was calculated by subtracting

the number of weeks of prematurity from the chronological age of each infant. The age range of the infants when adjusted for prematurity (adjusted age) was also seven to 21 months. The adjusted ages and chronological ages of the infants at pre-test, post-test one, and post-test two are described by means and standard deviations in Table III.

Table III

Mean Age in Months at Time of Testing and Standard Deviations Across Test Conditions

Test	n	Adjusted Age Mean	Adjusted Age S.D.	Chronological Age Mean	Chronological Age S.D.
Pre-test	16	14.6	4.06	15.3	4.13
Post-test One	16	15.9	3.80	17.3	4.00
Post-test Two	16	17.9	3.79	19.2	3.93

Five infants did not complete the study, and therefore the data from these infants was deleted from the results of the investigation. Two children were dropped from the study because of their lack of cooperation during the initial testing session. One child completed all of the items on the object permanence scale during the pre-test, and was excused from further participation in the study by the investigator. Two other infants completed the pre-test, but were unable to keep further appointments for post-testing.

Vestibular Stimulation

The raw data describing the number of minutes the infant was rocked each day was taken from the daily logs kept by the parents. The parents of two of the infants reported that their logs were either lost or destroyed accidentally. By verbal report, each of these two

parents stated that they rocked their infant about one minute each day. From the above data, means were calculated to determine the average number of minutes the infants were rocked per day. The average number of minutes the infants were rocked ranged from 0.5 to 30.0 minutes per day. The mean number of minutes rocked was 14.46 with a standard deviation of 11.51 minutes.

Length of Time Between Testing Sessions

The number of weeks between the pre-test and post-test one, and between post-test one and post-test two varied from a minimum of five weeks to a maximum of 13 weeks. This was due to a number of factors. One of the most common factors was that many of the children required multiple appointments to complete the pre-test or the post-tests. Other factors which frequently contributed to changes in the testing schedule were illness of the infant, parent or siblings; lack of transportation to the treatment center, and bad weather.

In order to determine the magnitude of this variable, the length of time (in weeks) between testing sessions was statistically compared. Specifically, the period of time during which the infants received vestibular stimulation was compared with the period of time during which the infants did not receive vestibular stimulation. The means for these two periods were 8.75 weeks and 8.56 weeks, respectively. An F test revealed that there was no significant difference between the variances ($F = 1.53$ (d.f., 16, 16) $\alpha = .05$).

Results of the Investigation

The following section presents the data related to the specific hypotheses of this study. This includes an examination of the data

comparing object permanence with motor behavior in infants with sensorimotor handicaps, a comparison of the object permanence scores of these infants with those obtained from normal infants of the same age, and the effects of vestibular stimulation on object permanence and on motor behavior.

Object Permanence and Motor Behavior

In order to determine the relationship between object permanence scores and motor behavior scores, Kendall's Tau Coefficient was employed to determine the agreement between the infant's rankings on these two measures. A positive correlation, which was statistically significant was found for the pre-test (τ = .65). However, the degree of agreement decreased on the two post-tests. On post-test one tau was only equal to .37, and declined further on post-test two (τ = .25).

In order to determine if age was a factor which influenced these correlations, the subjects were divided into two equal sized groups based on the mean age of all the infants at the time of pre-testing. Infants older than the mean age of 14.6 months (adjusted age) were placed in one group, and the infants younger than the mean age were placed in another group. Kendall's Tau Coefficient was then applied to each group to compare the infants rankings on the object permanence test and on the motor behavior test. Table IV depicts a large difference in the correlations between these two age groups. Overall, the correlations between object permanence and motor behavior in the younger group were very high and positive though gradually decreasing from the pre-test through the post-tests. The correlations computed from the older group of infants were low and became negative on the

post-tests.

Table IV

Measures of Association Between Object Permanence and Motor Behavior and Mean Age of Older and Younger Infants

Test	Younger Group n	Mean Age*	Tau	Older Group n	Mean Age*	Tau
Pre-test	8	10.6	.93	8	17.3	.28
Post-test One	8	12.8	.89	8	19.1	-.08
Post-test Two	8	14.8	.84	8	21.8	-.29

*Adjusted for Prematurity

A Comparison of the Object Permanence Scores of Sensorimotor Impaired Infants and Normal Infants

It was hypothesized that the object permanence scores of the infants with sensorimotor handicaps would not differ significantly from the object permanence scores of normal infants of the same age. In order to test this null hypothesis the age at which the subjects in this study passed object permanence test items was compared with the average age at which normal infants passed the same items using a Student's "t" test. The data on object permanence in normal infants was obtained from Uzgiris and Hunt (1975). Table V displays the means of the differences in age at which the infants achieved test items, the standard deviations of the differences, and the t_D values of the subjects in this study compared with normal infants. Tabled values of the "t" distribution indicate that the difference in object permanence scores between these two groups of infants is highly significant (see Table V for details).

Table V

Difference in Age at Which Experimental Subjects and Normal Infants Achieved Object Permanence in Months

Test	Mean of Difference	S.D. of Difference	t_D	Significance
Pre-test	7.44	2.13	9.88	$p = < .002^a$
Post-test One	5.50	4.24	4.33	$p = < .002^b$
Post-test Two	5.39	4.44	3.43	$p = < .01^c$

[a]Two tailed test, d.f. = 14

[b]Two tailed test, d.f. = 20

[c]Two tailed test, d.f. = 14

Although the infants in the study achieved object permanence on the average at a significantly later age than normal infants, it can be seen in Table V that at post-test two the differences were decreasing. During the course of the study two of the infants with sensorimotor handicaps achieved the highest level of object permanence five to six months earlier than did the average normal infant (see Figure 1). The third infant whose data are displayed in the figure was only one month behind the normal infants at the time of post-test two.

The Effect of Vestibular Stimulation on Object Permanence

A comparison of the gains in object permanence scores after a period of vestibular stimulation and after a period of no vestibular stimulation was made using the Mann-Whitney U test. This test was only applied to 15 subjects because one of the infants ceilinged the object permanence test on post-test one (before vestibular stimulation). The

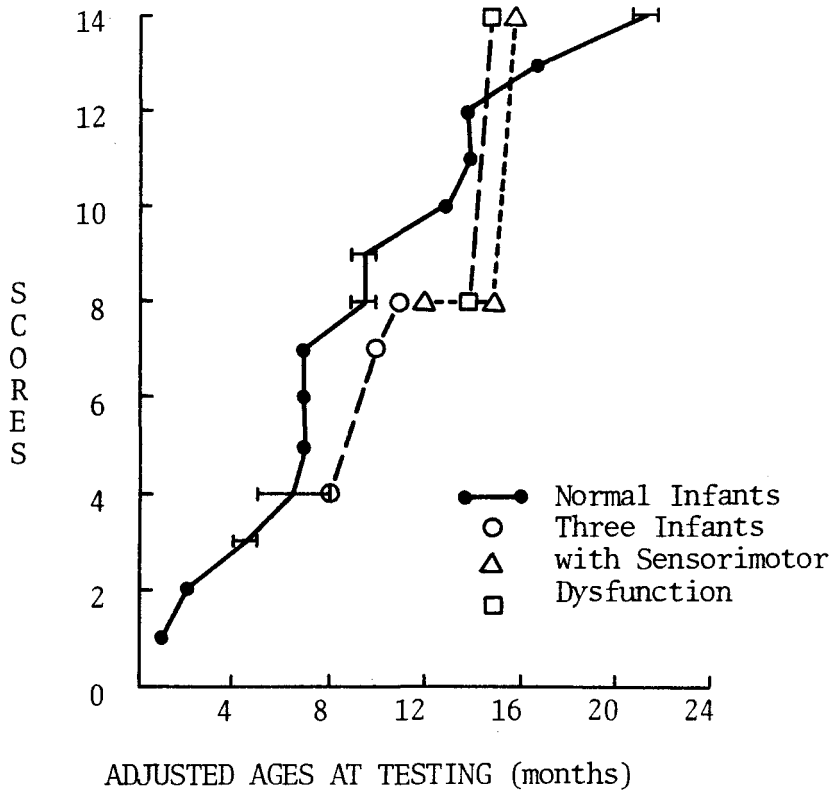

Figure 1. Object Permanence Scores of Three Subjects Compared with the Average Scores of Normal Infants

obtained U value of the remaining 15 subjects (U = 103.5) did not achieve significance on a two-tailed test with α = .10 (d.f., 16, 16).

The Effect of Vestibular Stimulation on Motor Behavior

The gains in motor behavior scores after a period of vestibular stimulation were compared with gains after a period of no vestibular stimulation. The Mann-Whitney U test was applied to the data from all 16 subjects. Using a two-tailed test of significance, it was determined that there was no significant difference between motor behavior gains in the two periods (U = 99.5 (d.f., 16, 16) α = .10).

Additional Findings

In this section information is presented pertaining to the gains the infants made during the first phase of the experiment as compared to those made in the second phase of the experiment. In addition, findings are presented which appear to explain the relationship between the amount of movement on the floor and object permanence scores.

Effect of the Phase of the Experiment on Object Permanence and Motor Behavior

Inspection of the data on object permanence and motor behavior suggested that gains made by the infants in these two areas were related to the phase of the experiment, rather than to whether or not the infant was receiving vestibular stimulation. Specifically, it appeared that greater gains were made during the first phase of the investigation (the period of time between the pre-test and post-test one) than during the second phase of the investigation (the period of time between post-test one and post-test two). The Mann-Whitney U

test was used to test this observation. The data from the two infants who achieved the highest possible score on the object permanence test during post-test one were not included in the analysis of object permanence gains. The calculated value (U = 67) was significant (α = .05, d.f. = 14, 16) using a one-tailed test. The subjects made significantly greater gains in object permanence during the first phase of the experiment than during the second phase of the experiment.

The Mann-Whitney U test was also applied to the data concerning the effect of the phase of the experiment on motor behavior. Data from all of the infants was included in evaluating motor behavior gains during phase one and phase two of the investigation. The calculated value (U = 78) was significant (α = .05, d.f. = 16, 16) using a one-tailed test. This indicated that the infants also made significantly greater gains in motor behavior during the first phase of the study as compared to the gains made in the second phase of the study.

Correlation of Age and Amount of Movement with Object Permanence

An overall intercorrelation matrix was calculated using all of the study variables.* The relationship of age and the amount of movement on the floor were correlated with object permanence scores using multiple regression procedures. Three multiple regressions were calculated on these three variables at pre-test, post-test one, and post-test two. The results obtained are presented in Tables VI through VIII. Both age and the amount of movement were highly

*The data analysis was performed on a Lear Siegler ADM 3A+ computer at the University of Illinois Chicago, Health Sciences Center using the SPSS (Statistical Packages for Social Sciences) program.

TABLE VI

The Relationship Between Age and the Amount of Movement and Object Permanence: Pre-test (N = 16)

Test of Significance for the Regression Model

ANOVA	DF	Sum of Squares	Mean Squares	F
Regression	2	109.95	54.97	39.73[a]
Residual	13	17.99	1.38	

[a] $p =< .001$

Summary Statistics for the Regression Model

Variable	Multiple R	R Square	Simple R	B	Beta	F
Age	0.60	0.36	0.60	0.22	0.322	8.30[a]
Amount of Movement	0.93	0.86	0.88	3.08	0.76	45.95[b]
Constant				-1.88		

[a] $p =< .01$
[b] $p =< .001$

TABLE VII

The Relationship Between Age and the Amount of Movement and Object Permanence: Post-test One (N = 16)

Test of Significance for the Regression Model

ANOVA	DF	Sum of Squares	Mean Squares	F
Regression	2	115.63	57.82	9.35[a]
Residual	13	80.37	6.18	

[a] $p =< .01$

Summary Statistics for the Regression Model

Variable	Multiple R	R Square	Simple R	B	Beta	F
Age	0.66	0.44	0.66	0.53	0.58	10.36[a]
Amount of Movement	0.77	0.59	0.51	2.28	0.40	4.80[b]
Constant				-3.64		

[a] $p =< .01$
[b] $p =< .05$

TABLE VIII

The Relationship Between Age and the Amount of Movement and Object Permanence: Post-test Two (N = 16)

Test of Significance for the Regression Model

ANOVA	DF	Sum of Squares	Mean Squares	F
Regression	2	96.08	48.04	7.58[a]
Residual	13	82.36	6.34	

[a] $p =< .01$

Summary Statistics for the Regression Model

Variable	Multiple R	R Square	Simple R	B	Beta	F
Age	0.63	0.40	0.63	0.59	0.67	12.56[a]
Amount of Movement	0.73	0.54	0.30	3.76	0.37	3.86[b]
Constant				-7.41		

[a] $p =< .001$
[b] $p =< .05$

correlated with object permanence scores at each of these three testing sessions. The amount of movement on the floor at the time of the pre-test correlated more highly with object permanence than did the age of the infant. This relationship shifted during post-testing with the variable of age becoming more important, and the amount of movement becoming less important on the post-tests.

Summary of Results

The results related to the background data of this investigation indicated that there was a high percentage of agreement between the primary investigator and the five assistants in rating the infants' motor behavior. The average adjusted age of the infants at the time of the pre-test was 14.6 months. The amount of time the infants were rocked by their parents varied a great deal, ranging from one half minute to 30 minutes per day. The length of time between testing sessions also varied greatly (five to 13 weeks). A comparison of the period of time during which the infants received vestibular stimulation and the period of time during which the infants did not receive vestibular stimulation revealed that this variability was not statistically significant.

Overall, the results of this investigation did not support the null hypothesis which stated that there is no significant relationship between motor behavior scores and object permanence scores. Object permanence and motor behavior were significantly correlated at pre-testing, but this correlation decreased with post-testing. In order to determine if age was a factor which influenced these differential correlations, the infants were divided into two equal groups based on

their age at pre-test. Findings indicated that the infants in the younger age group exhibited high, positive correlations between object permanence and motor behavior. The infants in the older age group, however, were found to have a low correlation on the pre-test. Interestingly, this correlation decreased and became negative on the post-tests. At the time of post-test two, the older infants displayed a low inverse correlation between object permanence and motor behavior.

The second null hypothesis was also not supported by the results of the present investigation. There was a highly significant difference in the age at which the sensorimotor impaired infants achieved object permanence scores as compared with the average normal infants. The data from the infants in the present study was compared to the data on normal infants presented by Uzgiris and Hunt (1975). The infants in the present study were significantly older at the time they achieved object permanence than were the normal infants.

It was hypothesized that there would be no significant difference in the rate of increase of object permanence scores after a period of vestibular stimulation and the rate of increase of object permanence scores after a period without vestibular stimulation. The results of the present study support the null hypothesis in this instance. The Mann-Whitney U test revealed that there was no significant difference between the two conditions. The vestibular stimulation provided in the present study did not result in greater gain scores on the object permanence scale after the vestibular stimulation.

The results of the present study also supported the null

hypothesis concerning the effect of vestibular stimulation on motor behavior. The period of vestibular stimulation resulted in no greater gain scores in motor behavior than did the period without vestibular stimulation.

An additional finding of this study, peculiar and difficult to explain, was that the infants made greater gains in object permanence and motor behavior during the first phase of the investigation (the time period between the pre-test and post-test one) than during the second phase of the investigation (the time period between post-test one and post-test two). The Mann-Whitney U test revealed that the infants made significantly greater gains in object permanence during the first phase of the study than during the second phase. The gains in motor behavior were also signficantly greater during the first phase of the investigation as compared to the second phase.

Finally, the relationship between age, the amount of movement on the floor, and object permanence scores was investigated using multiple regression procedures. Both age and the amount of movement on the floor correlated highly with object permanence scores. Initially, the amount of movement on the floor was the more highly correlated of the two variables. However, on post-testing the variable of age became more highly correlated with object permanence scores.

CHAPTER V

DISCUSSION

The overall goal of this investigation was to study object permanence in young infants with sensorimotor dysfunction. Specifically, the study was designed to determine the effects of vestibular stimulation on object permanence, to investigate the effect of vestibular stimulation on motor behavior in these infants, to examine the relationship between object permanence and motor behavior, and to compare the object permanence scores of these infants with a sensorimotor handicap to those of normal infants.

In this chapter the findings of the investigation are systematically examined, interpreted, and compared with those of previous investigations. The implications of the results of this study concerning the treatment of infants with sensorimotor handicaps are analyzed, and suggestions for future research are presented. The contents of this chapter are divided into six sections. In the first section, the relationship between object permanence and motor behavior observed in this study is discussed. The second section examines the differences between the object permanence scores of the infants with sensorimotor dysfunction used in the present study and the object permanence scores of normal infants. In the third section, the effect of vestibular stimulation on object permanence is examined. The fourth section presents a discussion of the effect of vestibular stimulation on the motor behavior of the infants in this study. In the fifth section,

the additional findings of this study are interpreted. The results found concerning the relationship between object permanence and the amount of movement of the infant are evaluated and compared with the results of previous investigations. The sixth section contains a summary of this investigation.

The Relationship Between Object Permanence and Motor Behavior

As reported earlier in this manuscript, object permanence was found to be positively correlated with motor behavior in the infants under study in the present investigation. The degree of correlation was the highest on the pre-test, and gradually declined on post-test one and post-test two. For further data analysis, the infants were divided into an older and a younger group: the correlations between object permanence and motor behavior of the younger group continued to remain high and positive; however, the correlations between object permanence and motor behavior of the older group of infants were lower and became negative on the post-tests.

Piaget (1952) states that the normal infant's sensorimotor development prepares the infant for, and is inextricably intertwined with, the development of object permanence. Other authors also report a positive relationship between object permanence and motor behavior (Hunt, 1961; Furth, 1969; Gratch and Landers, 1971; Landers and Gratch, 1971; Yarrow, et.al., 1972; Schoonover, 1973; Campbell, 1974; Gottfried and Brody, 1975; White, 1975; Uzgiris and Hunt, 1975; Wachs, 1976; and Uzgiris, 1977). In general, these authors report that the more active infants are, or are permitted to be, the higher are their object permanence scores. Chronological age is also a

factor which is correlated highly and positively with object permanence and motor behavior. Older infants perform better on scales of object permanence than do younger infants. Experience in interacting with the world is said to increase performance of cognitive and motor functions. However, in contrast to these investigators, Kagan (1971) states that he believes that there has been an overemphasis on the importance of the infant's motoric behaviors as a means of learning. Kagan questions the concept that actions on objects are necessary for cognitive structures to develop.

Only four studies comparing object permanence and motor behavior in infants who were not normal have been reported. Unfortunately, the results of these studies are somewhat equivocal because of the experimental designs used. Valvano (1976) studied the relationship between object permanence and gross motor skills in infants with Down's syndrome. She found a significantly high positive correlation between object permanence and gross motor behavior. However, the results of this study remain in question as the author states that many of the infants in the study ceilinged the items on the gross motor test.

Campbell and Wilhelm (1979) reported the preliminary results of a longitudinal study of seven infants at high risk for central nervous system dysfunction. At 12 months, the motor development scores, as measured by the psychomotor scale of the Bayley Scales of Infant Development (Bayley, 1969), were correlated significantly with object permanence scores measured with Scale I of the Infant Psychological Development Scales (IPDS) of Uzgiris and Hunt (1975) ($r = .99$). It

is particularly interesting to note that one of the infant's scores on the object permanence test regressed during the nine months of testing. Campbell and Wilhelm (1979) stated that the increase in symptomatology, indicative of sensorimotor dysfunction displayed by the infant, prevented the infant from interacting with the object permanence test items during the later testing sessions. It could be hypothesized that a lower correlation between object permanence and motor behavior might have resulted if there had been a larger number of subjects with sensorimotor handicaps in their study.

Two studies report comparisons of object permanence and motor behavior in infants with cerebral palsy. Fetters (1976) studied 12 infants with sensorimotor dysfunction who were between 13 and 29 months of age. Infants who could manually manipulate objects were compared with infants who could not, using a visual tracking task similar to that used by Bower and associates (Bower, 1971; Bower, Broughton and Moore, 1971; Bower and Paterson, 1973; and Moore, Borton and Darby, 1978). No difference in object permanence scores was found between these two groups of subjects. Fetters' study may have been confounded by the method of measurement used, since the success normal infants have in visual tracking tasks at five months of age, is due to object identity, not object permanence (Moore, et. al., 1978). Young (1977) studied infants with cerebral palsy who were between 13 and 26 months of age with a mean age of 20.9 months. The infants' motor development was measured with the motor scale of the Bayley Scales of Infant Development (Bayley, 1979). Object permanence was assessed using the scales developed by Corman and Escalona (1969)

and Tessier (1969). Moderate correlations were found between motor behavior and each of these two object permanence scales (r = .58 and .52, respectively).

Taken as a whole, the results of the present investigation are in general agreement with those previously reported in the literature. Most of the studies have found motor behavior to be positively and consistently related to object permanence. However, in the present study both the overall decreasing relationship found between object permanence and motor behavior, and the low and ultimately negative correlations found between motor behavior and object permanence in the older group of infants apppear to be inconsistent with the previous findings reported in the literature. Only the moderate correlations between object permanence and motor behavior reported by Young (1977) appear to be congruent with the present findings. Perhaps the correlation between object permanence and motor behavior is confounded by the age variable.

The decreasing correlations between object permanence and motor behavior found in the present study may also be due to the increasing symptomatology in the sensorimotor handicapped infants. This increase in symptomatology would be consistent with the findings of Bobath and Bobath (1975), Kong (1966), and Campbell and Wilhelm (1979), that the severity of the sensorimotor handicap in infants and children with cerebral palsy increases with age. In other words, the increasing age of these infants, combined with their interaction with the environment, leads to an arrest or regression of motor development, while cognitive development may increase or remain stationary.

Four of the infants in the present study made little or no gains in motor behavior during the course of the investigation. Three of the infants with low motor behavior scores made minimal gains in motor behavior (zero to five points on the 62 point scale) while their object permanence scores increased six to eight points (on the 14 point scale). These infants were unable to sit, creep, or walk independently, but were able to locate hidden objects after successive visible displacements at the time of post-test two. The fourth infant also lacked the same independent motor abilities, but achieved the highest possible score on the object permanence test six months before the average normal infant accomplished this. It could be hypothesized that though their activity within the environment was not normal, alternative experiences could have provided them with the necessary input required to develop object permanence. The infants may have been moved physically through their environment by an adult, which gave them the opportunity to explore the world through other sensory modalities (e.g. visual). The findings of the present study are however, in agreement with Kagan (1971) who questions the importance of motor behavior in the development of cognitive structures.

There is a third possible explanation for the decreasing correlations between object permanence and motor behavior found in the present investigation. Although no infants with severe or profound mental retardation participated in the present study, some of the infants may have been mildly mentally retarded. Bobath and Bobath (1972) report that 23.75 percent of cerebral palsied children

have intelligence quotients within and above the low normal range. Half of the infants in the present study were born prematurely. The incidence of mental retardation as reported in follow-up studies of infants born prematurely is stated to be at least 24 percent (Shirley, 1938; Harper, 1959). Tessier (1969) compared a retarded and non-retarded group of cerebral palsied children. She found that the mentally retarded group achieved object permanence at a slower rate than did the non-retarded group. It is possible that mental retardation also affected the results reported by Valvano (1976), Campbell and Wilhelm (1979), Fetters (1976), and Young (1977). The possibility of mental retardation in the infants in any of these previously reported studies could affect their reports related to the development of object permanence and its relationship to motor development. The final conclusion regarding the relationship between object permanence and motor behavior perhaps should best be delayed until further longitudinal studies are completed which systematically control the variable of mental retardation. The prevalence of mental retardation in this group of infants, in and of itself, may be a confounding and important variable.

Differences in Object Permanence Between Sensorimotor Impaired Infants and Normal Infants

The object permanence scores of the infants in the present investigation were significantly different from the scores of the normal infants of the same age studied by Uzgiris and Hunt (1975). The infants with sensorimotor handicaps in the present study were observed to achieve object permanence scores at a much later age than

did the normal infants. However, two of the infants in the present study obtained the highest possible score on the test five to six months earlier than did the average normal infant. In addition, one infant in the present study scored within the normal range at the time of the pre-test and was delayed only one month at the time of post-test two.

There have been only two studies reported in the literature comparing object permanence in normal children with object permanence in children with sensorimotor handicaps. Tessier (1969) measured object permanence in normal children, in non-retarded cerebral palsied children, and in retarded cerebral palsied children; however, she made no direct comparison of object permanence scores of the three groups studied while controlling for age. The 30 subjects of her study were between the ages of 18 and 36 months. Inspection of her data revealed that the 10 normal children completed all of the test items, nine of the 10 non-retarded cerebral palsied children completed all of the items, while only one of the 10 children in the retarded cerebral palsied group completed all of the test items.

It is difficult to compare the results of the present study with those of Tessier (1969) since the ages of the children and the object permanence test used, were markedly different. The fact, however, that only 10 of the 20 cerebral palsied children in her study achieved the highest object permanence score, does lend some support to the findings of the present study. Half of the cerebral palsied children in Tessier's study were able to perform as well as the normal children, while half of them were only able to complete some

of the test items.

The object permanence scores of 13 children with cerebral palsy were compared with the object permanence scores of 13 normal children by Young (1977). All of the children ranged in age from 13 to 26 months; the mean age of both groups was approximately 21 months. Young found that the normal infants had significantly higher scores on the two object permanence scales than did the cerebral palsied children when no variables were controlled. However, when age and motor development were controlled, there was no difference between the two groups. Since no statistical comparison was made controlling for age alone, it is difficult to make direct comparisons with the results of the present study. In addition, the object permanence test instruments used by Young (1977) were different from the test used in the present investigation. Given these inconsistent findings, it appears that further studies need to be conducted exploring the relationships between age, motor handicap, and object permanence in infants with sensorimotor dysfunction.

Another one of the variables that might be explored further in future studies is that of the number of trials required to complete a specific object permanence test item. The majority of the infants in the present investigation required more trials to complete test items than has been reported in the literature concerning object permanence in normal infants. The findings of the present study, however, are in agreement with those of Tessier (1969) who also found that the cerebral palsied subjects in her study required more trials and more support from the examiner in order to complete the test

items. It is possible that the motor and cognitive deficits of these infants and children with sensorimotor handicaps present these children with more than normal frustrations in completing a task, and if insufficient time is allowed for their performance a less than adequate response will be the result. This also implies that during learning activities these handicapped children will require an increased amount of time and an increased number of experiences over those required by normal children.

Effects of Vestibular Stimulation on Object Permanence

The results of the present study show that although object permanence scores of the subjects in this study improved during the period of investigation, the gains could not be attributed to the intervention procedures. The vestibular stimulation provided to the infants in this study did not accelerate the development of object permanence. In spite of the fact that the amount of rocking actually provided by the parents varied greatly, inspection of the data revealed that the amount of rocking received by the infants was not related to the performance of the infants on the test of object permanence. In other words, the infants who received the maximal amount of rocking (30 minutes each day) made no greater gains in object permanence than did the infants who received very little rocking.

There have been no previous studies on the effect of vestibular stimulation on object permanence. However there are a few studies which have related vestibular dysfunction to other kinds of cognitive functioning. DeGangi, et.al. (1980) and deQuiros (1976) studied

children with learning disabilities. In both of these studies the authors identified problems with the functioning of the vestibular system in the children studied, and correlated the vestibular system dysfunction to the learning disabilities. These authors further suggested that these learning disabilities were caused by a problem with symbolic learning. Although object permanence was not directly addressed in these studies, object permanence has been identified as the earliest evidence of symbolic learning (Piaget, 1952). Since both of these studies involved older children and different measures of cognitive functioning, direct comparisons are difficult to make. Angelo (1980) found that a program of physical activities which included, but was not limited to, vestibular stimulation, increased cognitive performance of low-achieving college students. Although academic achievement, which is a measure of cognitive functioning, was one of the dependent variables measured in this study, it is possible that different aspects of cognition or cognitive processing were operating in her study. That is to say, the cognitive processes involved in academic achievement may be different from those involved in object permanence.

The results of the present study are in general agreement with those reported by Sellick and Over (1980). In the Sellick and Over study, the effects of vestibular stimulation were measured in children with cerebral palsy who were between eight and 56 months of age. It is of interest to note that the methodology employed by Sellick and Over (1980) included the use of stronger vestibular stimulation (spinning) than that which was used in the present study. The infants

were held by an examiner while the examiner and the infant were spun in a rotary chair. The authors of this study report that vestibular stimulation did not result in significant cognitive gains in the treatment group as measured by the mental scale of the Bayley Infant Development Scales. This scale does not measure object permanence separately; however some of the items on this test for the younger infants are measures of object permanence. The average age of the infants in the study reported by Sellick and Over (1980) was greater than the average age of the infants in the present study. However, six of the 20 infants in their study were in a comparable age range, thus the results of Sellick and Over (1980) do lend some support to the results of the present study.

Unfortunately, the treatment history of the subjects was not controlled in either the Sellick and Over investigation (1980) nor in the present study. The infants involved in both studies were already receiving physical therapy which includes some stimulation of the vestibular receptors. Although there is no data reported in the published literature as to what constitutes normal or adequate amounts of vestibular stimulation for children, it can be assumed that these infants were receiving more than the usual amounts of vestibular stimulation from their parents and from their routine therapy. This stimulation, therefore, may have provided these infants with adequate or more than adequate amounts of the vestibular stimulation required for normal development of cognitive functioning, including object permanence development. Thus, if more than threshold amounts of vestibular stimulation were already provided, additional vestibular

input would not be expected to greatly change or enhance cognitive development.

The results of the present study indicated that the vestibular stimulation provided to the infants did not have a significant effect on object permanence. However, there is some evidence reported in the literature that indicates other forms of cognitive functioning are positively affected by vestibular stimulation. It is apparent, therefore, that additional studies are needed to clarify the role of vestibular stimulation in the development of cognition in young infants. Such studies could investigate the effects of varying both the amount of vestibular stimulation, and the kind of vestibular stimulation (e.g. rocking, spinning, and swinging) while controlling the treatment history of the subjects, if possible.

Effects of Vestibular Stimulation on Motor Behavior

The vestibular stimulation provided to the infants in the present study resulted in no significant increases in motor development that could not be explained by maturation. The infants made no greater gains in motor development during the period of vestibular stimulation than during the period without vestibular stimulation. This finding is at variance with most of the previously reported studies of the effect of vestibular stimulation on motor development. The fact that none of the studies reported used the same method of measurement, makes comparisons of these studies with each other and with the present study, difficult.

Three studies have been reported in the literature in which normal infants and young children have demonstrated accelerated motor

development after a period of vestibular stimulation. Neal (1967) reported the results of an experimental study designed to clarify the relationship between vestibular stimulation and the development of 28 to 32 week gestation age premature infants. The infants in the experimental group of this study received a compound rocking motion which was provided mechanically by a special apparatus attached to their cribs. The premature infants in the experimental group achieved significantly greater motor, visual, and auditory responses than the infants in the control group. Clark, et.al. (1977) studied normal infants between three and 13 months of age. The infants in the experimental group, who were spun while being held in the examiner's lap, demonstrated increased motor development compared with the infants in the control group. The procedures used by White and Castle (1964) to provide vestibular stimulation were similar to those used in the present study. A group of institutionalized infants were rocked in an upright position for 20 minutes each day for one month. The infants in the experimental group displayed significantly greater visual responses than the infants in the control group. It is possible that these results were obtained as a result of relatively low levels of vestibular stimulation prior to the investigation, which is in direct contrast with the conditions of the present study.

Increased levels of motor behavior have also been found in studies reporting the effects of vestibular stimulation on infants with sensorimotor handicaps. Norton (1975) reported a case study in which three multi-handicapped children between three and four years of age demonstrated trends toward higher developmental levels after

a program of intervention which included vestibular stimulation. Kantner, et.al. (1976) studied three normal infants and four infants with Down's syndrome. Infants were assigned randomly to treatment and control groups. The infants in the experimental group, who were spun in a rotary chair while being held by an examiner, demonstrated greater gains in motor performance than did the infants in the control group. Chee, et.al. (1978) observed the motor skills of 23 preambulatory children with cerebral palsy who were between two and six years of age at the time of testing. These infants were also spun in a rotary chair while being held by an examiner. The infants in the experimental group displayed a significant increase in motor skills as compared with those of the infants in the control group.

As indicated above, comparisons of the present study with those reporting increased or improved motor behaviors is made difficult by the fact that each of the studies reported above used their own unique methods of measuring motor development. In addition, the form of vestibular stimulation provided to the infants varied. Kantner, et.al. (1976), Clark, et.al. (1977), and Chee, et.al. (1978) used spinning, a relatively strong form of vestibular stimulation. Neal (1967) and White and Castle (1964) employed different forms of rocking to stimulate the labyrinthine receptors of the infants in their studies. Norton (1975) used an unspecified method of vestibular stimulation. The vestibular stimulation provided to the infants in the present study most clearly resembles the method used by White and Castle (1964).

Generally, the present study is in agreement with the investigation

of the effects of vestibular stimulation on motor development by Sellick and Over (1980). These investigators matched the cerebral palsied children in their study for age and diagnosis before spinning the children in the experimental group using similar procedures to those of Chee, et.al. (1978). Sellick and Over found no significant improvement in the motor behavior of the children in the experimental group as compared with the children in the control group. The motor development of the infants in this study was measured with the motor scale of the Bayley Infant Development Scales. This scale contains many items which are similar to the Motor Behavior Checklist constructed by the author of the present investigation. Although the children studied by Sellick and Over (1980) were generally older than the infants in the present study, six of the 20 infants in their study were between eight and 23 months of age at the time of the initial testing. There were several salient differences between the experimental design used by Sellick and Over (1980) and the design used in the present study: 1) the average age of the infants differed, 2) different methods of measuring motor behavior were used, 3) Sellick and Over (1980) used stronger vestibular stimulation than the vestibular stimulation used in the present study. In spite of these major differences, the results of their study and the results of the present study are the same. Particularly noteworthy is the fact that the use of stronger vestibular stimulation had no significant effect on the outcome of the study by Sellick and Over (1980). As stated in the previous section, lack of acceleration of the motor behavior of the infants in the study of Sellick and Over (1980) as well as in

the present study, could be due to the previous therapy history of the infants in both of these studies. In other words, it is possible that the infants in both of these studies had already received adequate amounts of vestibular stimulation from their physical therapy programs prior to the beginning of these two investigations.

In summary, the effects of vestibular stimulation on the motor behavior of the infants with sensorimotor handicaps reported in the present investigation are in conflict with most of the studies reported in the literature. In spite of the differences in methods of measuring motor behavior and procedures for providing the vestibular stimulation, all but one of the studies found increases in motor behavior after vestibular stimulation. The present study is one of two studies of handicapped infants in which the results did not demonstrate significant gains in motor behavior after a period of vestibular stimulation.

Additional Findings

The discussion presented in this section concerns the effect of the phase of the experiment on object permanence and motor behavior scores, and the relationship between the amount of movement on the floor and age of the infant and object permanence scores.

The Relationship Between the Phase of the Experiment and Object Permanence and Motor Behavior Gains

The results of this investigation revealed that the phase of the experiment had an effect on object permanence scores and motor behavior scores. The infants made significantly greater gains in object permanence and motor behavior during the first phase of the investigation

(the period of time between the pre-test and post-test one) than during the second phase of the investigation (the period of time between post-test one and post-test two). These peculiar findings are rather difficult to explain.

It might be suspected that the first phase of the experiment was longer than the second phase, which would suggest that the effects of maturation might be influencing the results. However, a statistical comparison of the average length of phase one and phase two indicated that there was no statistically significant difference between the two phases. Furthermore, there appears to be no logical reason to expect that maturation would be greater during the first phase of the experiment than during the second phase of the experiment.

A second possibility might be related to the fact that more infants received vestibular stimulation during the first phase of the experiment than during the second phase of the experiment. However, the results indicate that vestibular stimulation produced no statistically significant effect on either object permanence or motor behavior.

Perhaps changes in the infants' therapy program during either phase of the investigation could be offered as a partial explanation for the observed results. However, there were no major changes in any of the infants' therapy programs during the investigation.

Finally, a possible explanation of these peculiar results might be related to the Hawthorne effect; the infants' performance might have been affected by the extra attention given to them and their parents by the investigation itself. It is likely that many of the

parents anticipated improvement in cognitive and motor behaviors of their infants as a result of the experiment. Some of the parents may have given their infants more attention during the first phase of the study. Indeed, some of their increased attention may have been directed, either consciously or subconsciously, to improving their infant's performance on the experimental tests. The parents may have played an increased number of hiding games with their infants or may have been increasingly conscientious about carrying out their regular, assigned home therapy programs during the first phase of the investigation. Then, as the investigation continued the parents may have resumed their more typical patterns of interaction with their infants.

In summary, neither a difference in the length of the two phases of the experiment, nor the effects of maturation or vestibular stimulation appear to adequately explain the greater gains made by the infants in object permanence and motor behavior during the first phase of the investigation. Although there is no data available to support this conjecture, it would appear that the very fact of participation in the study may have precipitated this result.

The Relationship Between Age and the Amount of Movement on the Floor and Object Permanence Scores

Multiple regression procedures were used to explore the effects of age and the amount of movement on the floor on object permanence scores. The amount of movement on the floor was operationally defined as the distance covered by the infant during the testing session. No distinction was made in regard to the method of movement, e.g. rolling versus walking. Results indicated that both the age of

the infant and the amount of movement on the floor were highly correlated with object permanence scores. This, in and of itself, is not surprising, since in normal infants age and the amount of movement are highly correlated. Normal infants' mobility generally increases with age. This, however, is not necessarily true for infants with a sensorimotor handicap. Increased symptomatology in infants with sensorimotor handicaps frequently leads to decreased movement or mobility with increased age (Bobath and Bobath, 1975; Kong, 1966; Campbell and Wilhelm, 1979).

The results of the present study indicated that the correlation between object permanence and age was moderate ($r = .60, .66, .63$ on the pre-test and post-tests, respectively) and the beta weights increased from the pre-test through the post-tests ($b = .32, .58, .67$, respectively) indicating that age became increasingly important as a predictor of object permanence scores. Initially, the amount of movement on the floor was more highly correlated with object permanence scores ($r = .87$) and the beta weight was also high ($b = .75$). But the correlations decreased on post-testing ($r = .51$ and $.30$, respectively) as did the beta weights ($b = .39$ and $.37$, respectively). This indicates that the amount of movement on the floor became less predictive of an infant's object permanence scores than did the age of the infant. Or, in other words, age became a better predictor of object permanence scores than did the amount of movement on the floor.

There are several previous studies in the literature which relate the amount of movement to object permanence scores. Wach's (1976) longitudinal study of normal infants between 12 and 24 months

of age reported a correlation, r = .71, between object permanence and floor freedom in the three months previous to testing. White (1975) stated that the most effective caretakers of the infants he studied provided maximal access to living areas. Gottfried and Brody (1975) found that movement on the floor correlated more highly with object permanence than did interaction with toys in the eight to 15 month infants studied. Valvano (1976) reported that infants with Down's syndrome exhibited a correlation of r = .89 between locomotion and object permanence scores. No studies have been reported comparing these variables with object permanence in infants with sensorimotor dysfunction. Although the above-mentioned studies report high correlations between object permanence and movement, none of the studies factored out the variable of age.

In summary, age and amount of movement on the floor were found to be predictors of scores on object permanence tests. However, it appears that age is a better predictor of success on object permanence tests than is motor behavior. The variables of age and amount of movement are intercorrelated among themselves, and both of them appear to have a relative influence on object permanence. However, the beta weights, or regression weights, obtained in this investigation indicate that age is more important than the amount of movement in predicting object permanence scores in this group of infants with sensorimotor dysfunction.

In light of the above findings, the investigator recommends that future studies be conducted comparing the effect of different forms of vestibular stimulation (e.g. rocking and spinning) on object

permanence with a larger number of subjects. In addition, it would be particularly desirable that these studies be longitudinal, and designed to record the delayed effects of vestibular stimulation on object permanence and motor behavior. The Bayley Scales of Infant Development (BSID) might also be used to corroborate the cognitive and motor findings measured by the Infant Psychological Development Scales (IPDS) and the Motor Behavior Checklist. It would also be of interest to compare infants' performances on the IPDS with the visual methods of measuring object permanence employed by Bower and his associates (Bower, 1971; Bower, et.al., 1971; Bower and Paterson, 1973; Moore, et.al., 1978). Additional follow-up studies would be helpful in clarifying the potential effect of mental retardation in this group of subjects. For example, studies could be designed to measure the intelligence of infants with sensorimotor dysfunction two or three years after the final measurement of object permanence. Finally, it would also be of interest to compare the rate of response and the number of testing sessions required for completion of test items in a group of infants with sensorimotor handicaps and a group of normal infants of the same age.

Summary

In general, object permanence has been reported to be highly correlated with motor behavior in normal infants. Two studies of object permanence in infants with cerebral palsy (Fetters, 1976; Young, 1977) report conflicting findings. Fetters (1976) found no correlation between object permanence and the ability to manipulate objects, while Young (1977) stated that he found moderate correlations between

object permanence and motor development. The results of the present investigation indicated that the correlations between object permanence and motor behavior decreased from the pre-test to post-test conditions. In addition, the older infants in the study initially had low correlations; these correlations decreased and became negative on the post-tests. It was concluded that the correlations in the present study may have been confounded by the age variable. It was also concluded that the increasing sensorimotor symptomatology, which could lead to an arrest or regression of motor development, might have contributed to the decrease in the positive relationship between object permanence and motor behavior on the pre-test. Finally, the possibility that mild mental retardation in the present group of subjects might have influenced this relationship was discussed.

The difference in the age at which the subjects of the present study achieved object permanence scores as compared to the average normal infant was consistent with the investigation reported by Tessier (1969), but was in conflict with the study reported by Young (1977). Since the instrumentation and the controlled variables varied across studies, it was concluded that further investigation is needed before any firm conclusions can be drawn. In addition, it was suggested that future studies should compare the number of trials required by normal infants to complete test items with that required by infants with sensorimotor dysfunction.

Interestingly, the results of the present study and that of Sellick and Over (1980) are in conflict with the rest of the literature regarding the effect of vestibular stimulation on cognitive development.

The results of most of the studies reported in the literature have indicated a significant increase in cognitive skills after vestibular stimulation. It was suggested that the infants in the present investigation and those who participated in the study by Sellick and Over (1980) may have received more than adequate vestibular stimulation for cognitive development prior to the beginning of either of these two investigations. The conclusion was drawn that additional studies are needed to clarify the role of vestibular stimulation in the development of object permanence in infants with sensorimotor dysfunction.

Furthermore, most of the studies reported in the literature have found that vestibular stimulation accelerates motor development. These findings are in conflict with the results of the present investigation. Comparisons of the present study with those previously reported are made difficult by the fact that each of the studies reported have used different methods of measuring motor behavior. It was suggested, again, that perhaps the infants in the present investigation had already received adequate amounts of vestibular stimulation to facilitate motor development through their therapy programs. Though it would be difficult ethically and operationally, it would be of interest to compare the effects of vestibular stimulation in two different groups of infants: those who had not been enrolled in therapy programs and those who had been enrolled in therapy programs.

The additional findings related to the present investigation were that the infants made greater gains in object permanence and

motor behavior during the first phase of the investigation than in the second phase of the investigation regardless of vestibular stimulation, and that initially the amount of movement on the floor was a better predictor of object permanence scores than was the age of the infant. However, on post-testing, the age of the infant was a better predictor of object permanence than was the amount of movement.

Several possible suggestions were discussed in regard to the increased gains in object permanence and motor behavior during the first phase of the investigation. The most plausible explanation appears to be due to the classical Hawthorne effect; specifically, the extra attention given to the infants and their parents during the investigation may have changed parent-child interactions resulting in greater gains in object permanence and motor behavior on post-test one than on post-test two.

Several studies reported in the literature have described positive correlations between object permanence and the amount of movement on the floor (Gottfried and Brody, 1975; White, 1975; Valvano, 1976; Wachs, 1976). None of these studies factored out the variable of age from the amount of movement. The results of the present study are in only partial agreement with those previously reported. On the pre-test the amount of movement on the floor was highly correlated with object permanence. However, on post-testing, age was a better predictor of object permanence scores than was the amount of movement. It appears that the mobility of these infants with sensorimotor dysfunction did not develop at the same rate as did their object permanence. This finding is in agreement with another finding of this study, i.e. the

correlations between object permanence and motor behavior decreased during the course of the present investigation.

Further studies need to be conducted in order to more accurately assess object permanence in infants with sensorimotor dysfunction. Different forms of vestibular stimulation, such as swinging and spinning should be compared with rocking. Longitudinal studies would be helpful in controlling the Hawthorne effect and in identifying mild mental retardation. It would also be important to compare the test instruments used in the present investigation with those used in previous investigations.

In summary, the relationship between object permanence and motor behavior in infants with sensorimotor handicaps needs further clarification. It appears that most infants who have a sensorimotor impairment develop object permanence more slowly than do normal infants. The fact, however, that some infants with sensorimotor dysfunction achieve object permanence earlier than normal infants, indicates that further studies need to be conducted to clarify the influence of mild mental retardation in this group of subjects. Vestibular stimulation has frequently been implicated in the acceleration of cognitive and motor development in normal and in handicapped infants and children. Further studies need to be conducted in infants with sensorimotor dysfunction regarding the kind of vestibular stimulation provided, and the previous therapy history of the experimental subjects.

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APPENDIX A

Motor Behavior Checklist

Name _____ Therapist _____

Date _____

Activity	Present = 2	Partial = 1	Absent = 0
1) Visual tracking - eye movement dissociated from head movement.			
Head control			
2) Supine (rotation)			
3) Prone			
4) Vertical -- sitting, standing, or held upright. .			
5) Reach.			
6) Grasp.			
7) Coordination of vision and reaching.			
8) Coordination of vision, reach, and grasp			
9) Transfers objects.			
10) Hand to mouth.			
11) Hands to feet.			
12) Feet to mouth.			
Equilibrium reactions			
13) Prone.			
14) Supine			
15) Sitting.			
16) All 4s			
17) Standing			
18) Walking.			

Activity	Present = 2	Partial = 1	Absent = 0
19) Assumes prone on elbows.			
Rolls			
20) One direction.			
21) Both directions.			
22) Pivots in prone.			
23) Sits independently - arm support			
24) Sits independently - arms free			
25) Assumes sitting.			
26) Mobility (score one only)			
a) belly crawls.			
b) creeps.			
c) bottom scoots			
27) Pulls to stand			
28) Kneel walks.			
29) Stands independently			
30) Cruises.			
31) Walks independently. . . (partial = 6 to 8 steps). .			
Associated movements			

State tone - hypertonic, hypotonic, mixed; mild, moderate, severe.

Include trunk. State type of involvement, e.g. hemi_____

Amount of movement on mat_____

Additional comments: Total_____

APPENDIX B

June 23, 1981

Dear Parent,

I am a physical therapist, and am currently completing the final requirements for my Ph.D. This letter is to request your participation in a study that I am conducting to complete these requirements.

Therapists use many different techniques to help children improve their functioning, and it is important that we learn which ones are the most effective. Therapists also often ask parents to carry out part of their child's treatment at home. Therefore, it is important to learn how easy or how difficult it is for parents to carry out these requests. The purpose of my study is to investigate these two problems.

If you decide to join this study you will be asked to bring your child into the center three times during a two month period for observation of his or her motor skills and learning skills. Each session will last about 45 minutes, and will be scheduled at your convenience. These observation sessions will occur at the beginning, middle, and the end of the two month period. During one of the two months you will be asked to give your child a total of 30 minutes of simple stimulation (rocking) each day. This may be done at times that are convenient for you. You will be given a notebook in which you will write the time you spent each day, and any difficulties you had in carrying out the activity.

If you consent to participate in this study your child <u>may</u> benefit by an improvement in his or her motor skills and/or learning skills. Your participation will give therapists more information about the techniques we use, and the difficulties that parents have in carrying out such programs. This will help us in our understanding not only of

your child, but in understanding other children with similar problems.

Sincerely,

Sandra Levine, R.P.T.

If you have consented to participate in this study, please indicate which day of the week and time of the day are most convenient for you to bring your child in to the center. It is important for you to select a time that your child will be awake and interested in playing.

Please indicate first choice and second choice.

Monday_____ AM or PM (please circle)

Tuesday_____ AM or PM

Wednesday_____ AM or PM

Thursday_____ AM or PM

Friday_____ AM or PM

_____

Parent's name

_____

Child's name

PARENT'S CONSENT FOR RESEARCH INVOLVING A MINOR WHEN NO RISK IS INVOLVED.

Project Title:_____

I, the parent or guardian of_____, a minor_____ years of age, consent to his/her participation in a program of research being conducted by _____.

I understand that no risk is involved and that I may withdraw my child from participation at any time.

_____
(Signature of Parent)

_____
Date

APPROVAL SHEET

The dissertation submitted by Sandra Benzies Levine has been read and approved by the following committee:

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The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

12/2/82
Date

Anne M. Juhasz
Director's Signature