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COGNITIVE DEVELOPMENT AND MENTAL IMAGERY  
IN CONGENITALLY AND ADVENTITIOUSLY BLIND CHILDREN

by

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## INTRODUCTION

The purpose of this research is to analyze cognitive development and mental imagery in congenitally and adventitiously blind children.<sup>1</sup> This will be done by using an adaptation of reasoning tasks derived from Piaget's theory. This implies the use of the concept of 'stage.'

Originally this research was only intended to include those who were blind or had light perception only since birth, but because of the limited number of subjects that fall into this category, it became necessary to include subjects blinded at a later age.

Since many researchers believe those blinded after five years of age retain their visual orientation, and utilize and organize new information around their past visual experiences, this factor was noted and reflected in the analyses of the results and discussion.

Our results and interpretations are derived from twelve blind children between the ages of six and eleven. The purpose of interpreting the data after collection is to illuminate the process of thought and mental imagery that produces a differential phenomenon between the blind and normal child.

By presenting these children who are considered within the concrete operational stage of development with a problem concerning objects they are asked to manipulate, the articulated responses concerning anticipation, judgments, justifications and opinions concerning countersuggestions

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<sup>1</sup>Adventitious is a term commonly used for blindness which is acquired or accidental after birth.

show patterns which retain the richness and complexity from which the blind child processes his environment. Through rigorous and systematic examination of the data, one can infer or hypothesize the blind child's developmental process.

Since there are many ways in which the author can approach Piaget's theory, remarks will be confined only to particular aspects which are pertinent for this research or are part of the hypotheses that were generated. In view of the complexity of the conceptual materials, the author will be explicit not only about the sense in which terms are used, but also as to how they are applied to this research.

The results of this research, although all subjects have blindness in common, cannot be generalized to the entire population of blind children, since they were not randomly selected because of the limited number of subjects available. Using a clinical approach and analyzing the data quantitatively and qualitatively, this research seeks to achieve the following objectives:

- A. To determine the structure and organization of thought process among blind children.
- B. To analyze the nature of mental imagery among blind children in terms of images of anticipation, reproduction and transformation.
- C. To analyze the relationship between mental imagery and cognition in blind children.
- D. To determine if effective cognitive interventions can be devised from the analyses of the relationship between mental imagery and cognition.

## CHAPTER I

### THEORETICAL REVIEW

Many theories of knowledge started over 300 years ago with Aristotle and Descartes and their quest to understand the theory of knowing. Descartes states, "There is in me some faculty . . . able to produce these ideas without the help of any exterior thing" (Furth, 1969). What Piaget has done is to combine an internal and external "thing" into developmental structures or stages which appear within a given age. The age at which the stage occurs varies considerably according to intelligence, previous experience and culture, knowing of course that all individuals need not achieve the final stages of development. Beyond Descartes, Piaget believes that the state of knowing combines internal and external factors that develop in an invariant sequence or stage which progresses as a result of interactions between the organism and his environment.

The process of this interaction is the condition for all biological and intellectual operations. This interaction of the inner organization of the organism and the outer adaption to his environment is called assimilation and accommodation. Thought begins with assimilation or the taking in of reality and accommodation or emergence of new structures in response to the environment and thoughts of others. With the synthesis of these two, as the stages progress, originally the organism is said to be in a state of equilibration until ultimately thought becomes rational. In other words, a stage contains an initial period of

preparation and a final period of achievement. Structures defining earlier stages become incorporated in later stages.

It is with this in mind that, with Piaget's earlier and later theories, the similarities and differences of the blind and normal child will be reviewed by stages. Although the focus of this study is the concrete operational stage of thinking, it is imperative that the earlier stages of development be considered to understand the process whereby the blind child conceptualizes and achieves his concrete operational thought.

### Conception

#### Age Zero to Two Years

According to Piaget, during infancy the normal child interacts with his environment in various ways particularly through the assistance of his primary caretaker. He passes through six stages: The newborn uses his innate reflexes to interact with his environment, gradually modifying them to build schemas. During the second stage, the first signs of curiosity appear and he begins to repeat acts and tries to coordinate motor activity, such as visually guiding his hands and objects to the mouth. These activities strengthen the arms, improve coordination and prepare the infant for mobility. In stage three he attempts immature contact with his environment, although object concepts still are bound to his own behavior. In stage four, the infant is able to separate himself from animate and inanimate objects. Objects begin to have permanence whether he is in visual contact with them or not. He utilizes behavior to reproduce actions, and is able to model simple behavior, producing new behavior and novel events. During the sixth stage, the infant makes the transition to symbolic thought.

Using his new reaching, crawling and walking skills, the normal child spends most of his time exploring, examining and testing his environment.

Sandler (1963) states:

The blind child experiences a narrower range of stimulation than his sighted cousin. He will have a smaller set of cues upon which to build the progressive modification of his inborn reflex responses to increase his sensorimotor differentiation and his recognition and control of his body and outside world.

Many researchers have found, that in the initial stages of development, zero-one year, the blind and normal infant engage in exploration by repetition of sensual perceptions (kinesthetic sensations, vocalization and similar phenomena), and are therefore on equal terms since vision is not the dominant sense in infants at this early age. The difficulties and differences begin to manifest themselves during the second year when the child becomes mobile and begins to interact with his environment. Too often the blind child does not receive enough physical and sensory stimulation, and engages in self-stimulatory behavior known as blindism. For the blind infant Omwake and Solnit (1961) state:

During the first two years after birth, one of the main tasks of the infant undoubtedly has to do with making a sound separation from the mother and the commencement of an individual existence, with later establishment of the sense of reality of early object relationship.

The blind child is more dependent on locomotion than a normal child to make these distinctions between self and reality. Unfortunately because of his lack of vision, this is inhibited.

The blind child must depend on his mother's ability to introduce not only herself, but other objects in a manner that will appeal to not only his sense of sound, but touch, Burlingham (1964) states:

So far as is known, no one has yet explored the difference between an object which can simultaneously be seen and felt and one which can simultaneously be heard and felt.

Unless sound is accompanied by touch of the object or person, it is meaningless to the blind child of this age. The blind child does not reach out for non-existing objects. Once he has dropped his toy, it is gone.

Because touch is so important to the blind child, "the mother's body retains its function of a 'toy' well beyond early infancy and certainly until the age of three" (Lairy & Harrison-Covello, 1973).

In addition to touch and sound, position change, taste and olfaction are equally important to compensate for his lack of vision. The infant does not automatically compensate for its blindness by overdevelopment of other senses. The blind infant needs rich and multiple stimulation in all sensory areas the mother must make available to him. Tait (1972) states:

While it is possible that a blind child may be sensitive to auditory cues and establish contact by this channel, any relationship is a two way street, and the mother, basically a visually-oriented being, may not be as sensitive to auditory cues, and may find it difficult to establish contact on a non-visual basis.

It is still difficult to assess the blind child's conception, at this stage because of lack of communication. It can only be inferred in terms of emotional stability.

#### Age Two to Four Years

Ginsburg and Opper (1969) describe the normal child as follows:

In the period from two to four years, the child achieves the capacity to form mental symbols which stand for or represent absent things or events. In order to deal with things, he no longer requires that they be immediately present. . . . The child forms mental symbols through imitation. The child looks at things, handles them, and acts

like them, and in these ways incorporates a great deal of information about them. These actions of the child lay the foundation for mental symbolism. . . . He begins to imitate internally and thereby he forms the mental symbol. . . . During this period the child begins to use words. After a preliminary stage in which words are closely related to ongoing actions and desires, the child uses language to refer to absent things and events. . . . Despite his new ability at language, the child often thinks non-verbally. He forms mental symbols which are based on imitation of things and not on their names.

It can be seen at this stage that Piaget's theory, as many others, appeals to vision for conception at the concrete and functional stages. This includes individuation of self, nature of objects, time, space, movement and coordination of other senses.

Although I shall take up language later, it also begins here by naming objects and actions in a simplistic manner from visual stimulation or imitation.

The blind child depends on his mother to help him during this period to synthesize the wide range of perceptions from his different sensual experiences into conceptions. Wills (1970) states:

Before the blind child has acquired a concept of bodies by playing such games as finding mother's nose, then his own, etc., he probably has only a very vague piecemeal image of his mother. The number of different sensations (touch, smell, sound, etc.) with which she presents him are not easily unified without the vision of her as a whole person.

The blind child learns about other objects in his environment through feel, smell, taste, sound and manipulation. He must handle a variety of objects in order to develop concepts of size, shape and texture, thus enabling him to classify and recognize. The blind child cannot develop a sense of himself and reality without experiencing stimulation in other modalities which only the mother can give him. This takes longer than the normal child who is able to solve many of his problems by visual stimulation and association.

Often the blind child's means of comprehension are unconventional to the sighted, and therefore inhibited, making his ability to incorporate information about objects and events into mental symbolisms difficult.

Parents must give more attention to detail and more time for the blind child to explore his environment through the senses available to him. All sensual stimulation must not only be named or labeled, but explained in a manner that will associate it with the total concept.

During this period, the blind child must not only have the ability to recognize objects in his environment, but orient himself in space. Hapeman (1967) states:

The blind child cannot see positions illustrated, but must be tactually shown. He cannot imitate; he must be taught either by actual positioning by the parent or teacher, or verbally while actually performing such skills in carrying out his daily tasks. . . . The alert teacher or parent can attach the correct terms while the child is actually performing a skill. . . . Such a movement should be given a verbal description which when given at the time of actual performance, will be meaningful to the child.

Once the mother has made the child's environment a safe place, and she has encouraged him to explore his environment instead of restricting him, he will soon begin to label it, and his world will have meaning for him.

#### Age Four to Eleven Years

In this stage of development, Piaget's earlier works deal with the child's content of thought from visual perceptions and use of language. In his later works, he revised and refined some of his theories, since he felt that his clinical method relied too heavily on language. His later works deal mainly with pre-operational and concrete operational stages.

He points out that children, given they have adequate intelligence, attain different stages within the operational level in an invariant sequence, but by gradual transition. In each different concrete operation, with reference to different substantive areas, the level of achievement can be accomplished at different ages.

He found that conservation of substance is achieved at seven or eight; conservation of weight at nine or ten; and conservation of volume at eleven or twelve.

He also points out that the ages at which the stages occur vary according to culture. He also included in his genetic "Age/Stage" theory, that in addition to age and IQ, other factors that may influence achievement of reasoning tasks are personal and physical experience and social transmission.

Imagery and language were thought of as a symbolic function, or an auxiliary to thought formation, and will be discussed later in detail.

To investigate the cognitive development during this stage, Piaget used children's predictions, judgments and explanations as signs of pre-operational, transitional and concrete operational stages of thought.

During the pre-operational stage, the child is imagined or perceptually oriented. He makes judgments based on how things appear to him by the most influencing aspect or variable. He has a general impression of quantity, but is not capable of judging its crude difference (mass, weight, volume, etc.). His reasoning is egocentric and often rigid, centering upon static configurations, such as in the hotdog experiment, where non-conservation responses are given because their

general impression is that the ball is different from the hotdog. When asked to explain, they justify their arguments of quantity by a single dimension which they are unable to coordinate with one another. The transformation itself is negated.

During the transitional stage, the child does have a differentiated impression of quantity and can judge differences two by two. Piaget calls this "Logical Multiplication." However, he is unable to coordinate between parameters, that the hotdog is both longer in length and less in width, but equal to the ball. He lacks mental reversibility and logical necessity. If nothing is added or taken away, then it can be transformed back into the same thing, and is equal.

During the third stage, the child is no longer misled by the perceptual appearance of the configuration. The child has an abstract quantity concept, conservation is present as a logical necessity. He justifies his arguments in one of three ways: Identity, "The shape is different, but it's the same amount"; reversibility, "If you put it back into a ball, we will have the same amount"; and compensation, "It is longer, but thinner, therefore it's the same amount."

Since the focus of this study is confined within this stage, only limited remarks will be made concerning the blind child, since deductions of their cognitive development will be inferred from the analyses of the data.

For the blind child, recognition and differentiation of his environment is limited so that the ability to organize and store mental representations is impeded. The blind child's need is for real stimulation of objects, active daily tasks and symbolic play to decenter his

personal subjective point of view, so that objects or actions no longer direct his thought process, but where he can now operate in the form of a logical argument, ignoring empirical content.

### Language

Piaget views language as a symbolic function or auxiliary to the process of thought. Voyat (1972) states, "Language as an instrument of thought and communication is part of an overall intellectual activity. . . . Intelligence is not simply a set of linguistic structures." Furth (1969) states that linguistic impairment need not lead to deficiencies in learning and thinking. Learning is thought to be dealing with an attentional component.

However, inaccurate use of words (verbalisms) is noted in the blind child, and should be examined in depth, since language does play a role in thought.

Burlingham (1965) did many studies on verbalizations of the blind child. She states:

The advances of speech in the blind seem to proceed on two lines: one which is their own and which they develop on their own, guided by their own intelligence and inventiveness, finding words for their own affects and body feelings and things heard, more readily than the sighted; and the second one which is personally strange to them but also highly cathected as being the speech of the seeing world, i.e., the type of verbalization shared with the parents.

Speech is one of the first acts that the blind child can imitate of his mother's. Since interpersonal relations between the mother and child have been limited until this time to caretaking, the mother grasps this longed-for opportunity to communicate with her child. Often the consequence leads to what Cutforth (1951) calls "verbal unreality." The name of the object or act has an entirely different meaning from what is

felt or heard. Yet, if what is heard is named, it cannot be felt and still has no meaning for the blind child. Until the blind child is able to associate sound with touch, words are still meaningless. Cutforth (1951) demonstrates:

The blind child may learn to name and imitate the scream of the fire siren and to name and reproduce the rooster's crow, and he may make either sound correctly when asked in the right words to do so; but if given the opportunity to touch them with his hands, he might have no idea which was rooster and which was fire engine.

Verbal expressions of the mother of the blind are not based on the blind child's sensations of sounds, tactile perceptions and body sensations, but visual impressions.

Although words are not connected to his sensory perceptions, the child incorporates them into his vocabulary because they derive emotional meaning from the pleasure and praise he receives from his mother. The blind child displays an astonishing memory for words. He finds uses for speech that the seeing do not require. In one way, lack of sight requires more verbalization for understanding concepts that the normals take for granted. Burlingham (1961) states, "This often obscures the fact that what is cathected here by the blind child is not the person or the thing in itself but the achievement of remembering." The blind child appears to acquire understanding while in reality he acquires only words, and since speech provides a longed-for contact, the mother continues to promote what seems to be a common language.

Burlingham (1961) found that the blind child's uses for speech that the seeing do not require are:

For orientation, to collect characteristics for differentiating between persons, to discover some mark by which an object can be recognized. He asks questions, the main object of which is to provide clues.

In orientation, questioning takes the place of a glance, perhaps toward the mother, or to locate the position of a person, or to seek directions. At times the questions may be irrelevant, but in many instances it is not the answer the child seeks, but the reassuring sound.

When the blind child tries to collect characteristics for differentiating or gathering impressions about people, it is interesting to note what Burlingham (1961) found:

When they meet strangers they immediately ply them with questions: "What is your name?" "Where do you live?" "Have you children?" "Why did you come here?" . . . The purpose of the questions is to collect information and gain an impression of the person in place of the visual image which they cannot obtain. . . . The answers to their questions reveal much of them, in the tone of voice used, in the attitude of the person.

Metaphors used by the blind can never be imagined by the sighted for use in explaining the meaning of a word or act.

What are the components of speech in the blind child? Burlingham (1965) observed that the child acquires words in many ways, one of which is normally on the basis of sense experience. The child interacts concretely with his environment, and is able to internalize the experience and verbally recall it, with common reference to the sighted's conception.

Another would be verbalizing by sense association, which would be comparing one object or experience known to the child with a similar one having like characteristics.

Using words of the sighted world, is habitually done by the blind. They are common expressions or words, used by the sighted which can never have any meaning to the blind, i.e., "Come see my doll" instead of "Come feel my doll." The expression of "see" is commonly used by the blind, even when all the children present are blind.

Associating from memory of known words to unknown, is much more difficult for the blind child. It is almost in the category of meaningless words, because the concept is different. However, if the right association is made, it enables the child to generalize. However, the word is usually taken from a sentence which has a different meaning.

Confusion between word and thing is common in the English language. Many words can be used for the same thing or expression, and one word has many meanings.

Undigested parroting is rambling associations without understanding. The blind child tries to express feelings associated with words at the time they were spoken. He again uses the same expressions when similar feelings again arise. The words do not apply to the situation, making it a rambling association. One such example is given by Burlingham (1965). One of her subjects expressed the following, which was understood by Burlingham:

"Once upon a time there is a bird, he has nice wedding boots, so he can put his shoes on. The fishes come along, the dogs are barking, the kittens are crying, they found their mitten." Knowing Judy, it is possible to disentangle even here the elements picked up and repeated from nursery rhymes, talk of a wedding heard at home, the expectation of some happy event as in fairy tales, and the expectation of a new outfit given to her.

Although the psychic process or symbolic function of internalization may be the same for the blind child as the sighted, the limitations of what the blind child perceives make it difficult for him to put language in any syntactic or logical form. If the blind child is not to parrot the sighted world, then he must question it to collect information to compose a perceptual image. Only when he has gathered enough information, and has summoned forth mental images or representations that have

meaning for him, can he express himself verbally in the manner which can be understood by the normal world. Every effort should be made to increase his vocabulary with understanding, so that the words he learns to use will have meaning for both the blind and sighted. What the sighted sees, the blind is not feeling, thereby making a discrepancy in communication, although he will always have some difficulty in understanding the meaning and concepts of the language of the sighted.

### Mental Imagery

What is mental imagery? The term image itself is difficult to define, unless it is placed in its proper context of the overall system of thought or knowing.

Original views on images varied greatly according to the era, and were modified through experimentation. Originally it was thought that images were direct products of thought and sensation or intricate parts of thought. It was also thought that images were actual copies of objects and events, but not in a symbolic sense.

Imageless thought was also investigated in the sense that memory is characterized by recognition (Furth, 1969).

Blank (1958) did studies with the images of blind people during dreams. He found that those who reported images usually had been blinded after birth. Those who had been blinded at birth were only using words. Many were very intelligent and used words and descriptions that gave the impressions they could see.

Today after realizing experimentally that perception is always distorted when internalized, images no longer were perceived as extensions of perception, but acquired the status of a symbol, with the organism

making its own adjustments to its faulty perceptions.

Piaget (Piaget & Inhelder, 1971) states, "The image is not an element of thought, but functionally similar to language. . . . It can be in spatial domains a better symbolic instrument to signify the content of operational thinking."

Piaget views the image as a kind of intermediate between that of perception and that of intelligence, and it appears to be bound up with the formation of symbolic function, which makes its appearance between one and one half and two years old, where images are indispensable in symbolic play, language, and deferred imitation (the subject evokes or acts out events and objects not actually perceived at that time).

Piaget further states that the mental image itself is an internalized imitation which can be assessed through combined methods of verbal descriptions based on introspection, drawings, choices made by the subject from several prepared drawings, and gestures.

Mental images and concepts of the blind can only be imagined by the sighted. Although words may be the same, the concept is different. The usage of many words used by the sighted which form a concept are not in the realm of the blind. What is important is to know what the blind child's mental imagery is from using the modalities that are stimulated.

Cohen (1966) reported how different the images of space are from reports of those who were originally blind, and now have sight:

The perceptual distortions reported by many blind people after sight has been restored are mainly due to faulty spatial perceptions, mediated by non-visual senses. . . . If this kind of spatial sense is ever achieved by the totally blind, it is by painstaking serial exploration and may never be accurate.

### Classification of Images

There are two general overall classifications of images. The first is according to content (visual, auditory and tactual). The second is according to structure (reproduction, anticipation, etc.). Although the first is an intricate part of this study since the subject's primary method on content imagery is absent, it will not be discussed here, but in the results and discussion section.

Structure as it is referred to here, relates to the component parts that make up the image. Although they can be seen collectively in the adult (imagined static images, movement, transformation, etc.) there is a hierarchy in the child which corresponds to his stages of cognitive development.

The first hierarchical stage is considered to be primarily reproductive (R) where the images remain static and are unable to represent or anticipate (A) processes not known. Images of movement (M) and transformation (T) are not seen or utilized at this stage. The focus appears to be on the figural aspect of the configuration, the image is not equipped to integrate on a continuum the operations from beginning to end. This imaginal stage corresponds to the pre-operational stage of thinking, which has been discussed.

Around seven to eight years of age, the second stage is seen and points to the rise of anticipational (A) images and the introduction of images that correspond to (M) and (T). Formally (A) images could only be evoked for known objects (executorial A). This imaginal stage corresponds to the concrete operational stage of thought.

Piaget further states that "all development beyond this point depends on the process of reasoning and hence it is not a question of

stages of imagery, but stage of content" (Piaget & Inhelder, 1971).

### Images and Operations

The image Piaget states, constitutes an auxiliary that is not only useful to, but in many instances necessary for the functioning of the operation. . . . The operations in fact come to depend on the image. . . . The first relates to the cognition of states between which are interposed the governing transformation. And the second relates to the representation of these very transformations. For though the continuity, precise detail and especially the overall implication of transformation are not susceptible of representation, yet they can be grasped and manipulated better if an outline of imaginal representation helps operational reasoning. (Piaget, 1971)

Omwake and Solnit (1961) state for the blind:

When perceptual experiences can be transformed into mental images and representations, they can be differentiated and organized into thoughts, affects and memory traces which can be remembered or repressed according to the dynamic and economic factors involved. . . . Without vision from birth, the child has considerable difficulty in transforming perceptual experiences into mental representations, and this in turn creates obstacles to the development of a capacity to organize and store such psychic representations.

### Socialization

Socialization, in this research, will be concerned with some of the reasons for the difficulties the blind child experiences while trying to communicate socially with his external world. Meighan (1971) wrote, and it is generally believed, the following:

Research on the subject of disabilities, as reported by Emory E. Cowen, has found that society regards blindness as the worst possible disability that man could ever suffer. Society Cowen continues thinks of this particular disability, not as accidental to a person, but as "diffuse throughout the personality and behavior system" of the individual. The effect is that the blind "are subjected to a downward flowing pattern of pity for which gratitude is expected," and that the blind "occupy an inferior status," that they are "eliminated from the routine of our society."

Voyat (1975) wrote from a cognitive and social development perspective:

Thus from a Piagetian perspective one can infer a real correlation between the development of cooperation and cognition. Furthermore socialized thought progressively favors the resolution of contradictions: it is much easier not to correct oneself when one thinks of oneself in a private way. We have a much harder time contradicting ourselves when our peers are here to remind us of what has been said before and what has been agreed upon.

From these two different points of view, the problem becomes one of whether the sighted and blind can function separately, but equally or if they can ever be integrated by understanding the other's point of view.

Beliefs and attitudes toward the blind are both multiple and ambivalent. Since cognition develops according to the culture, it would seem that the blind child's cognitive development would be deviant, different, and at the very least difficult.

Piaget and Inhelder (1969) state that the affective, social and cognitive development follow the same general process since aspects of their behavior are inseparable. They further state:

Affectivity constitutes the energetics of behavior patterns, whose structures correspond to cognitive function, and even though the energetics may not explain the structuration, or the structuration of the energetics, neither one can function without the other.

Social corresponds to the relationship between the child and the adult which is the source of educational and verbal transmissions of cultural elements in the cognitive sense. Second there are also the social relations among the children themselves, and in part between children and the adults, but as a continuous and constructive process of reciprocal socialization and no longer simply a unilateral transmission.

The difficulties the blind child first encounters derive from the mother who is inexperienced, and, as Blank (1957) states:

. . . is anxious, depressed and bewildered unless she receives professional help. Feeling different, defective and isolated, the mother cannot identify herself with mothers of normal children, recoils from their pity, feels loath to discuss with any friend or relative the daily problems encountered with the blind child, and shuts herself and her child away from the 'nondefective' world.

The blind child is a feeling-listening person. Since he cannot respond to visual cues, he must listen and associate. People tend to be silent when they are listening and concentrating. This passive act is often interpreted by sighted mothers as the child's inattentiveness to her.

Unlike the normal child, he cannot reach with outstretched arms to her, since he is never sure where she is unless she makes herself known to him by their familiar communication. If she is unable to understand his passiveness and feels no communication, she reacts accordingly. The mother feels no rewards of motherhood, for she must initiate all acts of love. Feeling unneeded or thinking the child content, often play pens, rocking chairs and radios become the substitutes for the maternal love the child needs.

Literature describes the result of this misunderstanding between the blind child and his mother, as having an effect of impoverishment on his inner life; this leads to emptiness and lack of creativity. Often mothers don't know how to interest their blind child in play. It has a different meaning for them than their normal counterpart. Play should be an obvious learning experience, so that the satisfaction the blind child derives is not only a feeling of accomplishment to himself, but to others. His toys and games should be closely related to reality, and like language, he incorporates them because they have emotional meaning from the pleasure and praise he receives from his mother.

Too often, the mother anticipates her blind child's need, and is overprotective, not letting him get his share of bangs and bruises afforded the normal child in his exploration. Although the blind child

needs to learn when he should be independent, and when he should be dependent, the fine line is mixed with emotional factors and the blind child is inhibited from his environment.

Orientation to surroundings takes longer for the blind child, therefore independency takes longer. The releasing mechanism only becomes available when the child's curiosity enables him to explore his environment. However, the relationship he experiences with his mother must be secure and satisfying, for it is not only through trust in her that he explores his environment, but also through his ability to communicate with her, and feel the enjoyment she experiences from being with him.

If the blind child is unable to communicate with his external world because of insufficient communication, he will turn his attention to the inner self-satisfying stimulation known as blindisms. Tait summarizes this when he states (1972):

It can, thus, be seen that an unsatisfactory parent-child relationship may adversely affect the exploratory or play behavior of the blind child which, in turn, may affect the social development of the child later in life. Although several studies have examined the social adjustment of blind persons, methodological differences make it difficult to draw any definite conclusion. It is generally agreed, however, that defects of vision are associated with social retardation.

Since each blind child is a unique individual with different cultural life styles, there can never be a set pattern for his optimal development. However, if the basic elements peculiar to the blind are made available at different stages of development, the blind child should be emotionally and intellectually capable of functioning within his environment. As any other child, he must be taught to be socially

acceptable within his realm, since the affective, social and cognitive development are inseparable.

It is only with understanding that contradictory and paradoxical beliefs can be dispelled, and the gap in communication bridged between the blind and sighted.

### Intelligence and Standard Testing

What is intelligence and what are the measures of intelligence? Piaget came to reject the quantitative definition of intelligence which is based on the number of correct responses. He believed that intelligence is a system of living and acting operations, in terms of content, structure and function.

He points to his definition of operations, which differ from observable responses by number, in that they are geared to an internal and not merely an external function. Thus, intelligence is an activity in the creative sense of the word.

He further stated (Piaget & Inhelder, 1969):

Representative intelligence begins with the child's systematic concentration on his own actions and on the momentary figurative aspects of the segments of reality with which this action deals. Later it arrives at a decentering based on the general coordination of action and this permits the formation of operatory systems of transformation and constants or conservation which liberate the representation of reality from its deceptive figurative appearances.

Furth (1969) further elaborates by stating:

All representational knowledge supposes the activation of a symbolic function, without this symbolic function thought could not be formulated or put into an intelligible form neither for others nor for the self (inner language & etc.). Representation would then always refer to the direct product of the symbolic function (image, language) and would be connected in its figurative aspect with the real literal internalization of the external function.

It would thus appear that intelligent behavior is not tied to reflective knowledge nor to a verbal expression or comprehension.

### Standard Measures

Pinard and Laurendau (1964) state that the standard tests neglect the structural and functional aspects of intelligence. They make intelligence testing a numerical result which is the algebraic sum of successes and failures obtained by the subject. Mental age becomes a median performance instead of a true genetic state.

Hayes (1950) states that the Binet-Simon year scale has been used for the blind nearly as long as the sighted in America.

In 1914, R. B. Irwin, in Cleveland's public school in classes for the blind, used an adapted version of the Goddard's Binet scale to test children in year groups. In 1916, the Irwin-Binet test was prepared and became the standard guide for blind children. In 1923, the Hayes-Binet test was prepared by pasting into the Terman guide a number of typed slips covering changes, which then became the instruction manual "Scissor and Paste Guide" for blind testing. However, too little acceptable material was on hand to provide six tests for each year group. In 1930, Hayes-Binet again revised their test methods. In 1937, Terman-Merrill revised another Binet test after an elaborate statistical study. In 1940, two new tests were used from a selection of test items from the Terman-Merrill and the Verbal test of the Wechsler-Bellevue Intelligence Scale. The WISC Verbal was given the blind with the exception of substituting alternate items for problems two and seven in the Comprehension subtest, asking all questions for Comprehension and Similarities, and going beyond the five consecutive failures for Information and Vocabulary.

Various validating studies of the Interim Hayes-Binet and the adapted Wechsler-Bellevue found: Normal distribution of IQs; the percentages found at each intelligence level closely followed comparable samples of seeing children's; means and SD were satisfactory; correlations between individual intelligence tests; comparison of modifications of the Wechsler-Bellevue, Interim Hayes-Binet and the Hayes-Binet correlated; retest correlation on the Hayes-Binet was satisfactory; and the correlations reported between intelligence test scores and achievement test scores were high enough to demonstrate that those who tested highest in the individual intelligence test tended to do the best school work.

## CHAPTER II

## REVIEW OF RELEVANT LITERATURE

Review of the literature appears to indicate that although there has been some research dealing with cognitive development of the blind child as viewed by Piaget, the nature of mental imagery among blind children has not been investigated in terms of images of anticipation, reproduction and transformation. Some research done with blind children in the area of reasoning tasks and verbal comprehension lend themselves to mental imagery, although the researchers did not have this specifically in mind, except those that dealt with the dominant method of imagery as experienced by the sense used to replace visual imagery (Foulke, 1962; Schlaegel, 1953), or a specific sensory modality the blind child uses to gain knowledge of, or to process his environment.

Cutsforth (1951) found large discrepancies between tactually perceived standards and matched visual equivalents. One can infer as Miller (1969) did that tactual experience alone is not sufficient to overcome the deficit in cognitive visual functioning; however, no literature has been found that deals with mental imagery and the blind child as postulated in Piaget and Inhelder's (1971) theory, which has been reviewed.

The research done with cognitive development using Piaget's tasks and the blind child appear mostly to be in the area of reasoning, mainly conservation (Brekke, 1974; Cromer, 1973; Gottesman, 1971, 1973;

Hatwell, 1966; Miller, 1969; Stephens & Simpkins, 1974; Tobin, 1972), with the exception of Stephen and Simpkins (1974) who included moral judgment and moral conduct.

Researchers generally confirmed findings that conservation can reliably be measured in blind children. Most of the findings were comparison studies with sighted children (Cromer, 1973; Gottesman, 1971, 1973; Hatwell, 1966; Stephen & Simpkins, 1974), or with visually handicapped children of varying degrees of blindness (Tobin, 1972) or age when blinded (Miller, 1969).

Although Cromer (1973) disagreed, most studies found a developmental lag in reasoning tasks between congenitally blind children with no vision or light perception only, and those who were partially blind or sighted (Gottesman, 1973; Hatwell, 1966; Stephen & Simpkins, 1974; Tobin, 1972). However, most blind children despite this lag appear the same or ahead of the sighted children on verbal tasks (Cromer, 1973; Rubin, 1963), which many researchers infer may be due to verbalisms.

Harley (1963) states that excessive dependence on verbal learning may have negative effects on academic learning and concrete experience, he also found that verbalisms were negatively correlated between chronological age, IQ and experience. Lowenfeld (1955) implies there is a need for "concreteness" or a gaining of reality not from verbal descriptions of others, but from first-hand information through the senses available. Witkins (1965) found that although the blind are equal to the sighted in verbal comprehension he shows less ability to articulate. Terms used are often vague and global and appear to lack integration. Zweibelson and Barg (1967) found abstract concepts were not used as much

as concrete and functional concepts when blind children were compared to the sighted.

It appears (Harley, 1963) the "key to reduction of verbalisms is to increase interaction with the environment," although Cutsforth (1951) found that visual concepts were still given by the blind in response to forty nouns varying in degree of sensory availability, when other sensory concepts just as available or more meaningful could have been given, which makes the evaluation of any research with the blind child difficult. Although Cromer (1973) found no difference in language for reasoning tasks between the blind and sighted, he did find differences in language between conservers and non-conservers, which denotes that verbalisms or linguistics apparently do not help in operational tasks.

Stephen and Simpkins (1974) state: "To know an object or event is to act on it, modify it or transform it and, in the process, to understand the way the object is constructed. This act is an operation, and an operation is the essence of knowledge." Language is only an auxiliary.

Researchers generally found (Gottesman, 1973; Miller, 1969; Stephens & Simpkins, 1974) that the attainment of substance preceded weight, and weight preceded volume.

Researchers also confirm Piaget's theory that the same hierarchical stages of cognitive development and reasoning found in the sighted were also found in the blind, but that performance is interrelated to age, sex, and mental ability (Brekke, 1974; Miller, 1969). It appears that conservation comes with age (Gottesman, 1973; Miller, 1969), but is much slower for the blind. IQ is positively correlated with all tasks (Miller, 1969; Stephen & Simpkins, 1974). This correlation is

significantly greater for the blind than sighted.

It should also be noted that Piaget's reasoning tasks are viewed not only as diagnostic instruments, but learning tools (Miller, 1969; Stephen & Simpkins, 1974; Tobin, 1972).

In addition to conservation, research in other areas of reasoning dealt with classification (Friedman & Pasnak, 1973; Higgins, 1973; Stephens & Simpkins, 1974), and training programs (Moore, 1973) in skills of matching, classification and seriation to ready blind children for mathematics.

Unlike Friedman and Pasnak (1973), Higgins did not support the developmental lag, but felt that the deficiencies appeared to be perceptual or figurative and symbolic in origin rather than operative. Higgins (1973) further felt that blindness was not sufficient to support the lag, but that the blind were handicapped because of an inability to obtain sufficient data from their environment.

It would appear that the blind would be inferior to the sighted at all age levels on spatial tasks, since mobility is not only limited externally, but inhibited by the child himself.

Worchel (1962) studied congenitally blind children and later blinded children with simple geometric forms, and Swallow and Pouslen (1972) studied the visually limited on tasks of topological, projective and euclidean space. Generally both studies found the blind to be inferior to the sighted, but it is of interest to note that Worchel (1962) found that more handling does not lead to better tactual perception, and that identification was due to prominent features. The inability of the blind to translate tactile impressions into visual

imagery Worchel states, makes the blind child's verbal recall better than reproduction.

Researchers also found that males generally performed better than females.

This review generally concludes that the blind child's cognitive development is slower than the sighted. It also implies that the process is different, but loss of vision alone is not sufficient to inhibit achievement on reasoning tasks.

### CHAPTER III

#### METHODOLOGY

##### Design

The research method chosen to investigate cognitive development and mental imagery in the congenitally and adventitiously blind child was to examine the content and structure of thought by using Piagetian tasks. In addition, a qualitative analysis from clinical case material was done on each child to examine other contributing factors that may influence their cognitive and mental imagery development.

The approach to the research is observational, descriptive and analytical. From these approaches, the object is to analyze their relationship to the development of cognition.

##### Subjects

The subjects in this study are eight congenitally blind children and four children who were blinded after the age of five. These subjects were selected from public schools in the five boroughs of New York City. Preliminary clearance was obtained from Mr. Lester Barad, Bureau of Visually Handicapped. Once selected, clearance was obtained from the Principal, Community Superintendent, Special Educational Teacher and Parents. They were chosen according to the following criteria:

1. Subjects were totally blind, or had light perception only.

They relied almost exclusively on tactile or other non-visual forms of perception.

2. Blindness was the dominant disability, multiple-handicapped blind children were excluded.
3. Both male and female subjects were used.
4. Subjects were between the ages of six and eleven, inclusive.

Because the Bureau stated that most of these students were of Hispanic origin, a bilingual person was present at all times, and language was not considered a criteria.

#### Setting

Interviews with blind children were conducted in a room in the child's school. All Piagetian tasks were administered by the author, with the recording assistance of Dr. E. Maynard, Ms S. Scott, Ms T. Scott, and Ms D. Walden. All subjects were aware that they were being tape recorded, and the special educational teacher had the option to observe. Testing took approximately three hours, which was conducted either at one time with breaks, or split into sessions on different days. Each child was given a gift from the author, for his or her participation in the study.

#### Description of Variables Being Studied

##### Relational Terms

Prior to the administration of reasoning tasks, each child responded to measures which were designed to evaluate his understanding of such relational terms as: "more," "less," "same," and "different." The protocol is found in Appendix A.

### WISC Scales

Each child was administered the Verbal Wechsler Scale, adapted as previously discussed, to determine the relationship between scores on reasoning variables and the standard measures of intelligence, in addition to determining the homogeneity of the subjects.

### Reasoning Tasks

Piagetian reasoning measurements included: Conservation, Space, and Elementary Logic. Five of the Conservation tasks were designed to assess mental imagery and are extracted in the results section. The protocols for all reasoning tasks are presented in Appendix A.

Adaptations of reasoning tasks for the present study were as follows: each child was able to become familiar tactually with the materials before the experiments began; each child manipulated or made transformations himself or with the assistance of the examiner if necessary, and the examiner made sure the child understood the movement or transformation. Choice of materials were such that they could be easily manipulated and identified by the child.

Each child was presented in random order the following Piagetian tasks. An abbreviation of the structure and analysis of each reasoning task will be presented here. The criteria for stages from which the tasks were rated are listed in Appendix B.

1. One-to-one correspondence. In this task, the child is requested to place one apple figure in front of one star figure to establish equality or correspondence between the two rows. Then one of the rows is either spread out or pushed together by the manipulation of the examiner with the child's hands. Immediately following each transformation, the child

is asked whether there are as many stars as apples.

This task deals with the most primitive notion of conservation, and is usually acquired around the age of six or seven. During the initial stages, the perceptual correspondence is destroyed during the transformation. The child gives up his original belief that the rows are equivalent (cardinal referent), and is dominated by the perceptual features of the configuration, assuming that one row is longer by its length, or shorter by its density. The final stage is when the logical structure of number overcomes the perceptual distortion.

2. Conservation of matter. In this task, two equal balls of clay are given to the child to establish equality; one ball is successively transformed by the child into a "hotdog, pancake and small pieces." After each transformation, the child compares the amount of clay in the transformed ball with that of the unchanged ball.

This task calls for the establishment and understanding of an equivalence of matter after the transformations are made, and is usually acquired around the age of seven to eight. During the initial stages, the quantity of matter changes according to the physical transformation. The child totally relies upon his perceptions. The unchanged ball looks different from the transformed ball. In addition, the child is unable to coordinate more than one dimension at a time. He centers on one dimension with negation of the other. Once the child understands "Logical Multiplication," or that the hotdog is longer, but thinner and thus equal, or that changing the shape does not alter the amount of matter, then he has achieved conservation.

3. Conservation of weight. In this task, two equal balls of clay are given to the child to weigh, to establish equality. One ball is successively transformed by the child into a "hotdog, pancake and small pieces." After each transformation, the child compares the weight of the transformed ball with that of the unchanged ball.

In this task, the child judges the weight rather than the size of the transformed ball (the two often being confused). Piaget noted there seemed to be a time-delay between the acquisition of the conservation of matter and conservation of weight, the latter being acquired around nine or ten years of age. Here again as in conservation of matter, the child ignores the transformation and is misled by the perceptual features of the configuration. He assumes that one is bigger, so it must weigh more. Not until the child conceives of the logical invariability of the two equal sized and weighted balls even after the physical transformation has he achieved conservation.

4. Conservation of volume. In this task, after the equality of two clay balls and the equality of two beakers of water have been established by placing an elastic band at the water level, the child is asked whether the water levels in the containers would remain the same if the transformed ball were placed in one and the non-transformed ball in the other. If the child wishes he may or may not transform one ball into a "hotdog, pancake and pieces." In the second part, a glass ball of the same size, but different weight, replaced one of the clay balls.

The task calls for the child to recognize that the transformed ball and the non-transformed ball continue to displace equal volumes, or to recognize whether the water level rises the same in both containers.

It requires the child to understand the concept of conservation of matter, but disregard the concept of conservation of weight. This conflicting fact may contribute to his not understanding the constancy of size-amount rather than weight, which is not acquired until the age of eleven or twelve. This is one of the reasons why a glass ball of equal size, but different weight, is introduced into the task. After the child is able to coordinate all the aspects of the situations, he is no longer misled by perceptual appearances of the configurations; then conservation of volume is present as a logical necessity.

5. Conservation of liquids. In this task, two identical beakers are filled with equal amounts of water, to the level of the elastic band, by the child. After the equality of the same amount of water has been established, the child pours the content of one beaker successively into a tall beaker, a short flat beaker, and four small beakers of equal size. After the transformations, the child is asked whether the containers have the same amount of water.

In the initial stages, the child is again misled by the perceptual changes he has observed, which vary according to the height, width, number of glasses and water levels. In addition, he is unable to coordinate height and width. He centers on one dimension with negation of the other. Once he conceives of conservation as independent of the transformation, basing it on the coordination of the different parameters, conservation is achieved between the ages of seven to eight.

6. Conservation of length. In this task, the child is requested to confirm the equality of two rods, chosen from a selection of five rods, two of equal length. The rods are then placed parallel to each other and

the child's hands are placed on both rods to observe the movement tactually. The experimenter then moves one rod to the left, midpoint of the stationary rod, then to the right, midpoint of the stationary rod, and finally both are moved simultaneously. After each transformation, the child is asked if the rods are the same length.

Piaget infers that non-conservation is not attributed to perceptual factors, since five-year-olds can estimate equality of lengths in staggered positions with greater precision than eight-year-olds. However, he infers that the operational problems are closely linked to imaginal representation and attitudes toward boundaries. There appears to be confusion between further and longer (displaced rod is thought to be longer, because it is moved further); however, conservation does not amount to verbal misprehension. The ordinal and metric estimate of length is not differentiated since it is a particular nature of early spatial field. Around nine years of age, through the coordination of the parameters, the conception of conservation is seen as a logical necessity.

7. Conservation of length (sectioned). This task is similar to the above except four rods of equal length are compared to one rod which is equal to the four rods. The transformations consist of  $\overline{V V}$ ,  $\overline{VV}$ , and  $\overline{-V}$  shapes.

In this task, the child is asked to determine the equivalency of parts to whole, which requires the coordination of the parameters which compensate for the physical displacement of those parts involved. Initially the pre-operational child does not recognize the equality of parts to whole after the transformations have been made. Until his conception of length includes part to whole as a logical necessity he has not acquired conservation.

8. Rotation of beads. In this task, three differently shaped beads were strung consecutively on a stiff wire by the child, after they were examined and given a name. The child is assisted in placing the beads on the wire in a tube, and then the tube was tilted or rotated (direct order, inverse order, 1 reversal and 2 reversals). The task was to judge which of the beads would emerge first from the tube.

This task studies the child's notion of movement in space to determine whether he comprehends the operational changes of order, which are indicated by direct order, inverse order, one reversal being equal to  $180^{\circ}$  and two reversals being equal to  $360^{\circ}$ , which result in the original order. There also remains discussion of the center bead. In one of the studies done in Piaget and Inhelder (1971), it was found that more older than younger children thought that the middle bead would come out first. Usually the direct and inverse orders are understood first, and the other rotations are not acquired until around six to seven years old.

9. Class inclusion. In this task, a box containing ten beads, eight of one shape and two of an obviously different shape (square and round) are given to the child to examine and tell what they are. His attention is drawn to the fact that all the beads are wooden. Different variations of questions are asked concerning the number of shaped beads and wooden beads.

This task examines the relationship between a class and its subclass in the box, then in the world. Although the child is aware that all the beads are wooden, in the pre-operational child, when he is asked "are there more wooden beads or square beads," he is unable to think simultaneously of the whole being equal to the sum of its parts. In addition

he is usually unable to answer questions concerning subtraction of the classes. "If I give you all the square beads, what remains in my bunch?" In the transitional stage, he is now able to subtract classes, but is still unable to understand and coordinate extension of classes. "Are there more wooden beads or square beads?" The square beads are still a sub-portion of the wooden beads, not only in the box, but in the world. Once he understands logical classification which coordinates comprehension of the intention and extension of a class, he has achieved conservation.

10. Change of Criteria. In this task, four large plastic circles (two thick, two thin) and four small squares (two thick, two thin) are placed in disorder before the child. He is asked to examine and describe them. Attention is drawn to the shape, size and thickness. He is asked to classify or group them into two piles or families. The procedure is encouraged for the three criteria.

This task is also one of classification to assess the factors of hindsight and anticipation. All the elements are introduced from the start. The child is allowed to make up his own form of classification and is then asked to change it. Flexibility explains their development. Is the data that has been given him being used to anticipate dichotomies in advance or has it given him mobility after the first arrangement? There are two approaches to this task: ascending method, which means that the child deals with each element if and when it comes to him; there is no anticipation and consequently when told to change criterion he tends to find rigidity associated with hindsight; and secondly, the descending method, which starts from the more general classification (shape, size and width) and may take the form of broad dichotomies. The child anticipates results and has less difficulty in using hindsight to change criteria.

He begins a systematic survey of the material, formulates a plan and carries it through using the descending method. Generally most children are able to classify shape.

#### Scoring of Reasoning Tasks

Inter-rater reliability on measures of reasoning were established by generating scores obtained from three judges who assessed each of the ten reasoning tasks and assigned a stage according to the criteria for stages as outlined in Appendix B. The obtained reliability coefficients were measured by Cohen's Kappa (Fleiss, 1973), and ranged from .50 to 1.00 (Appendix C).

#### Data Analysis

1. To determine the homogeneity of the group (ABB & CBC), measures of central tendency and dispersion were used in the following statistical techniques:
  - A. t-test to show the differences between IQs
  - B. t-test to show the differences between ages
  - C. correlational technique to determine effect on performance from time of blinding
  - D. t-test to determine the differences between CBC and ABB performance on reasoning tasks.
2. Correlational techniques were used to determine the degree of relationship which existed among reasoning variables.
3. Partial correlations were used to determine the effects of chronological and mental age (IQ) on reasoning variables.
4. To assess the average stage of achievement as a function of age, a graph was prepared to compare the differences between normal, CBC and ABB children.

5. A qualitative analysis was done to explore the content and structure of conservation and mental imagery.
6. A qualitative analysis was done on clinical case material by subject to examine other contributing factors of cognitive development.

## CHAPTER IV

### RESULTS

To investigate cognitive development and mental imagery of the blind children in this study, the data obtained was used to study issues in the following sequence: (1) Do the congenitally blind children (CBC) and after birth blind children (ABB) form a homogeneous group? (2) How do these blind children compare to standards of normal development? (3) Are the cognitive tasks homogeneous for blind children? (4) Does the quality of their operational responses and case material indicate any particular processes or factors that are linked to their blindness which are factors in their development, such as:

1. Patterns of response by task within each stage of conservation;
2. The relationship of mental imagery to reasoning task achievement, by task;
3. Qualitative clinical analyses by subject.

#### Analyses of CBC and ABB

To determine if significant differences existed between the two groups of blind subjects (CBC and ABB) on measures of reasoning, age, onset of blindness and IQ, tests were computed from the mean scores shown in Table 1.

For IQ, a t test based on the scaled scores of the Verbal Scales of Wechsler Intelligence Scale for Children (WISC) as shown in Table 1 was calculated. The results (t = 2.03, df = 10, p >.05) indicate there

TABLE I

10. AGE AND STAGE PERFORMANCE FOR EACH TASK  
WITH THE AVERAGE OVERALL LEVEL OF COGNITION

CBC (Subjects)	AGE (Months)	AGE (Yr./Mos.)	IQ (Verbal)	Conservation of Matter	Conservation of Weight	Conservation of Volume	Conservation of Liquids	Rotation of Beads	Conservation of Length	Conservation of Length Sectioned	1:1 Corr.	Class Inclusion	Chg. of Criteria	Avg. Stage Level each Ss	Stage
1	77	6-5	124	1	1	1	1	1	1	1	3	1	1	1.2	Pre-operational
2	93	7-9	129	1	1	1	1	2	1	1	2	2	2	1.4	Pre-operational
4	105	8-9	114	1	2	2	3	2	3	3	3	1	1	2.1	Transitional
5	114	9-6	133	2	2	2	2	1	1	2	2	3	1	1.8	Transitional
6	114	9-6	110	1	1	2	2	3	2	1	2	3	2	1.9	Transitional
7	115	9-7	110	3	3	3	3	3	3	3	3	2	3	2.9	Concrete Operational
9	120	10	123	1	2	2	1	3	1	2	3	2	1	1.8	Transitional
11	125	10-5	82	3	2	2	2	2	2	2	2	2	1	2.0	Transitional
Overall Average	107.88		115.62	1.6	1.7	1.9	1.9	2.1	1.7	1.9	2.5	2	1.5	SD .5 1.89	Transitional
ABB 3	100	8-4	95	2	3	2	3	3	2	3	2	3	2	2.5	Concrete Operational
8	115	9-7	108	3	3	2	3	3	3	3	3	3	1	2.7	Concrete Operational
10	122	10-2	63	1	1	1	1	3	1	1	1	1	1	1.2	Pre-Operational
12	132	11	108	3	3	3	3	3	3	3	3	3	2	2.9	Concrete-Operational
Overall Avg.	117.25		93.5	2.2	2.5	2	2	3.0	2.2	2.5	2.2	2.5	1.5	SD .76 2.32	Transitional
Means for All Ss	111.08		108.25	1.83	2.0	1.9	2.08	2.41	1.91	2.08	2.42	2.16	2.0	2.03	Transitional
SD for All Ss	14.37		19.27	.89	.82	.64	.66	.76	.86	.86	.64	.80	.41		

was no significant difference between the two groups for IQ.

For age, a  $t$  test from scores for chronological age (in months) as shown in Table 1 was calculated. The results ( $t = 1.01$ ,  $df = 10$ ,  $p > .05$ ) indicated no significant difference for age exists between the two groups.

Since the CBC and ABB children did not differ in age and IQ, their cognitive performances were compared to see if there was an effect from "time of blinding."

From the obtained correlations in Table 2, CBC and ABB children were coded so that a positive correlation would indicate higher performance for the ABB and a negative correlation would indicate higher performance for the CBC. The results indicated there was no significant relationship between onset of blindness and stage of achievement on any of the tasks.

To determine if there was a significant difference between the performance on reasoning tasks of CBC and ABB children, a  $t$  test from the average overall scores for each subject, within each group shown in Table 1, was calculated. The results ( $t = 1.10$ ,  $df = 10$ ,  $p > .05$ ) indicate there was no significant difference between the two groups.

To determine the overall performance for each group, each subject's stage level assigned for each task was given an averaged mean which was rounded to its nearest whole unit stage. Those subjects who had a mean of 0 to 1.5 were considered pre-operational. Those who had a mean from 1.5 to 2.5 were considered transitional, and those from 2.5 and over were considered concrete operational. This procedure allowed the child to be placed within a stage by his mean, and thereby obtain some

TABLE 2

INTERCORRELATION MATRIX FOR SCORED REASONING VARIABLES, AGE, IQ, AND AGE WHEN BLINDED\*

	IQ	Blindness	Age	Matter	Wt.	Vol.	Liq.	Beads	Len.	Len.Sec.	1:1	Class Inc.	Ch. Crit.
IQ	1.000												
Blindness	-0.540	1.000											
Age	-0.398	0.291	1.000										
Conservation of Matter	-0.185	0.328	0.511	1.000									
Conservation of Wt.	-0.026	0.433	0.411	0.796**	1.000								
Conservation of Vol.	0.069	0.092	0.607	0.701 *	0.797 **	1.000							
Conservation of Liq.	-0.061	0.341	0.302	0.664 *	0.828 **	0.767 **	1.000						
Rotation of Beads	-0.462	0.543	0.546	0.224	0.403	0.414	0.328	1.000					
Conservation of Len.	-0.119	0.273	0.357	0.628*	0.710 **	0.742 **	0.906 **	0.435	1.000				
Conservation of Len.Sec.	0.003	0.341	0.349	0.664 *	0.947 **	0.767 **	0.887 **	0.328	0.794 **	1.000			
1:1	0.558	-0.184	-0.085	0.265	0.478	0.491	0.390	-0.014	0.516	0.541	1.000		
Class Inc.	0.197	0.294	0.375	0.503	0.510	0.515	0.463	0.297	0.262	0.342	0.027	1.000	
Ch. Crit.	-0.148	0.0	0.539	0.454	0.500	0.637 *	0.473	0.537	0.473	0.473	0.0	0.255	1.000

\*  $P < .05$ , \*\*  $P < .01$  are .576 and .703 respectively

1= Blind at birth, 2= Blind after birth so that a positive correlation would indicate higher performance for the ABB and negative correlations indicate higher performance for the CBC group

measure of his cognitive development according to his general performance level.

Of the eight children who were blinded at birth, two were pre-operational, five were transitional and one was concrete operational. Of those subjects who became blind after birth, one was pre-operational and three were concrete operational. The mean achievement level for all subjects was 2.03 and thus transitional.

In the absence of any significant differences between the two groups for IQ, age, onset of blindness and performance on reasoning tasks, further analyses of cognitive development and mental imagery in these CBC and ABB children will be conducted as combined groups.

#### Comparison of Standards to Normal Development

From the means (Table 1) for all subjects within each task some measure of "decalage" was obtained. Decalage refers to the fact that one sees similar mental operation occurring at different ages of cognitive development. It was found that successful performance on conservation of matter did not precede successful performance on conservation of weight in either group. The most difficult task for each group was found to be change of criteria. The least difficult task for the CBC group was one-to-one correspondence, while the least difficult for the ABB group was rotation of beads.

Intercorrelations among variables (reasoning tasks, age and IQ) were computed on the group as a whole, and are presented in Table 2. Findings indicate there was no significant relation between IQ and stage of achievement on reasoning tasks. One significant correlation was found between age and stage of achievement: conservation of volume, which means

that the older the child, the higher the stage achieved.

It has been previously stated that task performance may be a function of age and IQ. In order to determine the extent to which performance on reasoning tasks was dependent on these variables, partial correlation coefficients were performed to remove these effects statistically from the matrix. Arbitrary factoring, a computed algorithm by Cooley and Lohnes (1971), was used for this purpose. The results of the partial correlation analyses presented in Table 3 indicate that for the blind child, removing age and IQ does not decrease the correlations shown in Table 2. In fact, it increased correlations between one-to-one correspondence and the conservation of weight, volume, length and length sectioned.

These findings would seem to suggest that contrary to normal development, there were still substantial relationships among performances on Piagetian tasks even when the effects of age and IQ were statistically removed.

When comparing the average stage of achievement for normal children as shown in Table 4, with CBC and ABB as a function of age (Figure 1), the findings indicate there is a difference between the age and stage of achievement of blind and normal children. This suggests that the blind child is slower in the achievement of tasks. On the basis of this data, it appears that the process whereby the blind child achieves conservation is slower than the normal child and may indicate a difference in process.

TABLE 3  
MATRIX OF PARTIAL CORRELATIONS WITHOUT AGE AND IQ

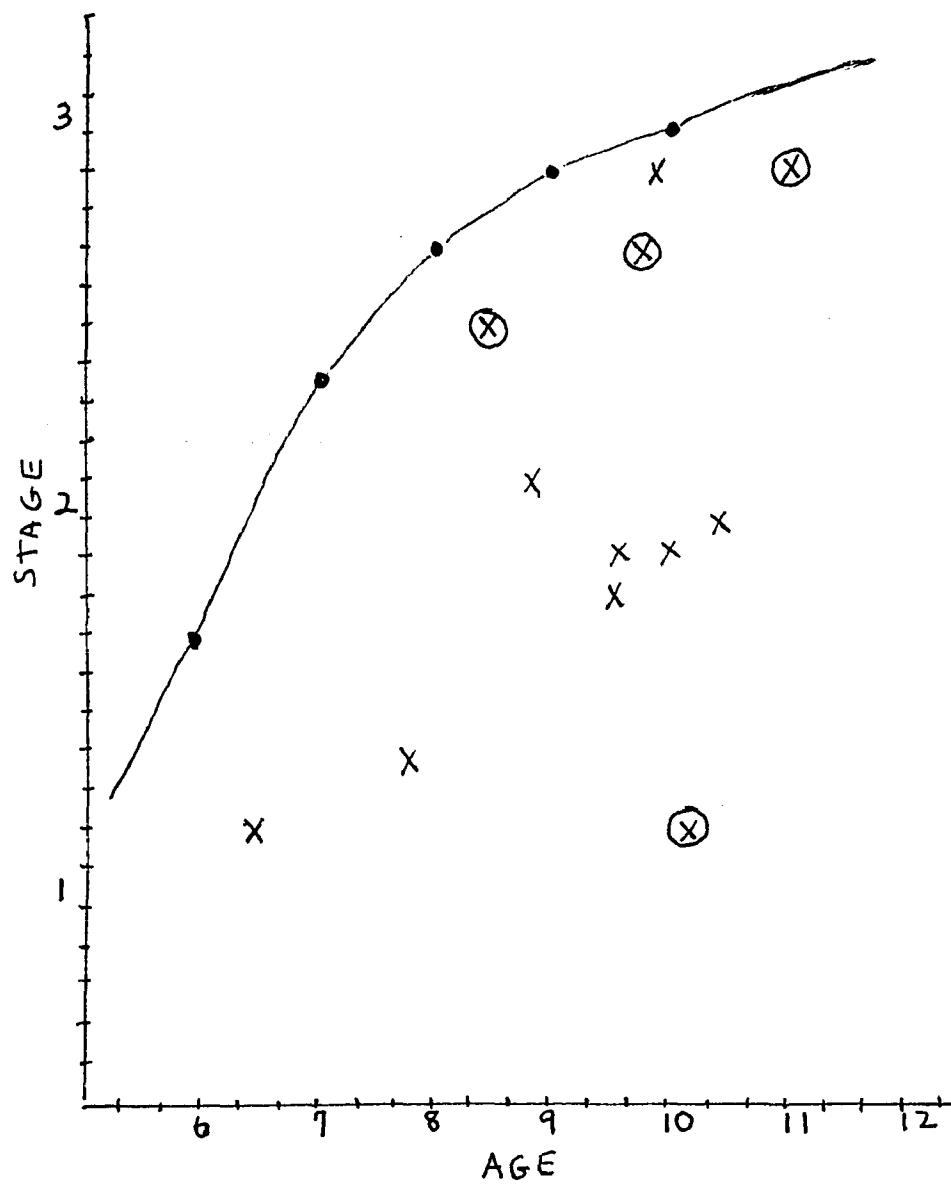
	IQ	Blindness	Age	Matter	Wt.	Vol.	Liq.	Beads	Len.	Len.Sec.	1:1	Class Inc.	Ch. Crit.
IQ	0.0												
Blindness	0.0												
Age	0.0	0.00											
Conservation of Matter	0.0	0.26	0.00										
Conservation of Wt.	0.0	0.50	0.00	0.76**									
Conservation of Vol.	0.0	0.12	0.00	0.62*	0.78**								
Conservation of Liq.	0.0	0.36	0.00	0.62*	0.81**	0.83**							
Rotation of Beads	0.0	0.39	0.00	-0.08	0.30	0.29	0.24						
Conservation of Len.	0.0	0.23	0.00	0.56	0.67*	0.77**	0.90**	0.34					
Conservation of Len.Sec.	0.0	0.40	0.00	0.60*	0.94**	0.76**	0.88**	0.24	0.77**				
1:1	0.0	0.16	0.00	0.44	0.59*	0.60*	0.49	0.29	0.71**	0.64*			
Class Inc.	0.0	0.51	0.00	0.41	0.39	0.26	0.40	0.29	0.14	0.19	-0.23		
Ch. Crit.	0.0	-0.18	0.00	0.24	0.36	0.48	0.38	0.39	0.35	0.35	0.01	0.04	

p < .05, p < .01 are\* .57 and \*\* .71 respectively

TABLE 4  
 AVERAGE STAGE FOR NORMAL CHILDREN BY AGE  
 FOR REASONING TASKS

Reasoning Tasks	Ages				
	6	7	8	9	10
Matter	2.5	3	3	3	3
Weight	1.5	2.5	3	3	3
Volume	1	1	1.5	2.5	3
Liquids	1.5	2.5	3	3	3
Beads	2.5	3	3	3	3
Length	1	1.5	2.5	3	3
Length Sect.	1.5	2.5	3	3	3
1:1 Corr.	1	2.5	3	3	3
Class Inc.	1.5	2	2	2.5	3
Chg. of Crit.	2.5	3	3	3	3
Average	1.65	2.35	2.7	2.9	3

Obtained from G. Voyal (1975)



Sighted Norms •  
 Congenitally Blind X  
 Blinded After Birth (X)

Figure 1

Task Performance as a Function of Age and Blindness

### Homogeneity of Tasks

Although it is useful to think of an individual as generally being within a stage of concrete operations, he does not necessarily have the ability to perform within that structure for all reasoning tasks. Those included in this study are comprised of conservation, space and elementary logic. As Flavell (1963) states, "Task contents do differ in the extent to which they resist and inhibit the application of cognitive structures." Findings on reasoning tasks indicate significant correlations were among:

1. Conservation of weight and matter
2. Conservation of volume and matter and weight
3. Conservation of liquid and matter and weight and volume
4. Conservation of length and matter and weight and volume and liquids
5. Conservation of length sectioned and matter and weight and volume and length
6. Change of criteria and conservation of volume

The results of the correlations suggest the relationship among reasoning variations exist when the ability to master problems successfully involves similar mental operations. The arguments used are the same for justifying the above conservations and therefore homogeneous although they may be achieved at different ages.

### Quality of Responses

In an attempt to illuminate the process whereby the blind child cognitively develops, qualitative findings were examined in the form of thought content, mental imagery and clinical data. This reflects other contributing factors of personal or physical experience and social transmission.

Patterns of Response by Task  
Within Each Stage of Conservation

Since content is the basic observable process underlying structure by which the child's private reasoning and cognitive exchanges demonstrate his ability within developmental periods of intelligence or stages of concrete operations, the purpose of analyzing the data in this manner is to determine the frequency of the type of responses given within each stage and how these responses differ from stage to stage.

The subjects' responses to seven reasoning variables involving retaining quantities of conservation are shown in Table 5. They are categorized in terms of patterns of response for each variable within the three stages. The numbers shown in the upper corner of the cell are not quantitative in the sense that there is a positive correlation with number of questions asked and number of responses given, or, that repeated responses by the same subject increase the number shown. The lower numbers indicate subjects using these responses.

The categories for the subjects' responses include the following: (1) Identity (the shape is different, but it is the same; nothing is added or taken away); (2) Reversibility (if you put it back, it is the same); (3) Compensation (it is wider and shorter, but it is the same) is a coordination of any relationship; (4) Dimension (it is longer or shorter, thinner or fatter, etc.) deals with measurement, one dimension or two, but not compensated; (5) Amount (it is a lot; it is bigger; it has more pieces); (6) Sensory (it looks or feels like more); (7) Figurative (you have a ball and I have a hotdog; I rolled mine or made it a lot of things and you did not) gives reference to the static state of the object or movement; (8) "I don't know"; (9) Other

TABLE 5  
 TYPE OF RESPONSES TO CONSERVATION QUESTIONS  
 BY TASK, STAGE AND SUBJECT

	Pre-operational						
	Matter	Weight	Volume	Liquids	Length	Length Sect.	L:1 Corres.
Identity							
Reversibility							
Compensation							
1 Dimension	4/10,2 4,9	3/10 1,2		3/1,2,9	5/10,1 2,5,9		
2 Dimensions	1/9			1/9		4/10,1,2,6	
Amount	5/1,2,6,9,4	3/1,2,6		3/10,2,9			1/10
Sensory	1/4	1/6		1/1			
Figurative	4/1,4,6,10			1/9	1/9		
Don't Know	1/10	2/1,10	1/10	2/1,10	1/1	2/1,10	1/10
Other	3/1,4,10	1/10	1/1,2,10	3/1,9,10	3/2,9,10	1/6	1/10
		2/5,9	Transitional		2/3,11	3/5,9,11	1/11
Identity			5/3,3,4,5	2/5,6			
Reversibility	2/3,5	1/4	1/5	1/11	1/11		
Compensation							
1 Dimension	1/5	4/4,5,9,11	6/5,9,11 3,4,6,8	2/6,11	1/6	1/5	2/3,6
2 Dimensions	2/3,5	1/9	1/11	1/5	2/6,11	1/9	1/5
Amount	1/3	1/4		1/6			2/2,5
Sensory							
Figurative							
Don't Know							
Other		1/11	4/5,6,8,11	2/6,11	1/11	2/9,11	
			Concrete Operational				
Identity	3/3,7,12	3/3,7,8	2/7,12	5/3,4, 7,3,12	4/4,7,8,12	3/3,7,8	6/1,4,7,3,9,12
Reversibility	2/7,11			2/7,12			
Compensation	1/12	1/12	1/12	2/3,12		2/4,12	1/3
1 Dimension	1/11			1/3			
Amount							
Sensory							
Figurative							
Don't know							
Other							

Number in left hand corner refers to total number of subjects  
 Other numbers refer to the subject by number, giving this type response within the task

or unusual responses ("Yours is a glass and mine is a dish, water in a dish stays like a swimming pool so yours is higher) are probably peculiar to the blind.

Since the blind child recognized that the two amounts were equal in all the conservation tasks before the transformation, the question now becomes what is the process by which he judges equality after the transformation. Does he still recognize this or is he misled by the changes in appearance? Does he focus on only one aspect to the exclusion of others? Is he capable of maintaining equality after perceptual changes because of logical necessity?

These differences according to Piaget imply stages, and the reasoning tied to these mental operations is examined in Table 5 from the content of the blind child's responses. The responses within each stage include the following factors.

#### Pre-operational.

(#) indicates subject; (1,2) indicates age in years/months

1. Conservation responses. No pre-operational child justified his argument with correct conservational responses.

2. Dimension. The majority of children focused on one dimension with negation of the others. Below are some examples:

#2 (7,9) For conservation of matter (pie) said, "they're not the same, because the pie is flat."

#4 (8,9) For conservation of matter (hotdog) said, "they're not the same because I rolled mine and yours is just a ball and mine is longer than yours."

#9 (10) For conservation of matter used two dimensions but was unable to justify their equality "I have more (pie) because mine is flatter and wider, and yours is longer."

Of the seven subjects who were considered pre-operational on one more of the conservational tasks, all (100%) justified some of their arguments by using dimensions. Fifteen (71%) of these responses were only of one dimension with negation of the other.

3. Amount. It appears that the focus on the less familiar terms of height, width and length was replaced with the language of bigger, whole, less, etc. It seems that this inability to integrate more abstract concepts within tasks makes conservation difficult and can be considered to be a less advanced thought process. Below are some examples:

#1 (6,5) For conservation of matter (ball and pieces) said, "they're not the same because this is lots of pieces and this one is a whole one." . . . For conservation of weight (ball and pieces) "ball is less than pieces, one is whole and one is broken."

#2 (7,9) For conservation of weight (ball and pieces) said, "they're not the same because the pieces are lighter." For conservation of liquid (small glasses) "they're not the same because the glasses are little."

#6 (9,6) For conservation of matter (hotdog) said "they're not the same because I made mine bigger."

#9 (10) For conservation of liquids (small glasses) said, "mine is more, but smaller, No! I think yours is bigger, all of these glasses have a tiny bit, but makes the same amount as yours, but yours is one big glass." (same amount?) "No, because yours is one big glass."

Of the seven subjects who were considered pre-operational, six (85%) justified some of their arguments by using amount.

4. Sensory. The process of perceiving, which is determined primarily by action of sense organs, can be classified for the blind under other responses when looking is implied. However, some examples are:

#4 (8,9) For conservation of matter (hotdog) said, "mine feels bigger."

#1 (6,5) For conservation of matter (pie) said, "it looks like a circle."

Of the seven subjects who were considered pre-operational on some tasks, three (42%) justified some of their arguments by using sensory methods.

5. Figurative elements. This implies that the subjects made reference to the state of the object or its change of position in a static manner instead of transformations in reference to equality.

Some examples are:

#1 (6,5) For conservation of matter (hotdog) said, "they're not the same because you don't have a hotdog."

#4 (8,9) For conservation of matter (hotdog) said, "I rolled mine and yours is still a ball."

#6 (9,6) For conservation of matter (hotdog) said, "you have a ball and I have a hotdog."

#9 (10) For conservation of liquids (shorter glass) said, "yours is a glass and mine is a dish." . . . For conservation of length, "yours is going this way and mine went that way."

Of the seven children who were considered pre-operational on some task, five (71%) made reference to transformations figuratively.

6. Don't know. Of the seven subjects who were considered pre-operational on some task, two (28%) stated they didn't know.

7. Unusual responses. These responses are critical since they are specific to blind children and can be classified in two general categories: (1) inappropriate use or lack of understanding of relational or other terms; (2) inappropriate use or lack of physical and personal experience with the environment. In this case, the child

attempted to transfer previous experience to a new experience. Below are some examples:

Inappropriate use or lack of understanding of relational or other terms

#1 (6,5) For conservation of matter (pie) said, "I have more because it looks like a circle, yes it is a circle, so both are more."

#9 (10) For conservation of liquid (lower glass) said, "yours is a glass and mine is a dish, water in a dish stays like a swimming pool, so yours is higher."

Inappropriate use or lack of physical and personal experience

#1 (6,5) Asked the following questions: "What does volume mean?" "Can I make a sausage since I don't know how to make a hotdog?"

#4 (8,9) For conservation of matter (pieces) said, "my ball feels bigger because we did so many things with it. If you break things up into pieces, more and more pieces will break up, and more and more stuff comes out."

#6 (9,6) For conservation of length said, "you would walk straight on your road, and I would go around all these curves, and that's crooked, so it wouldn't be the same walk."

#9 & 10 (10 & 10,2) For conservation of liquids thought they could confirm their reasons by "let's drink it to find out."

#10 (10,2) For conservation of matter asked, "what is pie-shape?" (for pieces) "How are we going to put the pieces together again?" Size was used to justify all arguments of conservation of matter, weight and length.

Of the seven subjects who were considered pre-operational on some task, six (85%) justified their arguments with reasons that implied a difference in processing information.

### Summary of pre-operational tasks

Many responses observed were similar to those found in normal pre-operational children and others were specifically used by blind children. Although no pre-operational child gave correct responses to conservation questions and countersuggestions (Appendix D respectively), these responses would seem to imply that when there is a discrepancy between language and the reasoning process the task is not achieved. The incomplete and incorrect concepts appear to be the result of limited personal and learning exposure which limits mental operations and restricts success on tasks. It appears by the unusual responses, that the blind child processes his environment in a different manner from the normal child. This will ultimately make his success on tasks slower.

### Transitional

(1) Conservational responses. Of the twelve children, seven were considered to be in the transitional stage on one or more of the conservation tasks. All justified one or more of their conservational responses by using identity. Four (56%) based their arguments on reversibility. None used compensation.

This was similar to what Piaget and Inhelder (1969) found in their studies, "Identity does not necessarily precede reversibility, but results from it implicitly or explicitly."

(2) Dimension. Of the seven subjects who were considered transitional on one or more of the conservational tasks, all (100%) based their arguments on some task by using dimension. All subjects based their arguments on some tasks by using one dimension. Five (71%) were based on two dimensions.

(3) Amount. Of the seven subjects who were considered transitional, five (71%) justified some of their arguments by using amount.

(4) Unusual responses. Unusual responses can again be classified under the two general categories of: (1) relational or other terms; (2) physical and personal experience. Some examples are:

Relational or other terms

#6 & #11 (9,6 & 10,5) For conservation of weight said, "they're the same because they're the same size."

#5, #6 & #11 (9,6; 9,6 & 10,5) For conservation of volume said, "they're both the same heavy," weight being substituted for size.

#6 (9,6) For conservation of liquid said "I have more because the glass is heavier."

Physical and personal experience

#6 (9,6) For conservation of liquids said, "you have more because mine is like a swimming pool; it's round and little."

#8 (9,7) For conservation of volume (pieces) said, "they're the same because the pieces will stick together when they get wet."

#9 (10) For conservation of length said, "We would walk the same length but different; one is harder to walk, they're different things; the pieces are shorter; we go up and down."

#11 (10,5) For conservation of length said, "We would walk the same length, but one is whole and the other is broken. I have to turn all these blocks."

Of the seven subjects who were considered transitional on some task, five (71%) based their arguments on unusual responses.

### Summary of Transitionals

Many responses observed in the transitional stage were similar to normal children in the sense that some responses affirmed conservation and others denied it. In Appendix D, initial conservation responses on most tasks were incorrect, with vascillations within each task, while countersuggestions were mostly correct with the following exceptions:

#6 (9,6) For conservation of liquids when told that a little girl argued that no matter what, we have the same amount to drink, commented "it's the same drink, not the same amount, some are low and some are high."

#11 (10,5) For conservation of volume commented, "same size doesn't mean nothing."

#3 (8,4) who had been constantly arguing with the boys in his class and was always told by them he was dumb, reacted to "another boy said. . ." by continually changing because he felt the other boy was a member of his class, said, "everybody tells me I'm dumb, I'm not special."

Arguments justified by the use of two dimensions increased, although the parameters were not coordinated. Justification by sensory, figurative elements or "don't know" were not observed.

### Concrete operationals

(1) Conservational responses. Of the twelve children, eight (66%) were considered to be in the concrete operational stage on one or more of the conservation tasks. Their justifications to the various forms of conservation were based on identity, reversibility and compensation. Of the eight children, seven (87%) based their arguments on identity on one or more of the conservational tasks. Three (37%) based their arguments on one or more tasks on reversibility. Conservers generally gave correct justifications to all forms of

conservation questions including resistance to countersuggestions.

(Appendix D).

(2) Dimensions. Of the eight children who were considered to be in the concrete operational stage, two (25%) made reference to one dimension in the first transformation, which might have been an orientation process.

(3) Unusual correct responses. Other responses of interest in operational children were:

#3 (8,4) For one-to-one correspondence said, "they only look like they're more, but not really."

#4 (8,9) For conservation of liquids said, "it's the same amount; only thing is, I switched mine to little glasses for the party."

#7 (9,7) For conservation of matter said, "If it's wild onions before, it's the same no matter what you do to it."

Many responses observed in operational children are similar to normal children, in that their justifications to various forms of conservation are mainly based on identity, reversibility and compensation. These findings show that the thought process whereby the blind child achieves conservation and articulates it is also a means of showing that: (1) by organizing his concepts as he interacts with the materials, increases his familiarity with the properties of the materials and their dimensions, and indicates what happens when these materials are transformed; (2) blindness itself also shields the varying nature of the object, and fosters pseudo-conservation; (3) the manner of expression is in terms of actions that are familiar to the blind child, and that from these forms of thought, operations must be deduced and might not be those generally used by normal children.

### Pseudo-Conservation

Although Piaget infers that the child arrives at the conservation inference through mental operations of reversibility and logical multiplications, other researchers have found that "it is possible to maintain an identity concept through shielding the changing dimension and forcing attention on the unvarying nature of the object" (Elkind & Flavell, 1969). In other words, the transformation or perceptual change was not included in the thought process. This was encountered in one of the subject's responses to one-to-one correspondence.

#1 (6,5) (If moved will we have the same amount?) "If you take one away we won't," (transformation made - Same amount?) "yes, because I counted them."

It appears that the subject ignored the transformation. What was important to her was the concept of same amount when a number could be given independent of the change in position.

Also noticeable is the way in which the blind child can change his concept when he interacts with the materials

#3 (8,4) For conservation of matter agreed to the balls' equality initially, but once transformed into a hotdog, he said "mine's skinnier"; when transformed into pishape, he said "we have the same amount of clay" -- (pieces) he said, "when I rolled it up before, it was the same."

Each time it was reversed, he stated "it's always the same." This was said with surprise. At first he paid attention to one dimension, then focused on the amount of clay. He justified his argument with reversibility when he realized it was always the same when the experimenter rolled it up.

## Responses of Other Reasoning Tasks

### Class Inclusion

Of the twelve subjects, three (25%) were considered pre-operational, four (33%) transitional, and five (42%) concrete operational. Of the five children who were considered to be at the concrete operational level of thought, the responses observed were not qualitatively different from those of normal children.

Transitional children had no problem in distinguishing the qualities which define membership in the logical class or in differentiating between the objects. However, one (25%) subject #2 (7,9) could not make a comparison between the sub-categories. "Which bunch is greater, the round blocks or the square block?" He also could not deal with subtraction of members of the class. "If I give you the square blocks, what remains in my bunch?" His response was "none." The question that posed the greatest difficulty was "In the world, do we have more wooden blocks or square blocks?" All transitional children stated they were guessing. Three guessed correctly, and #9 (10) stated "Oh my God, the world! I'd say square because the world is a completely different story."

### Pre-operational children

One of the pre-operational children (33%) had difficulty with subtraction of members of class and, when asked, "If I give you the square blocks, what remains in my bunch?", he replied, "big." This probably referred to the different size of the wooden blocks, but he would not elaborate. All three children stated they did not know if

there were more wooden or square blocks in the world. One child #1 (6,5) stated, "I never counted them."

Aside from the fact that class inclusion is a concept that requires the coordination of various operations, the greatest difficulty encountered by the blind child was his inability to deal with concepts beyond his immediate grasp.

#### Change of criteria

Of the twelve children, seven (59%) were considered to be pre-operational, four (33%) transitional, and one (0.8%) concrete operational.

On closer examination, the task which called for the child to form his own system of classification, or make new arrangements of the elements, the child #7 (9,7) who was considered to be in the concrete operational stage of thought by changing criteria, gave three types of responses, two of which were the same; "low ones and high ones" and "fat and skimpy." Therefore, no subject conserved when faced with a change of criteria.

What was noticeable was the preference to express thick and thin in terms of fat and skimpy or skinny, although the examiner used thick and thin. Five (42%) of the children used these terms.

No child made families or groups of large and small, although this was initially noted by all children.

#### Rotation of beads

Of the twelve children, two (16%) were considered pre-operational, three transitional (25%) and seven (59%) concrete operational.

Although the responses of all stages were not qualitatively different from those found in normal children, the process by which the blind child justified his responses may be in question because of the nature in which the task was administered. Because the child held both ends to feel the rotations, memory from perception of senses was in question, rather than his deducing that the rotations were understood.

One child thought that 'B,' the middle bead, would come out first.

#### Summary of Reasoning Tasks

An analysis of the pattern of responses in the blind child by task and stage revealed that the cognitive development or thought process was similar to those found in studies done with normal children. Achievement of these tasks by blind children was functionally different and specifically slower because of the difficulties encountered in three areas of structure of thought. The features of this pattern are as follows:

1. Previous levels of thinking. Throughout the stages, blind children often continue to use terms that are a part of previous levels of thinking which do not explain the complexity of the operation. Instead the terms are ambiguous (big, less, lots, whole, etc.), and cannot be applied adequately to operations which require compensation or coordination between parameters. Also, the figurative aspect which is the static state of the object or movement, exemplified in perception, image and memory does not lend itself to understanding the transformation of the operation for successful achievement.

2. Misunderstanding or ignorance of terms. Some children did not know or understand the basic vocabulary of the tasks, making it difficult to integrate language and thought into concepts such as: "What is pishape?"; "Can I make a sausage instead of a hotdog?"; "What is volume?" Relational terms (longer, skinnier vs. fatter, etc.) created the most difficulty which appeared to be exacerbated by confusion of spatial orientation (left vs. right, higher vs. lower). This was clearly observed in the responses dealing with anticipation.

3. Personal inexperience or limited experience. Many children attempted to recall previous experiences of walking, drinking, and other experiences which would help in the concept of reasoning tasks. The result of many attempts was that these concepts were not clear enough to aid in correct justifications. The information obtained from the experience was limited to the following: one subject insisted it was the same walk, but different, in that one was a crooked walk and one was a straight walk. Both statements were correct according to the way he was taught to walk. Other children had no idea of the process. "How are we going to put all these pieces together again?"

#### The Relationship of Mental Imagery to Reasoning Tasks

The method of five reasoning tasks which were adapted to examine the relationship between mental imagery and conservation of quantity in blind children was extremely simplified in comparison to the tasks done with normal children by Piaget and his collaborators in Mental Imagery in the Child (Piaget & Inhelder, 1971). Although the method used was incorporated within the reasoning tasks, the adapted

method for mental imagery was extracted and condensed here for clarity.

In this study, the general adaptations were as follows: Prior to the transformations in each task, the subject was questioned as to how he imagined what the results of the quantity would be if the object were changed. In other words, he was asked whether there would be the same amount when transformed. On some tasks, the subject was also asked to demonstrate what he thought the results would be when transformed and reversed.

The relationship of mental imagery and conservation were first examined. Afterwards the nature of mental imagery in the blind child was examined by the content of their responses by tasks.

#### Relationship

Conservational responses of nine children, tested and judged to be in one of the three stages of five reasoning tasks given to demonstrate mental imagery, were correlated with successful and unsuccessful anticipation as shown in Table 6. The purpose was to examine the relationship of mental imagery and the child's ability to conserve.

The numbers shown in Table 6 were the types of anticipations given as opposed to the correct (conservers) or incorrect (pre-operational and transitional) conservational responses that were asked within each task, e.g., of all the children examined who were pre-operational on conservation of matter, five correct anticipations were justified by incorrect arguments for conservations. Results were as follows:

Pre-operational children. Only one response had a correct anticipation and conservation response. Fifteen correct anticipations

TABLE 6

RELATION OF ANTICIPATIONS AND OPERATIONS

	<u>Pre-Operational</u>		<u>Transitional</u>		<u>Concrete Operational</u>		
	C	HC	C	HC	C	HC	
Matter	SA	////	5	////	1	1	
	UA	////	9	1	1	////	
Weight	SA	////	4	////	1	1	
	UA	////	6	1	4	////	
Volume	SA	1	2	3	4	1	////
	UA	////	5	////	5	////	////
Liquid	SA	////	1	////	2	7	1
	UA	////	8	1	5	////	////
Length	SA	////	2	////	2	5	////
	UA	////	9	2	2	////	////

SA = Successful Anticipations UA Unsuccessful Anticipation  
 C = Conservers HC = Non-Conservers  
 ///// = No responses of this type

were given with non-conservation responses. Nine incorrect anticipations were given with non-conservation responses.

Transitional children. Three correct anticipations were given with conservational responses. Five incorrect anticipations were given with conservational responses. Ten correct anticipations were given with non-conservational responses. Seventeen incorrect anticipations were given with non-conservational responses.

Concrete operational children. Twenty-six correct anticipations were given with conservational responses. Two incorrect anticipations were given with conservational responses. Two correct anticipations were given with non-conservational responses.

It appears that for pre-operational children, more (37) unsuccessful anticipations were given with non-conservational responses, and less (15) successful anticipations with non-conservational responses. For transitional subjects, although the above was similar, more (5) gave unsuccessful anticipations with conservational responses than successful anticipations with conservational responses (3). For concrete operationals, if the conservational response was incorrect, the anticipations were successful.

#### Content of Responses by Task

The discrepancy appeared in the blind child more frequently between demonstration and achievement of the operation, or between what he imagined and what really happened.

In Table 7, only the anticipations and conservational responses to the three transformations of each conservational task were shown. However, within each task, in addition to the above anticipations,

TABLE 7  
RELATION OF ANTICIPATIONS AND OPERATIONS BY  
SUBJECTS, STAGE AND ORDER OF RESPONSE TO TRANSFORMATIONS

Overall Level		Subject	Conservation of Matter	Conservation of Weight	Conservation of Volume	Conservation of Liquid	Conservation of Length
Pre-operational	#1	1/4 4	1/4 4	1/4 4	1/4 4	1/4 4	1/4 4
	#2	1/2 4	1/2 2	1/4 4	1/4 4	1/4 4	
	#10	1/2 4 4	1/2 4 2	1/4 4	1/4 4	1/2 2	
Transitional . .	#6	1/4 2 4	1/4 2 4	2/2 2 2	2/2 4 3	2/4 2	
	#9	1/4 2 4	2/4 3 4	2/1 1	1/4 2 4	1/4 4	
	#11	3/2 3 1	2/4 3 2	2/1 4 4	2/2 4 3	2/4 2	
Concrete Operational	#3	2/4 3 2	3/3 1	2/4 1	3/2 1 1	2/4 4 1	
	#8	3/1 1 1	3/1 1 1	2/4 4 2	3/1 1 1	3/1 1 1	
	#12	3/1 1 1	3/1 1 1	3/1 1 1	3/1 1 1	3/1 1 1	

1= Correct Anticipation and conservational response  
 2= Correct Anticipation and non-conservational response  
 3= Incorrect Anticipation and conservational response  
 4= Incorrect Anticipation and non-conservational response

Numbers in left hand corner of each cell represents stage of achievement by task  
 Numbers in Lower box represent, type and order of response for each transformation.

other questions were asked, and findings will be given on examination of that task.

### Matter

In this task, the subjects were asked before each transformation (hotdog, pleshape and pieces) to anticipate: (1) whether there would be the same amount if the clay were transformed, after the transformation and usual conservation questions; (2) if reversed, whether they would still have the same amount, and (3) if they chose from three different size balls, which one the transformed ball would be like if transformed back.

1. Transformation. In other studies (Piaget & Inhelder, 1971), the initial response of non-conservers to transformation was that the quantity of matter would not be the same because of the form change. The subject attended to the change which affected one dimension, while the other was negated. This was not entirely the finding here by non-conservers (pre-operational and transitional). Of the six subjects who were non-conservers (Table 7) three initially anticipated correctly and three did not. Of the three conservers, all initially anticipated correctly.

2. Reciprocal anticipation. Initially five of the nine children said, "Yes we will have the same amount." One said, "I don't know." One said, "They wouldn't be the same," and one vacillated. However, when the second transformation was made all said "Yes we will have the same amount." After the third transformation was made, two children again didn't know. This clearly indicated transitional thinking.

3. Demonstration. Seven children chose the same size ball regardless of their previous anticipations. This could suggest that they were responding more concretely to what the examiner asked and were comparing it to their ball by weight or size in their hands. However, two children did choose larger balls: one anticipated that the ball and hotdog were the same, and one did not know whether the hotdog and ball were the same.

### Weight

In this task, the subject was again asked before each transformation to anticipate: (1) whether they would weigh the same if the clay were transformed, after the transformation and usual conservation questions; (2) if reversed whether they still weighed the same. However, when each transformation was made and questions justified, the child was allowed to weigh the ball and the transformed pieces.

1. Transformation. Of the six subjects who were non-conservers, two initially anticipated correctly and four did not. Of the three conservers, two initially anticipated correctly and one did not.

2. Reciprocal Anticipations. All subjects agreed it would weigh the same. Apparently the weighing influenced their responses, because when asked to anticipate the next transformation their responses varied.

### Volume

In this task, after equality of balls and similar containers with equal amounts of water was established, the subject was asked: (1) what he imagined would happen to the water level if the clay balls

of equal size were dropped into similar containers; (2) to demonstrate whether the water level would be higher, lower, or the same when one ball was transformed; (3) to determine whether the water level would rise in the same manner if a glass ball equal to the size of the clay ball (both were felt) were dropped into similar containers.

What happens to the water level? The subjects' anticipations of what might happen to the level if the clay balls of equal size were dropped into similar containers illustrate the many aspects of a concept formation in the blind child, and show that he screens out and integrates his thinking before his imagery approximates the normal child. Important here is the discrepancy between anticipation, demonstration and conservation. The blind child's attempts at integration can be seen in the following examples:

#1 (6,5) the youngest subject, when asked (What happens to the water level?) - "Gets higher or lower, ball gets soft." (When asked to demonstrate) she could not; nor could she respond to any conservation questions.

#2 (7,9) (What happens to the water level?) "Gets lower." Even after he was allowed to dip the balls, he stated that the level was lower. (When asked to justify his argument of conservation) - he stated, "Because the water would get lower in both."

#3 (8,4) stated he didn't know what would happen to the water level, because he never dropped anything in water before. Once he dipped both balls, he stated that the water level was higher. Ultimately he justified his conservational responses by stating, "I didn't change it."

#4 (8,9) said, "If you put something in water, the level goes up, because it gets heavier like, so it would rise up." (What asked what gets heavier) "Clay." (When asked again about the water level) "If same size, it will rise the same." (hotdog) "Won't rise the same because the hotdog is heavier." - (pieshape) "Won't rise the same because you flattened it and smashed the side down." - (pieces) "The little pieces are lighter." He was able to conserve with the glass ball but not the clay ball "It's the

same size." All other children had difficulty with this except one who was a conserver.

#5 (9,6) said "If you drop something in water, the ball will melt, and the water will get clay-like." (Water level?) "The clay rises and picks up the water with it, so it would be higher." Although the reason for his anticipation was incorrect and his demonstration correct, he was able to justify his conservational response by saying "They're the same because it was the same amount of clay before."

#6 (9,6) What is interesting about this subject is that although he was correct in his anticipation and demonstration, said, "The ball will go down, water will go up a little because the ball is heavier than the water," he was able to conserve by his past experience of weight - "They weigh the same." However, this inhibited him when it came to the glass ball, "It won't be the same, because the clay ball is heavier."

#9 (10) anticipated that the ball would melt, and the water level would get lower - yet he was able to conserve when the clay ball was transformed by "Both are still the same size." When given the glass ball, he could not conserve because "The glass ball is heavier."

#10 (10,2) said, "Nothing will happen to the water level, but the ball gets soft and the water gets nasty." Since he did not understand level, the task had to be discontinued.

#11 (10,5) said "The water level would get bigger." He justified his conservational responses by weight. "It was the same on the scale; water will rise the same." This inhibited his responses for glass ball and clay ball; "The glass ball is not as heavy as the clay ball."

#12 (11) the oldest, who was a conserver, stated, "Clay will absorb some of the water, the water level will go down; it will decrease." He justified his conservational responses by the same size; however, when it came to glass ball and clay ball, he said, "They're the same because the glass ball doesn't take in water either."

These findings appear to indicate that the achievement of operations in blind children is different. It derives from discrete representations of past experience (reproductive), such as dropping things in water (melt, float, absorb); inexperience, personal experiences of size and weight in their hand; past experiences of weight with

other tasks and imagery of the transformed ball. All of these relate to his ability to reason and demonstrate, but they do not determine whether he can conserve or not. One could infer that being dominated by these images of past experiences, which are often misunderstood or not taken as integrative totalities, they cannot serve as a base for operations, and in fact might even impair achievement.

### Liquid

In this task, before the liquid was poured into different containers the subject was asked: (1) to anticipate and demonstrate the level when the liquid is poured into 'B' then 'C'; (2) to determine whether there would be the same amount to drink once the liquid was poured into 'B,' 'C' and small glasses, after the usual conservation questions; (3) to state if reversed, whether he would have the same amount to drink.

1. Level. Of the two children who were considered conservers, one correctly anticipated and demonstrated the two transformations, and one initially anticipated and demonstrated same, then correctly anticipated for 'C.' Of the seven who were considered non-conservers, there were three correct anticipations and demonstrations for 'B' or 'C.' Three children initially anticipated and demonstrated that 'B' would be the same. One initially anticipated the same and pointed higher. For 'C,' three children anticipated and demonstrated that the level would be the same; two anticipated the same and pointed higher; one anticipated higher and pointed lower.

2. Transformations. Of the six children who were non-conservers, two initially anticipated correctly and four did not (Table 7). Of the three conservers, two initially anticipated correctly

with conservation responses, and one anticipated correctly with a non-conservation response.

It appears that anticipations and demonstrations had nothing to do with the stage of conservation found, rather, they processed information as the result of the transformation itself; some examples are:

#1 (6,5) initially anticipated correctly the level in 'B' to be higher - (Same amount to drink?) "No, Yes." (poured - Do we have the same amount?) "The water is almost to the top in both." In glass 'C,' the level was also anticipated to be higher - (Same amount?) "I don't know."

#6 (9,6) initially anticipated the level in 'B' to be the same - (Same amount to drink?) "No, Yes." (poured - Do we have the same amount?) "Yes." (Why?) "Because this glass is heavier; no it's bigger." in 'C,' the level was anticipated to be the same. (Same amount to drink?) "No."

#9 (10) initially anticipated the level in 'B' to be higher, then changed to lower - (Same amount to drink?) "No." (poured - Do we have the same amount?) "No." (Do I have more?) "No." (Do you have more?) "Yes." (Why?) "Because my glass is higher." - In 'C,' the level was anticipated to be the same. (Same amount to drink?) "Yes."

The findings were similar to those found by Piaget (1971), but were not confined to age groups or stages. It appears that incorrect anticipations and demonstrations did not interfere with conservation for the blind child, but were composed of past experiences, personal experiences of the operation (incorrectly assuming that glasses were almost filled or that one weighed more than the other), modification by experience of the first transformation, and negation of the fact that water levels had anything to do with conservation. All of these are contributing factors that might influence thought process.

### Length

In this task, once equality of length had been established, the subject was asked: (1) to anticipate before each transformation, "If the rods were moved whether they would still be of the same length; (2) to point or demonstrate before the transformation where they would stop if they were moved. After the usual conservation questions to determine; (3) if reversed whether they would be the same length.

1. Anticipation. Of the two subjects who were conservers, both anticipated correctly, that if moved, rods would be the same length, and if reciprocated they would be the same length. Non-conservers incorrectly anticipated that if moved they would be the same length. However, they did agree that if placed again in their original position they would be the same length.

2. Demonstration. When asked to demonstrate where it would stop if moved, only one child who was a conserver was consistently correct in anticipating where it would stop by pointing, in addition to his giving correct conservational justifications. However, what was most notable in the blind child was his disorientation to space (horizontal vs. lateral, left vs. right or backward vs. forward).

This posed the problem of the role of topological (spatial) factors in the development of operations. Some examples of the mentioned topological problems in space were:

#1 (6,5) initially pointed correctly to the right, then when asked to demonstrate the second transformation (L), didn't know where it would stop.

#3 (8,4) had no idea where it would stop - to the (L) or (R)

#8 (9,7) pointed to three irrelevant places initially; then he was shown by the examiner what was meant by right. On

the second transformation he correctly identified left.

#9 (10) continued to be confused even after being shown, throughout all transformations. He pointed vertically, horizontally and even to places on top of the other rod.

#11 (10,5) constantly used the terms "here" and "there" and "spaced different," but had no idea of direction.

Some findings were similar to Piaget's (1971) in that the confusion appeared to be one stemming from the role of the ordinal referent in the evaluation of the transformation (i.e., further and longer) and from the equality based on the projection of the rods themselves. These were images of reproduction (past experiences). However, the blind child had difficulties with the topological aspects of the configuration which played a specific role in the conservation of length.

#### Summary

The analysis of mental imagery and operations in the blind child revealed as found in Piaget's studies, incorrect imagery did not hamper the achievement of conservation. In fact, conservation appeared to correct imagery within the structured task after conservation had been achieved.

It appeared that imagery in the blind child was reproductive, and his ability to anticipate the results of transformations were based on experiences previously learned, or learned within the context of an operation.

What the analysis of mental imagery and operations pointed out was that the blind child struggled with integration of his experiences which produced a slower, painstaking pace of functional cognitive development. Mental imagery in this study highlighted domains of

difficulty in the blind child which pointed to the importance of factors which were taken for granted by the sighted. The factors that were not fully understood by the blind child specifically were: relational terms, topological factors, meaning of words, mechanisms of operations, integration of past experiences and the concept of operations.

#### Qualitative Analysis of Anecdotal Data

The purpose of analyzing the data qualitatively by subject was to allow a better integration of the contributing factors that influenced the blind child's thought process, and attempted to present him as a whole person. However, all subjects do have blindness in common, and it is with this in mind that the following factors were taken into further consideration: (1) Four children were not blinded until five years old or older; (2) Although the total population had a mean Verbal IQ of 108.25, the IQs ranged from 63 to 133; (3) Each was faced with different parental and societal attitudes, which influenced his emotion and affective stability; (4) Many children did function appropriately within the normal age range, but they should only be compared to the sighted in order to provide greater understanding of ways to apply this knowledge to the blind for maximal growth in their intellectual world.

#### Subject #1

Subject #1, who was the youngest child, six years, five months, was blinded from birth by high oxygen content in an incubator. This was her first year in public school, but she had previously attended nursery school for three years at the Lighthouse. Her teacher felt

that she was extremely bright, eager to learn, and might feel "left out" if she were not included in the research. Her parents felt the same, since they wanted her to have every opportunity available that might increase her psychological and intellectual growth.

She achieved a Verbal IQ of 124, and has an above-average command of English which she used fluently. Her thought process was of the type seen in normal children of her age. She demonstrated this by figuratively referring to the object or movement and by taking into consideration one dimension, expressed in amount, and by negation of the other. Her overall performance (Table 1) was 1.2 or pre-operational. Some of her representations were:

The manner in which she used relational terms: "We both have more" meant same; however, she used "equivalent" and "equal" in many instances instead of "same" as the examiner used. Their meaning was not understood. She could never justify the terms themselves.

Her lack of experience was manifested by her question: "How do you make a pishape?" However, she attempted to integrate this new experience from a past experience. To her, the pishape felt like a circle compared to the ball, but she negated the transformation itself. This was also seen in liquids in her attempt to determine whether there was the same amount to drink by lifting the glasses to feel their weight with the liquids, or by feeling the water levels with reference to the top of glass.

She was also a pseudo-conserver on one-to-one correspondence. The transformation or change in position meant nothing with reference to the quantity. Her only concern was that one would not be taken away.

Certainly her educational advantages and her eagerness to learn were greatly influenced by her parents' attitude, but the focus of her learning should be such that she can understand and appropriately modify and transfer her learning experiences.

Subject #2

Subject #2 was a bright boy, seven years, nine months, who was blinded from birth. He came from a large family. His mother's greatest concern was that he be treated no differently from normal children. She phoned the examiner and talked at great length, stating that she treated him no differently than she did her other children. In fact, she encouraged him to do more than the others. At her insistence, he was being bussed from a great distance to be integrated into a normal class. His independence was noted during testing by the particular attention he paid to all cues and his asking questions repeatedly for clarity, such as: how many inches the rods were. Later he referred to them by sixteen inches and four inches.

He achieved a Verbal IQ of 129. His overall performance was 1.4 or pre-operational (Table 1). His thought process was also of the type seen in pre-operational normal children, in that reference was made to one dimension with negation of the other. However, his understanding and integration of experiences were better than average for the blind child with the exception of his misuse of relational terms (higher is to rise above and lower is to go below). For example:

For conservation of volume, when asked to anticipate what would happen to the water level, he stated, "It would get lower." He was then asked to put his hand in the water, drop the ball, and feel what happened to the level. When the ball was dipped and the water rose over his fingers, he said, "I told you it would get lower."

Although his mother's attitude was to expose him to a vast amount of experiences, it appeared that his needs were unable to be fulfilled without the help of another to clarify his understanding.

Subject #3

Subject #3 is a "foster" boy, eight years, four months. He became totally blind at five years of age, but had poor eyesight from cataracts for some time. He was quite insecure, because he had been shuttled from one foster home to another most of his life.

He was considered disruptive in his class not only by his teacher, but by other classmates who constantly told him he was dumb, and that they did not want to be bothered with him. In spite of his many disadvantages, he wanted to be liked, and attempted to do so by being a comedian and "fooling around." This was reflected in some of his responses which influenced many ratings. He would say things such as "Yes, no, maybe so"; attempted to be a magician by making the materials disappear in his pocket and stated that they could not be the same. This behavior seemed to indicate that his potential was higher than his actual performance.

He achieved a verbal IQ of 95, and his level of thinking was of the type seen in normal children. His overall performance (Table 1) was 2.5 or concrete operational. What was questionable was his resistance to justify his anticipations and his responses to conservation questions, such as:

In conservation of length, as in normal children, the confusion between further and longer persisted. However, when asked to demonstrate where the rods would stop if moved (left or right), he would not respond. It was hard to tell whether he didn't know left from right, was fooling around, or he didn't think it was necessary by his conservation responses: (When asked if moved would they be the same length?) "No." (When transformed, Same?) "No." (Why?) "None's longer; they're both the same length."

The reason for his hesitation or confusion could be attributed to his lack of direct experience with the operation, by his statement

for volume, "I never dropped anything in water before." Because of his general overall insecurity, he was never quite sure of himself, and, although very aggressive, really did not want to look like a fool.

#### Subject #4

Subject #4 was an extremely polite, eight years, nine months old girl, who had been blind from birth. Her family did not accept her blindness as permanent, and were extremely protective. They did not allow her to start public school until late, and then did not want her to learn braille. They did not speak English, but spoke to the examiner and teacher several times through an interpreter. They had to be reassured frequently that she was not being singled out or subjected to any mental stress by the examination.

She achieved a verbal IQ of 114. Her overall performance (Table 1) was 2.1 or transitional. However, her thinking vacillated between all three stages of thought more than any other child. Her tactile sense of perception was extremely acute. She guided her fingers over every aspect of the materials and outlined the configuration of each operation before responding. She touched her face with the wooden rods, the blocks, and plastic material to confirm and understand what the examiner said they were made of. She also smelled the water, to decide whether it really could be drunk or not. All of this seemed to indicate that, in using every sense available, her achievement was based on how well she understood and was able to integrate this experience.

She achieved conservation in many instances by making it a game, as in 1:1. She stated that they were holding hands before, and

"now they're not, but they're still the same." For liquids, she stated, "I only switched mine to small glasses for the party, but they're the same."

Notable were her elaborate explanations without adequate or correct experience. They did influence her thought process when trying to reason, and contributed to her confusion. For example:

For conservation of matter, her justification for pishape and ball not being the same was "Because mine looks like a big pancake, and it's flatter. And if you flatten things out, it gets to be bigger and bigger and bigger." For pieces, she stated she had more because "If you break things into pieces, more and more pieces will break up, and more and more stuff comes out." When asked about reciprocation, she stated, "My ball feels bigger because we did so many things with it."

Although #4 used many other senses in trying to deal with reasoning with the tasks, her parents' inability to accept her blindness greatly influenced her thinking. The vacillations of thinking were reflected in her use of "looks like" at times and "feels like" at other times. Her elaborate explanations appeared to be "parroting" her parents, who attempted to explain concepts in a sighted manner, which did not contribute to her understanding, nor did it assist in her transfer of learning.

#### Subject #5

Subject #5 was an enthusiastically bright boy of nine years, six months, who had been blind since birth. He held your attention because of his wild fantasies and vivid imagination. He was apparently supported in them by his parents who traveled extensively, and always took him with them (his father was a pilot). He described scenes he saw when traveling, in minute detail, even recalling what the outline

of islands looked like from the air, as if he really had seen them. He wanted so much to be accepted as sighted, that he stated he had a computer in his brain that replaced his eyes. However, what was of interest was that he became angry with his mother because she would not teach him to tie his own shoes.

He achieved a Verbal IQ of 133. His overall performance (Table 1) was 1.8 or transitional. His thinking was appropriate for that stage, but not for the normal age. Noticeable was his inability to integrate adequate conversational thinking into task achievement. On most reasoning tasks, he correctly described both dimensions of each object, such as, "the ball is fatter and shorter," and "the hot-dog is skinnier and longer"; however, he failed to coordinate these relationships to justify the presence of conservation. For example:

For conservation of liquids, after the transformation of 'C,' when asked, (Same amount?) "No." (Do I have more?) "Yes." (Do you have more?) "No, Yes." (Why?) "Mine's wider and shallower, and the water is lower, and yours is higher, and the sides are closer together making the water higher."

What he appeared to lack was the experiencing and understanding of his concepts, which hindered his task performances. Apparently, in his parents' attempt to become his eyes, it was at the expense of physical and personal experience. This left him with his own imaginations which he longed to confirm.

#### Subject #6

Subject #6 was a timid soft-spoken boy of nine years, six months, who had been blind since birth. He did not talk much about himself, and little was known about his background.

He achieved a Verbal IQ of 110, and his overall performance on reasoning tasks was 1.9 or transitional (Table 1).

What was most obvious was his concrete thinking and his total reliability on tactile senses as to how something felt, or as he said, "looked like," in order to reason and conceptualize tasks. For example:

For conservation of matter, he stated, "They are not the same amount because you have a ball, and I have a hotdog." or "Yours is a pie and mine is a ball."

For conservation of weight, when asked whether they weighed the same, his responses were, "They feel the same," or "They don't look the same."

For conservation of liquids, he stated they were not the same when referring to how heavy the glass felt to him when he picked it up, or to how high up the water came to his fingers.

For conservation of volume, he conserved because he said they all weighed the same.

For conservation of length, reference was made to how he learned to walk. He stated it wasn't the same walk because "I must walk crooked and go around these curves, while you just have to go straight."

In addition to #6 making reference to the characteristics or external aspects of the object, he was unable to recognize the different elements of quantity that belong to the different conservations. Indeed, he was experiencing, but not with understanding.

#### Subject #7

Subject #7 was an extremely active boy of nine years, seven months, who had been blind from birth. He was extremely confident in his responses, and felt that the questions were childish. One example of this was the statement, "Even if it's wild onions before, it's the same no matter what you do with it." It was hard to believe that he

was always blind. Unfortunately, little was known about his background.

He achieved a Verbal IQ of 110, and was the only child who was blind from birth whose overall level of achievement on reasoning tasks was 2.9 or concrete operational (Table 2). He mainly justified his conservational responses by identity and reversibility, and had a good understanding of the operations.

#### Subject #8

Subject #8 was a quiet boy of nine years, seven months, who was the most recently blinded child. He was still in the process of a long series of operations for cancer of the eyes, and had not been totally blind until seven. He was now attempting to make an adjustment to his blindness, an illness that he did not understand.

He achieved a Verbal IQ of 108, and his overall level of achievement on reasoning tasks was 2.7 or concrete operational (Table 1). He spoke as a sighted child (which confirmed other researchers' beliefs that visual imagery is retained after age five), an observation made during explanation on one-to-one correspondence: "there are places in between which are empty, and that makes them look like more, but they're really the same." What was most notable was the way he was adjusting to his loss of sight by replacing it with his sense of touch. This was often misleading. For example:

For conservation of liquids, once the water had been poured into different containers, he knew they were the same amount, but he attempted to determine levels by feeling with his fingers. When compared they were always the same to him, instead of higher or lower.

For conservation of length, when asked to demonstrate where it would stop, he pointed to three different places instead of left or right.

Concepts that he had taken for granted when sighted could not be demonstrated now. The difficulty here appeared to be an adjustment to blindness, specifically, the use of spatial referents, not conservation.

#### Subject #9

Subject #9 was a bright ten-year-old boy, who had been blinded since birth. He appeared to be very insecure and uncertain of his responses or of what was required of him.

He achieved a Verbal IQ of 123, and his overall performance on reasoning tasks was 1.8 or transitional (Table 1). The uncertainty reflected in his responses, or the fact that he could never make up his mind was shown in some of the following examples:

For conservation of matter, when asked, (If we make a hotdog will it be the same?) "No." (Can you make a hotdog?) "I think I know how it goes." (If reciprocal, same?) "Yes." (Choose which one it would be like.) He can't make up his mind; finally chooses "same." After transformed back into ball - (Same amount?) "Don't know." He then puts one ball on top of the other to measure size and shape, and says, "Yes." then "No, yours is bigger, because yours was not changed into a hotdog." For piesshape, there was the same uncertainty.

For conservation of length, he pointed to three places before the examiner demonstrated what moved or what left-right meant.

For conservation of liquids, when asked to demonstrate the water level, he pointed to higher and said "lower."

In countersuggestions, what was notable was that he not only agreed to the correct countersuggestion, but said he didn't know why he said the other things. He attempted to justify his incorrect

conservation responses by saying "She's right, but maybe she didn't know that four pieces not being together makes shorter roads of one long road."

In addition to his misunderstanding of relational terms and the use of spatial referents, it was unfortunate that not enough was known about this child to determine the factors contributing to his insecurity and uncertainty. Both greatly influenced his performance on reasoning tasks.

#### Subject #10

Subject #10 was a regressed ten years, two months old boy, who had been blinded at age five by glaucoma. He had adjusted very well when originally placed in the public school setting. He had been tracked into sighted classes by his special teacher, but was then moved to another school. Here he was not given the support nor the consideration of his former teacher who had given him confidence and understanding. He psychologically and physically withdrew from his environment and became so immobile that he would not walk without assistance. His parents then requested that he be returned to his former school and teacher.

Regression as referred to here is one of the classifications of conflicts and disorders. As discussed by Wolman (1972), it is that regression which causes the developmental process to return to an earlier stage, and can be assumed to be successfully reversed "so that development can be redirected to its proper path and once more proceed in a normal manner."

When tested, he was just beginning to come out of an autistic type existence. Because of this dramatic regression, the teacher wondered whether he would even be able to concentrate enough to follow the operational task. The behavior manifested was his wanting to eat the clay, and drink or play with the water. He wandered around the room touching materials and other articles without responding to the questions of the examiner. For limited periods when he did respond to tasks, he responded correctly from past experience, or he appeared not to understand the mechanics of the requests such as, "What is pie-shape?" or "How are we going to put these pieces together again?" He also appeared not to understand the different elements of quantity.

If his teacher had not known his former potential, he might have been considered mentally retarded. The teacher stated that she had seen symptoms develop in functional areas as a result of standards and values (expressed by significant others) which the child felt incapable of living up to. The teacher also stated from her experience that it would take at least three years for him to attain his previous level of functioning.

He achieved a Verbal IQ of 63, and his overall level of achievement on reasoning tasks was 1.2 or pre-operational (Table 1). It was difficult to assess his reasoning ability because he did not appropriately interact with the materials, and most of his responses were "I don't know."

#### Subject #11

Subject #11 was a timid, soft-spoken ten years, five months old "foster" child, who was blind since birth. He achieved a Verbal

IQ of 82, and his overall level of achievement on reasoning tasks was 1.9 or transitional (Table 1).

Notable in his thought processes were his misunderstanding of relational terms, his inability to use the correct expressions for different quantities and his spatial disorientation. For example:

Several times in response to whether they were the same, he stated, "Yes, both have more."

In justifying his responses for weight, he stated they were the same because of their size or number, but made no reference to weight.

In volume, he justified his responses by saying that they were different weights, although he initially stated, "If they're the same on the scale, the water will rise the same." However, when asked about size, he stated, "Same size doesn't mean nothing."

In length, he didn't understand direction. After the examiner demonstrated, he still pointed to several places on the table which had no relation to the position of the rods when moved left or right.

In liquids he could not demonstrate where he thought the water level would be once the transformation was made.

#### Subject #12

Subject #12 was the oldest child tested. He was an outgoing eleven-year-old boy who had been blinded with glaucoma from age six. He had four brothers and sisters, and one parent who were also blind. They all had made good adjustments, and he was quite unconcerned with his blindness. While the examiner was testing other children, he sat making diagrams of places he had visited on school trips, so that he could take other members of his family because he thought it might interest them also.

He achieved a Verbal IQ of 108, and his overall level of achievement on reasoning tasks was 2.9 or concrete operational (Table 1). His

thinking was very detailed, and his ability to verbalize these thoughts was expressed very well. He took every cue into consideration and correctly justified his arguments. His response to length, when asked whether we would walk the same length, was, "Sure we will walk the same length. I mean we would walk as much as each other. One may look longer, but it's not. You turn five blocks here and five blocks there, but it's still the same walk even though your road doesn't have any turns."

Because most members of his family are blind, he has a sense of oneness, or of not being different. Apparently it is necessary for the entire family not only to share the responsibility of his blindness, but also to be on the alert for the survival of the entire family.

#### Educational Setting

Although all the subjects were in a public school setting, there were varying degrees of integration or tracking with the normal children. Every school had a designated area which was isolated from normal classes, where children with differing degrees of blindness were taught. One of these classrooms was specifically designated for those who were totally blind or had light perception only.

These students were assigned a special educational teacher who coordinated the child's activities and learning experiences. Some of these were: teaching them braille; sending them to mobility classes; taking them on trips and teaching them the basic manner in which to adjust and understand everyday living.

She was extremely protective in that she picked them up and put them on the bus, controlled their play in designated areas of the

playground and supervised their lunch period in the confines of their room. She also kept close contact with their families, often teaching some member of the family braille.

When reference was made to mainstreaming or tracking in normal classes, it was only at the discretion of the teacher, who then coded the assignments of the normal class in braille, made the corrections and did the grading herself. Most teachers were overworked and felt that this was an imposition, often retaining children within the special class instead of tracking them.

It appeared that the educational opportunities for the blind child, although housed in a normal setting, were restricted and placed at the discretion of the teachers and administration of that particular school.

#### Summary

Analyzing the data by subject in this manner seemed to confirm the findings that cognitive development and socialization were inseparable. Voyat (1975) states:

At the concrete operational period of thought, a new progress in socialization occurs: the child becomes capable of concrete cooperation. This implies that he will no longer think only as a function of himself but that he will be able to coordinate points of view, will be able to discuss, reflect, organize the exposition of ideas; in other words common rules will underlie collective activities. Above all, he is truly understandable to peers, parents, teachers and society in general.

Findings that supported the previous quantitative and qualitative analysis were in the areas of education. Some of these were: relational terms; the use of spatial referents; elaborate explanations as a result of inadequate understanding or lack of experience; incorrect

transfer of experience with misunderstanding of terms and the improper use of other senses.

However, the socialization and psychological factors that contributed to the blind child's cognitive development as reflected in this clinical approach can be classified in three areas:

1. Attitude of parents. Some overprotective parents limited the child's experience by not allowing him to do things he was capable of. Other parents rejected and abandoned these children. Some children were shuttled from one foster home to another; others started their education late. A few parents wanted over-achievers through early educational opportunities and by fostering verbalisms for their own self-gratification; others wanted their children to progress normally within their limits in order to do as well as their other children.

2. Attitude of society. Society imposes restrictions on the blind, some of which are in their best interest while others are not. Two such restrictions are isolation, and being placed at the discretion of others who do not understand that the blind child needs to socialize and exchange views with normal children.

3. Emotional and affective factors. The need to be accepted by others is one of the greatest burdens placed upon the blind child. In addition to wanting to be sighted, they want to be able to do for themselves, not to be pitied. One child was comfortable with his blindness because other members of his family were also blind. Those who could not understand the status of blindness were uncertain and insecure, not knowing what was expected of them. Those who were blinded after five had difficulties adjusting to their blindness and, in one case, regression was noted.

## CHAPTER V

## DISCUSSION

Klein (1962) states, "Blindness, I have said, is to be understood not in terms of the loss of visual function, but in the manner or organization of information provided by the residual modalities." This implies that cognitive development is not in the optical centers, but that it develops as the organism adapts to its environment by organizing into a coherent system through those senses stimulated. The process of this organized thought can only be developed by the child's understanding of reality and by his engaging in activity that will enable him to discover and construct concepts that he can understand.

Cutsforth (1951) states:

No single mental activity of the congenitally blind child is not distorted by the absence of sight. Not a single sense escapes; the sensory equipment and processes of observing are organized quite differently in the blind from the normal seeing child. His social world, like his world of objects, or perceptual world, is not the same world in which the seeing child lives. It is denying the facts to hold as a great many of our educators of the blind do, that the blind child's organization and growth can continue as in the normal child except for the absent sense.

This was the most pertinent finding in the cognitive development of the blind child. Although comparable to normal children on intellectual measures of Verbal IQ Scales (WISC), the performance of blind children on reasoning tasks was at a lower level than would be expected of normal children of the same age.

Although it was not reflected in the statistical analysis, children blinded after birth did perform better on reasoning tasks than the congenitally blind child. Seventy-five percent achieved the concrete operational stage; however, because there were only four ABB children, the pre-operational child who had psychological problems adjusting to his blindness, decreased the mean overall score, so that it appeared that the ABB children's overall achievement was transitional.

This finding supported Lowenfeld (1955) who maintained that useful visual imagery was not retained if blindness occurred before age five. All of these children were blinded after age five. Schlaegel (1953) claimed that some useful vision might be retained if blinded between three and five.

One child who was congenitally blind also achieved the concrete operational stage, and was so sure of his responses that he stated, "Even if it's wild onions, it's the same no matter what you do to it."

Cohen (1966) attempted to compromise between the two when he stated, "The child who becomes blind realizes that he will never see again and his feelings of hopelessness and despair may cause chronic anxiety and depression. Children born blind tend to be more affected by people's attitudes toward them." It cannot be clearly shown to what extent previous visual imagery was useful in task performance. Since all children regardless of stage did give responses which indicated limited experience, these responses made their organization of thought incomplete.

Researchers have inferred that age, intelligence and experience are contributing factors in cognitive development. Findings indicated

that age and IQ were not significantly correlated with task performance. Vague and inaccurate concepts of the blind child might be the result of limited and insufficient experience by which his residual senses inhibit him from being able to abstract and form concepts which are the basic elements of thought and knowing.

In isolation, the blind child is not oriented toward the collection of useful information. He does not know how to compensate by using other sensory modalities that will give him this useful information, unless he is taught to use them and unless the sighted understand his dilemma. Auditory and tactile experiences lead to different kinds of experiences from which the blind child derives his concepts and forms his symbolic thinking.

Applying the concept of equilibration and accommodation, the blind child must come into opposing points of view as he explores the nature of his environment from concrete experiences, and exchanges these ideas through social transmission. This allows him to go through the process of decentration, which develops at different ages and stages. For the blind child, Wills (1970) points out, "The danger is of course not only that the blind child will fail to find out about and so cathect the world around him, but that this cathexis will remain centered on his own body for far too long." Not only is his experiences limited, but in many instances he is unable to interpret, validate and modify concepts that lead to new structures, which in turn lead to operative thinking. Moreover, he experiences no conflict in fostering the concept of logical necessity.

Voyat (1975) states, "Reversibility and conservation are in opposition to the appearance of things. . . . The corresponding operations begin to become more stable when they can replace objects by signs (cues) and symbols (language and imagery), in short when they will be mediated by an achieved system of collective expressions." (parentheses, author's) The question becomes: what is the nature of signs and symbols that create a state of equilibration for the blind child? What enables him to progress from one stage of operation or level of intelligence to another.

Although memorizing words and operations is not thinking, many blind children depend on verbalization of experiences as a substitute for visual integration.

"Piaget observes that as long as the thinking organization is incomplete, its actions are not fully reversible. Reversibility of thinking action thus becomes Piaget's observation criterion of differentiating operation in the strict sense from preoperational activity" (Furth, 1969).

Flavell (1963) states that important features of Piaget's system of cognitive development are structures that change with age. They are the organizational properties of intelligence, which can be inferred from the behavioral contents whose nature they determine. Furth (1969) further elaborates that the ability to verbalize information relative to the operation, is only assimilated at those levels where the operation has already been internalized.

Since language is not developed in isolation, it is this symbolic function that illustrates ways in which the blind child processes

his environment and verbally transmits his understanding of it to others.

From the findings of the blind child's verbal responses and demonstrations, much can be inferred about his cognitive development. Some general findings that appeared were in contrast to the normal child. The succession and order of achievement on tasks were not the same (matter, weight then volume); success on one reasoning task appeared unrelated to any other task. Only one task, conservation of volume, was positively correlated with age. Since the overall stage of performance varied, and was considered transition, retardation cannot be implied. There was, however, a difference in perceptual integration.

Findings supporting Furth's statement indicated that the concrete operational child's justification for arguments on reasoning tasks were similar to those found in normal children. What was different was his imagery, as in conservation of volume: "What happens to the water level if the clay balls are dropped into similar containers of water?" The responses appeared to be the result of many notions of what was expected from several images of past experience (float, melt, absorb). The blind child does not ignore cues which have no meaning. It has become a matter of validating which cue has meaning for which operation.

In demonstration of spatial referents, the concrete operational child also had difficulty. At the cognitive level, near space for the blind, probably depended on utilization of auditory, mental, kinesthetic and spatial information. Poor body image also seemed to inhibit his awareness of simple directions, left-right positions, and distance in relation to his own body.

All of which would seem to imply that although language and mental imagery cannot be thought to inhibit operational thinking, they are a means of communication by which the sighted can correct and accelerate the blind child's understanding of his environment for better integration and cognitive development. This is better defined by the responses and demonstrations of those blind children in the transitional and pre-operational stage of thought. The unusual responses that were peculiar to the blind child indicated that their thought organization was incomplete and that they did not achieve the concrete operational level of thought.

From the point of view that the development of cognition, socialization, language and mental imagery are inseparable in the blind child and cannot be discussed in a discrete manner, a clinical approach will be taken.

Assuming that slower implies a different level of thinking, perhaps we can think of the infant's mind as Locke, "Tabula rasa," or blank at birth. If this is true, we then must think of cognitive development as being experienced through perception. To a blind child who is born in a world of void, his key is that the world must not only be introduced to him through his residual modalities, but must be interpreted and communicated to him through the sighted from whom he then forms concepts.

Bearing in mind the overwhelming psychological factors of an inexperienced mother, blindness gives the appearance of mental retardation. The blind child is a listening, touching person. When communication begins she expresses herself, and perhaps rightly so, in simple,

literal and familiar terms which she thinks her child understands. If his behavioral response is favorable, she continues to use rather ambiguous terms: (big, lots, little) instead of relational more precise terms (higher and lower, wider and narrower) that would explain the complexity of the operations. It was noted that for change of criteria, forty-two percent of the children used fat, skimpy and skinny instead of thick and thin as the examiner used. Was it easier to connect these terms to the blind child's sensory modalities?

At the other extreme, Subject #1 never used the term "same." It was not a part of her vocabulary. Her parents were high achievers, and expected the same from her. She was sent to the Lighthouse School at age three, and was taught terms on higher levels of expression. Although she frequently used terms such as "equal" and "equivalent," her understanding of "same" was "both have more."

What should be said about the blind child's sensory experience, in terms of comparing one object or experience to another? One subject felt that the ball was the same as the pancake because both felt like a circle.

Associating from memory of known words to unknown is most difficult for the blind child, in addition to making him understand the many meanings for one word. For example, when asked in change of criteria to make two families or groups, one child said, "families are people"; another said, "King and Queen family," a statement which also implied people. The examiner then said, "Make two piles of the same kind," and the child proceeded to pile the plastic shapes on top of each other.

Using the words of the sighted without understanding leads to confusion. One child stated, "Can I make a sausage instead of a hot-dog?" Was she unaware that they are the same shape, or didn't she recognize the terms? Was it easier for her mother to express this shape in terms of a sausage?

In the author's pilot study on adults, one subject blinded after age fifteen stated that she did not understand. Once the operations were explained, she said, "Oh, that's what you meant." Can the incorrect response also be interpreted as an inappropriate question that does not address itself to the remaining intact senses? When language is understood and expressed in common terms so that both the sighted and blind can communicate, then the differences between cognitive development and reasoning can be reduced. This then poses the question as to whether the blind children in the transitional and pre-operational stage understood what was expected of them.

As can be noted, language does play an important role in the formation of reasoning. Many tasks lend themselves to perceptual conflicts, not understood by the blind, unless expressed in a manner that addresses itself to the residual senses, or in a way that demonstrates how he experiences his environment. In the task of one-to-one correspondence, same amount meant counting. In conservation of length, "Would we walk the same length?" meant to many, straight or crooked. In conservation of liquid, "Would we have the same amount to drink?" meant, "Let's drink it and find out."

In addition to language, although it has been found that incorrect imagery does not hamper achievement of conservation, the responses

indicated that the image of an operation is an aspect of what is understood. Language, too, is understood in a discrete manner, partially from piecemeal concepts from the sighted, or from concepts beyond their realm. In class inclusion, in response to "In the world," one child said, "I never counted them"; another child said, "In the world, that's a completely different story."

As Piaget states, "The fact that the child has not understood and cannot memorize relationships that he has not understood goes without saying. He schematizes them in terms of intellectual rather than experienced schemes" (Piaget & Inhelder, 1969).

The area of greatest difficulty of cognitive development in the blind child is personal and physical experience. Both are influenced by parental and societal attitudes.

To compensate for his lack of vision, the blind child depends on direct contact with his environment which requires more mobility; however, he is exposed to a narrower range of stimulation from which he must distinguish, interpret and organize his concepts.

Whether it is the psychological adjustment of the parents or the restriction society places on him, the blind child is indeed limited. He does not have as many experiences from which to make comparisons.

Moore (1973) give examples of many experiences that the blind child is not exposed to in everyday living. These experiences begin before the normal child's formal schooling. The normal child classifies dogs, cars, siblings' and parents' clothes sizes, and etc. She states:

Since mathematics is involved with the comparison and relationship of numbers, and entirely verbal, abstract concept, the child should be encouraged at each step to differentiate and classify objects in a symbolic mode. He should master

the vocabulary of size, width, and height, etc. as well as develop the mental classification of objects upon these properties.

The primary source of the blind child's education and social adjustment begins with his parents. Many of these relationships were manifested in the clinical case material and reflected in some of the child's responses. Overprotection and isolation reflect non-experiences and insecurity when the child is called upon to make decisions which involve internalized reasoning. Overexposure does not mean understanding or knowing unless the concept has been explained in terms that the blind child can understand. Non-acceptance involves self-worth, and is reflected in responses of "I don't know" or "I'm dumb."

The blind child wants to be accepted, he does not want to feel shame or pity. He has a right to experience his environment through his remaining senses of touch, sound, olfaction and kinesthetics, yet, society fears that the psychological effect of the 'odd' manner in which the blind child experiences his world will have on the normal child if he is socially integrated before he is 'acceptable.'

Because of this need to be accepted, that all humans experience, the blind child indulges in elaborate explanations and wild imaginations when he is able to communicate with others. This makes it difficult for him to differentiate reality from non-reality.

Cohen (1966) states:

Blind children usually have endured some degree of social isolation and this coupled with dependence on verbalization of experience as a substitute for visual integration and the inadequacy of perceptual data for intersensory confirmation of the environment, may lead to emotional problems and inadequate intellectual functioning.

Some of the responses that reflected inexperience were: "What is pishape?" "What is volume?" "How are we going to put the pieces together again?"

The difficulty in making comparisons was also evidenced by what was to be compared. In conservation of liquids, many children compared the weight of the glasses to assess the same amount of liquid; others compared the liquid by measuring the levels from the top of the glass with their fingers.

Foulke (1962) states:

Fluid gives rise to another class of experiences that are available for vision but not for touch. Liquids may be felt. However, the shapes they occasionally assume do not have sufficiently rigid boundaries to permit inspection by touch.

In conservation of length, children often compared length by walking the way in which they had been taught to walk straight or crooked, negating length and considering walk.

Spatial referents were also difficult for the blind child, especially if he had to demonstrate. This was observed in demonstrating higher and lower. Some children said "higher" put pointed lower for conservation of liquids. In conservation of length, many children could not demonstrate left from right in relation to their own body position; others had no idea what direction meant. All of which indicated that the restrictions placed on the blind child do not increase his ability to be independent.

One of the important factors this research pointed out was that the blind child did experience his environment differently. If the developmental process was slower, it was that the needs of the blind child had not been met, for he was a product of significant others and a product of the opportunities afforded him.

## CHAPTER VI

## SUMMARY AND IMPLICATIONS FOR FURTHER RESEARCH

In summarizing the quantitative and qualitative analyses of the cognitive development and mental imagery of eight CBC and four ABB children, ages six through eleven, from the New York City School System, it was found that their Verbal IQ (mean 108) was within the normal range of intelligence. This suggested that their 'stored' or learned verbal and reasoning memory was not impaired, and was therefore equal to the normal child. However, Verbal IQ was not positively correlated with higher performance on reasoning tasks.

The overall level of performance on reasoning tasks for all subjects was within the transitional stage of cognition for concrete operations (2.03), and was considered to be lower than that of normal children of this age. Of the ABB children, three (75%) did achieve the concrete operational stage. One (12%) CBC child achieved the concrete operational stage which can be considered equal to the normal child.

In regard to the order of succession of achievement on problems involving similar mental operations, Piaget found that for normal subjects success on matter preceded success on weight, and weight precedes volume. The data did not reveal this for CBC and ABB children. Success on one reasoning task was not related to any other task. Conservation of volume was the only task that was significantly correlated with age.

Results also showed that while the blind child was slower in achievement on reasoning tasks than the normal child, age, IQ and task performance were not significantly correlated.

The analysis of the pattern of responses in blind children by stage of cognitive development or thought process revealed that those who achieved the concrete operational stage of thought, justified their arguments in a manner similar to those of normal children. However, the responses of other blind children revealed three structural areas of difficulties not encountered in normal children of their age: (1) previous levels of thinking; (2) misunderstanding or ignorance of terms; (3) limited personal experience which inhibited them from forming correct concepts that could be applied to the success of the operation.

It was also found that incorrect imagery does not hamper the blind child from eventually achieving conservation. It appeared that their imagery was based on experiences previously learned or learned within the context of an operation.

The qualitative analysis of the anecdotal data further revealed that other factors contributed to the cognitive development of the blind child. These factors appear to influence the content of their responses. They can be classified as follows: (1) parental and societal attitudes toward blindness; (2) environmental and educational opportunities; (3) emotional and affective stability; (4) socialization.

#### Implications for Further Research

This study of CBC and ABB children, although limited in number, has implications for further research of blind children. As Harley (1963) inferred, the intention of expanded research should not be to

further isolate the blind child, but rather to focus on integrating him into the mainstream of normal activity at an optimum level. Voyat (1972) pointed out that the child needs to be helped to structure his actions on objects in such a way that the logical process will be strengthened. The first step is to devise ways of teaching the blind child to understand his relationship to his environment by action learning.

Preschool years are crucial in helping the blind child to develop basic concepts. Discriminations are made in everyday living; therefore, it is imperative that the blind child have a variety of concrete experiences involving his remaining senses. Since it is the parents' role of fostering autonomy in the child's first years of life, the original focus of research would be to explore methods that will increase the quality and quantity of contacts that will enable the blind child to compare and validate errors in conception. Programs should be designed for parents of the blind to help their children think, compare and classify in a symbolic manner from concrete experiences. These experiences can then be generalized to meaningful operations that can be understood and articulated by the blind. Sighted parents have a tendency to think that sighted explanations suffice for the blind, when in fact, they do not; but do give rise to "parroting and verbalisms."

Lowenfeld (1955) emphasized the need for concreteness in teaching the blind child from falling into a pattern of unreality. The question of further research becomes: how often, and, how many contacts must the blind child have with an object or operation to correct and classify his conceptions in order to include broader classifications which can be generalized to deal appropriately with various operations.

It has been generally confirmed by other researchers that the blind child's cognitive development is slower, implying that the process is different. Compensatory teaching methods need to be explored by examining a multi-sensory approach to learning, which would give the blind child the maximum use of his remaining senses.

The adapted reasoning task battery of Piagetian assessments along with a variety of different type materials can be used to determine areas of difficulty of cognitive development and correct mental imagery. Materials more familiar to the blind child, and remedial methods should be directed toward these areas to assure success in operational thinking from a variety of different experiences and activities.

Because of the psychological effects of blindness resulting from the child's insecurity and dependence on significant others, and because of the stigma society has placed on the blind, further research is needed. The research should include a clinical approach which integrates behavior, affective, cognitive, and social development, rather than research in the discrete way it is presently done.

In order to determine whether research on remediation is effective, longitudinal studies with the same subjects should be given at various intervals, stages, or ages. These kinds of studies should be done to determine the process of thought between transitional and concrete operational thinking, in preference to cross-sectional research which does not allow for modification of techniques.

## APPENDIX A

## CRITERIA FOR REASONING TASKS

Conservation of MatterMaterial:

- 2 clay balls of equal size
- 3 clay balls of different sizes (one the size of the standard, larger and smaller)

Presentation:

Two clay balls of equal size are given to the Ss to touch and examine. He is then told, make believe these are to eat, and is asked:

1. Do we have the same amount to eat?
2. If not, make them the same.
3. Are they the same now?
4. If you roll yours into a hotdog, would we have the same amount to eat?

Part I:

The Ss is asked to roll his into a hotdog.

1. Do we still have the same amount to eat?
2. Do I have more?
3. Do you have more?
4. Why?
5. If you make yours into a ball again, do we have the same amount?
- 5a. If rolled into a ball, which one would it be like?

The Ss is then asked to return hotdog to a ball.

1. Now do we have the same amount to eat?
2. Do I have more?
3. Do you have more?
4. Why?
5. If you make yours into pie shape would we still have same amount?

Part II:

The Ss is asked to make his into a pie shape.

1. Do we still have the same amount to eat?
2. Do I have more?
3. Do you have more?
4. Why?
5. If you make yours into a ball again, do we have the same amount?
- 5a. If rolled into a ball, which one would it be like?

Conservation of Matter  
(continued)

The Ss is then asked to return pie shape to a ball.

1. Now do we have the same amount to eat?
2. Do I have more?
3. Do you have more?
4. Why?
5. If you made yours into many small pieces would we have the same amount to eat?

Part III:

The Ss is asked to make his into many small pieces.

1. Do we still have the same amount to eat?
2. Do I have more?
3. Do you have more?
4. Why?
5. If you make yours into a ball again, do we have the same amount?
- 5a. If rolled into a ball, which one would it be like?

The Ss is then asked to return the pieces to a ball.

1. Now do we have the same amount to eat?
2. Do I have more?
3. Do you have more?
4. Why?

Countersuggestion: A little girl told me; (opposite of child's conception).

Conservation of Weight

Material:

- 2 clay balls of equal size and weight
- 1 Roman Scale

Presentation:

The Ss is asked about the scale, and what it does, how it works, and his knowledge about the scale. The E explains its working to him if necessary. The Ss is then given the two clay balls, and told that they are the same weight. (The E does not actually put the clay on the scale unless it becomes necessary to prove to the child that they do weigh the same). The E then asks:

1. If I were to put this one here (R) and that one there (L), would they weigh the same?
2. Why?
3. If you rolled yours into a hotdog, would they still weigh the same?

Part I:

The Ss is asked to roll his into a hotdog.

1. Do they still weigh the same?
2. Would the hotdog be more?
3. Would the ball be more?
4. Why?

Weigh if necessary.

5. If you make yours into a ball again, would they both weigh the same?

The Ss is then asked to return his hotdog to its original form.

1. Now do they weigh the same?
2. Why?
3. If you make yours into a pie shape would they both weigh the same?

Part II:

The Ss is asked to make his into a pie shape.

1. Do they still weigh the same?
2. Would the pie be more?
3. Would the ball be more?
4. Why?

Weigh if necessary.

5. If you make yours into a ball again, would they both weigh the same?

The Ss is then asked to return his pie shape to its original form.

1. Now do they weigh the same?
2. Why?
3. If you make yours into many small pieces, would they both weigh the same?

Part III:

The Ss is asked to make his into many small pieces.

1. Do they still weigh the same?
2. Would the pieces be more?
3. Would the ball be more?
4. Why?
5. If you make yours into a ball again, would they both weigh the same?

Countersuggestion: A little girl told me. (opposite of conception)

### Conservation of Volume

#### Material:

- 2 glass beakers of equal size
- 2 elastic bands
- 2 clay balls of equal size
- 1 glass ball

#### Presentation:

The Ss is presented with two beakers of equal size, an elastic band is applied at his agreed equality, he is then assisted by the E in filling the beakers with water to an equal level at the elastic band. He is then given two clay balls of equal size, and is asked to adjust them until he agrees that they are equal. He is then asked:

1. If I dip this ball into the glass of water, what will happen?
2. Why does the water rise?
3. If I dip a ball into each glass, will the water rise the same in each glass?
4. Or more in one than the other?
5. Why?

The balls can be dipped at this time if necessary.

If the Ss is sure, the procedure is not carried out (hotdog, pie, pieces) and part IV is done.

#### Part IV:

The Ss is presented with a glass ball and a clay ball equal in size. He is allowed to feel their respective weights, and adjust their equality in size. The clay ball being heavier, he is then asked:

1. If I dip the clay ball into this glass and the glass ball into the other, will the water rise the same in the two glasses?
2. More in the beaker with the glass ball?
3. More in the beaker with the clay ball?
4. Why?

Countersuggestion: A little girl told me. (opposite of conception)

### Conservation of Liquids

#### Material:

- 2 beakers of equal size (A-1 and A-2), with elastic band
- 1 higher, thinner beaker than A-1 and A-2, called B
- 1 shorter, wider beaker than A-1 and A-2, called C
- 4 small beakers of equal size

Conservation of Liquids  
(continued)

Presentation:

The Ss is presented with two identical beakers, and is asked to feel their equality, and the equality of the elastic band levels. He is then assisted by the E in pouring water into each beaker to the elastic level. When he agrees on the equality of the water level, he is asked:

1. If I drink from one and you from the other, will we both have the same amount?
2. If not, make them the same.
3. If you poured yours into B, how far would the water go up? (higher, lower, or the same as other glass)
4. Would we still have the same amount to drink?

Part I:

The Ss pours the water into B.

1. Do we still have the same amount to drink?
2. Do I have more?
3. Do you have more?
4. Why?
5. If you pour yours back again, will we have the same amount?

The Ss pours the water into C.

1. Do we still have the same amount to drink?
2. Do I have more?
3. Do you have more?
4. Why?
5. If you pour yours back again, will we have the same amount?

Part II:

The Ss pours the water into C.

1. Do we still have the same amount to drink?
2. Do I have more?
3. Do you have more?
4. Why?
5. If you pour yours back again, will we have the same amount?

The Ss is asked to pour it back.

1. Now do we have the same amount to drink?
2. Why?
3. If you poured yours into all these glasses, would we still have the same amount to drink?

Conservation of Liquids  
(continued)

Part III:

The Ss is asked to pour into the 4 small glasses.

1. Do we still have the same amount to drink?
2. Do I have more?
3. Do you have more?
4. Why?
5. If you pour yours back again, will we have the same amount?

The Ss is asked to pour it back.

1. Now do we have the same amount to drink?
2. Why?

Countersuggestion: A little girl told me. (opposite of conception)

Conservation of Length

Material:

- 2 sticks of equal length (A-1 and A-2)
- 1 stick shorter than A-1 and A-2, called B
- 1 stick shorter than B, called C
- 2 houses

The Ss is given a group of four wooden sticks to examine. He is then asked to choose two sticks of the same length. After they are placed parallel to each other in a horizontal position on the table without one extremity passing over another, the houses are placed at the beginning.

1. If these were roads, are they the same length?
2. If I moved my house here (R - 1/2 length) would the roads still be the same length?
3. Could you point where my road would stop by yours? (further, less, same)

Part I:

The E then places the road in front of the house (R - 1/2 length).

1. Now are these roads still equal length?
2. Is one longer than the other?
3. Why?
4. If I put my house as before, would the roads be the same length?

Conservation of Length  
(continued)

The E returns the house to the initial position.

1. Now are the roads the same length?
2. Why?
3. If I moved my house here ( $L - 1/2$  length) would the roads still be the same length?
4. Could you point where my road would stop by yours?

Part II:

E then places the road in front of the house ( $L - 1/2$  length).

1. Now are the roads still equal in length?
2. Is one longer than the other?
3. Why?
4. If I put my house as before, would the roads be the same length?

E returns the house to the initial position.

1. Now are the roads the same length?
2. Why?
3. Now if we both moved at the same time, and took our roads ( $R - 1/2$ ,  $L - 1/2$ ), would the roads be the same length?

Part III:

E then places the roads and houses ( $R - 1/2$ ,  $L - 1/2$ ).

1. Now are these roads still equal in length?
2. Is one longer than the other?
3. Why?

Countersuggestion:

Conservation of Length (Sectioned)

Material:

- 1 stick (16 inches)
- 4 sticks (4 inches)

Presentation:

The Ss is presented with four sticks of equal length, and one long stick equal to the smaller sticks. The Ss is then asked to place the four sticks parallel to the long stick and agree on their equality.

1. If I move these four sticks around would they still be equal to the long one?

Part I:

The E then makes this configuration:

1. If I walk this road and you walk this road would we walk the same length?
2. Is one shorter?
3. Is one longer?
4. Why?
5. If we put them as before, would we walk the same length?

Part II:

The E then makes this configuration:

1. If I walk this road and you walk that road would we still walk the same length?
2. Is one shorter?
3. Is one longer?
4. Why?
5. If we put them as before, would we walk the same length?

Part III:

The E then makes this configuration:

1. If I walk this road and you walk that road would we still walk the same length?
2. Is one shorter?
3. Is one longer?
4. Why?
5. If we put them as before, would we walk the same length?

Countersuggestion:

Rotation of Beads

Material:

3 pairs of differently shaped wooden beads  
 1 wooden rod  
 1 cardboard tube

Presentation:

Three differently shaped beads are tactually examined by the Ss and given names. (ABC or 123) The Ss is then assisted in placing the beads in the tube on the rod. The Ss then places his hands on the E's

in order to follow the rotations which are done on the table. The other half of the set is placed in front of him in the order they have been placed in the tube (reference).

Part I:

1. In what order will the beads emerge if the tube is tilted to the left? (ABC)
2. In what order will the beads emerge if the tube is tilted to the right? (CBA)

Part II:

A rotary movement of 180 degrees is made with the Ss hand. (tube marked L is now on R) ABC to CBA)

1. In what order will the beads emerge from the right? (1 reversal)  
CBA

Part III:

A rotary movement of 360 degrees is made from this position.

1. In what order will the beads emerge from the right? (2 reversals)  
CBA

Part IV:

Many random number of semi-rotations are made.

1. Which one will emerge first? A \_\_\_\_ B \_\_\_\_ C \_\_\_\_  
If number B
2. How?

Countersuggestion: that B will emerge first, then ask how.

Class Inclusion  
(wooden blocks)

Material:

8 wooden square blocks  
2 wooden round blocks  
1 box

Presentation:

The Ss is asked to identify the shapes of the blocks, from a box containing 10 wooden blocks, his attention is drawn to the fact that all the blocks are made of wood. Ss asked to name other things of wood.

Part I:

1. Are all the blocks wooden?
2. Are the square blocks wooden? How many?
3. Are the round blocks wooden? How Many?
4. Are there more square blocks or wooden blocks?

Part II:

The E then says there are two children who would like to put together wooden blocks. One would like to put together all the square blocks, the other would like to put together all the round blocks.

1. Which bunch will be greater?

Part III:

1. If I give you the square blocks, what remains in my bunch?
2. If I give you the round blocks, what remains in my bunch?
3. In this box, do we have more wooden blocks or square blocks?
4. In the world, do we have more wooden blocks or square blocks?

Dichotomy: A Change of CriteriaMaterial:

- 4 large circles (two thick, two thin)
- 4 small squares (two thick, two thin)

Presentation:

Four large circles and four small squares are placed in disorder before the Ss. He is then asked to examine them and describe, making sure he realizes the shape, size and thickness. (large-small, thick-thin, circles-squares)

He is then asked to put (sets, groups, or classes) a lot alike together, or separate those that are different, but into two piles only.

For each of the three groups he is able to make, he is asked:

1. What do you call this group?
2. Why like that?
3. Can you make a different group?

After each group, the figures are remixed together.

One-to-One Correspondence

Material:

- 9 plastic apple figures
- 9 plastic star figures

Presentation:

The sets of apple figures and star figures are put in a straight line parallel to each other in front of the Ss. The Ss is then asked to touch them, and given them a name. The name that the Ss gives is the name that the E will use.

Part I:

1. How many apples are there?
2. How many stars are there?
3. Do we have the same number of stars as apples?
4. If I move the stars further apart, would I still have the same number?

Part II:

The E takes the Ss hand to do the transformation, the E leaves the apples as they are, but extends the stars in space.

1. Are there as many apples as stars?
2. More apples?
3. More stars?
4. Why?
5. What would you do to make them the same amount?
6. If we put them back like before, would we have the same amount?
7. How do you know?

He then assists the Ss in rearranging them as in the beginning.

1. Now do we have the same amount?

Part III:

The E takes the Ss hands and assists him in extending the apples in space.

1. Are there as many apples as stars?
2. More apples?
3. More stars?
4. Why?
5. What would you do to make them the same amount?
6. If we put them back like before, would we have the same amount?
7. How do you know?

Countersuggestions:

Relational TermsMaterial:

- 1 card with one nickel
- 1 card with five nickels
- 2 cards with three nickels

Presentation:

The Ss is told that he will be given four cards with nickels on them, and some questions will then be asked. The Ss is then given the card with three nickels (standard) and is asked to feel it and is then presented with the comparison card.

Part I: one nickel

- 1. What can you tell me about these two series of nickels?
- 2. Are they the same or are they different?
- 3. Does one have more, less, or the same?
- 4. Which one has more? \_\_\_\_\_ Which one has less? \_\_\_\_\_

Part II: three nickels

- 1. What can you tell me about these two series of nickels?
- 2. Are they the same or different?
- 3. Does one have more, less, or the same?

Part III: five nickels

- 1. What can you tell me about these two series of nickels?
- 2. Are they the same or are they different?
- 3. Does one have more, less, or the same?
- 4. Which one has more? \_\_\_\_\_ Which one has less? \_\_\_\_\_

APPENDIX B  
SCORING CRITERIA

Conservation of Matter

- Stage 1 Matter is not preserved during the transformation, quantity changes according to the physical transformation.
- Stage 2 He affirms some transformations and denies others; he does not resist countersuggestion.
- Stage 3 He is no longer misled by perceptual changes. Conservation is seen as a logical necessity based on one of the following arguments:
- a. Identity: none added or taken away.
  - b. Compensation: coordination between parameters.
  - c. Reversibility: you can put it back and it's the same.

Conservation of Weight

- Stage 1 Weight is not preserved during the transformation; quantity changes according to the physical transformation.
- Stage 2 He affirms some transformations and denies others; he does not resist countersuggestion.
- Stage 3 He is no longer misled by perceptual changes. Conservation is seen as a logical necessity based on one of the following arguments: identity, compensation, reversibility.

Conservation of Volume

- Stage 1 The child has no understanding of the conservation of volume. The conservation of liquid volume is not preserved during the perceptual transformation.
- Stage 2 At times he affirms matter-conservation and weight-conservation which confuses his understanding of volume-conservation. At other times he will validate both weight- and matter-conservation, but disregard weight of equally-sized objects as an unnecessary concept in the understanding of volume-conservation.

- Stage 3            He is able to coordinate all the aspects of the situation and is able to disregard consistently the concept of weight and supports his belief of volume conservation with one or more of the following arguments: identity, compensation, reversibility.

#### Conservation of Liquids

- Stage 1            Liquid quantity is not preserved during the transformation; quantity changes according to the physical transformation.
- Stage 2            He affirms some transformations and denies others; he usually resists countersuggestion.
- Stage 3            There is a coordination of different parameters, conservation is independent of the nature of pouring, and is justified by one or more of the following arguments: identity, compensation, reversibility.

#### Conservation of Length and Length Sectioned

- Stage 1            The child does not recognize the equality of length except when the sticks are put in direct optical correspondence. The child is incapable of anticipating the quantitative meaning of the transformation.
- Stage 2            The child vacillates between the concept of further vs. longer. He affirms some transformations, and denies others. Countersuggestion usually destroys previous convictions.
- Stage 3            The concept of conservation (parts to whole, or movement) is seen as a logical necessity and is justified by one or more of the following arguments: identity, reversibility, compensation.

#### One-to-One Correspondence

- Stage 1            There is little understanding of the concept of equivalence; the child respects an ordinal reference, but not a cardinal one.
- Stage 2            The child understands the concept of equivalence. When perception is destroyed by spreading out or closing up, the child gives up his former belief in cardinal reference. The longer row is thought to have more objects because of length, or the shorter row has more because of density.

Stage 3            The logical structure becomes more powerful than perceptual change, and is justified by one or more of the following arguments: identity, reversibility, and compensation.

#### Rotation of Beads

Stage 1            The child understands direct order, but not inverse order. There is no understanding of order after rotations.

Stage 2            The child understands inverse order and begins to affirm that the intermediate element will not emerge first, but he does not understand rotations as a whole.

Stage 3            The child understand direct order, inverse order and rotations as a whole; the whole operation is understood.

#### Class Inclusion

Stage 1            The child is perceptually dominated. He is unable to differentiate between sub-categories and class. He cannot coordinate the intention of class (properties common to all members, but specific to others). He cannot conceive of extension of class (part-whole relationships of class membership conveyed to all, some and none).

Stage 2            The child has difficulty with the comprehension and the extension of the class. He unites objects on the basis of similarity. He usually succeeds with one of the three questions of extension of class, "More wooden or square beads?"

Stage 3            The child understands logical classification which coordinates comprehension of the intention and extension of a class. All questions are answered.

#### Change of Criteria

Stage 1            The child has no flexibility in hindsight; he is unable to make any groups.

Stage 2            The child has some flexibility in hindsight; he is able to make one group, and possibly shift to another due to the way he apprehends the problem.

Stage 3            The child is able to accomplish the three dichotomies; he has complete anticipation and flexibility of hindsight.

APPENDIX C

Inter-Rater Reliability of  
State Scores for Reasoning Variables

Variables	Rater 1 vs 2	Rater 1 vs 3	Rater 2 vs 3
Matter	.620 * *	.625 **	.868 **
Weight	.746 **	.874 **	.874 **
Volume	.710 **	.509 **	.617 **
Liquids	.621 **	.504 *	.621 **
Rotation of beads	.687 **	.687 **	1.000 **
Length	.625 **	.741 **	.746 **
Length (Sectioned)	.722 **	.745 *	.661 **
1:1 Correspondence	1.000 **	.723 **	.723 **
Class Inclusion	.613 **	.613 **	1.000 **
Change of Criteria	1.000 **	.838 **	.838 **

\* =  $p < .05$     \*\* =  $p < .01$

APPENDIX D

Summary of Successes For All Responses By Stage For All Tasks \*

	Pre-operational										Transitional										Concrete-operational										
	Conservation of matter	Conservation of weight	Conservation of volume	Conservation of liquids	Rotation of beads	Conservation of length	Conservation of length (sect.)	1:1 Correspondence	Class inclusion	Change of criteria	Conservation of matter	Conservation of weight	Conservation of volume	Conservation of liquids	Rotation of beads	Conservation of length	Conservation of length (S)	1:1 Correspondence	Class inclusion	Change of criteria	Conservation of matter	Conservation of weight	Conservation of volume	Conservation of liquids	Rotation of beads	Conservation of length	Conservation of length (sect.)	1:1 Correspondence	Class inclusion	Change of criteria	
Ca (1)	40	50	0	20	0	66	100	0			0	0	60	100	100	0	100	75			100	66	100	100	100	100	100	100	100		
Ca (2)	0	0	33	25	100	25					100	50	60	0	66	0					66	100		100	100	100					
Ca (3)	0	75	0	0	50	0					100	50	66	0	25	100					100	100	100	100	100	100					
Cp (1)	0	0	0	0		0	0	0	100	100	0	0	28	0	66	50	20	100	100		75	100	100	75		100	100	100	100	100	
Cp (2)	0	0	33	0		0	0	0	0	0	50	50	42	0	33	0	20	100	100		100	100	100	100		100	100	100	100	100	
Cp (3)	0	0	0	0		0	0		0	0	50	0	14	66		50		0	0		100	100	100	100		100	100		100	100	
Ar (1)	75	100	0	100		75	100	100			0	100	60	100		100	100				100	100		100	100	100	100	100			
Ar (2)	100		0	100		25	75	100			100	100	60	100		100	100				100	100		100	100	100	100	100			
Ar (3)	50	100	0	100		0	100				100	100	66	100		100	100				100	100		100		100					
D	80		0	60		57					100		60								100		0	75		50					
C	100	0	0	33	50	25	0	0			100	100	75	50	100	100					100	100		100	100	100	100	100	100	100	

Ca = Anticipated Conservation  
 Cp = Operational conservation in the presence of the actual transformation  
 Ar = Reciprocal anticipation  
 D = Demonstration of anticipations  
 C = Countersuggestions

\*As % of the responses.

one two or three  
 Class inclusion Cp =/three responses to "flor square or wooden beads."  
 Change of criteria Cp = one, two or three classifications  
 Rotation of beads = Ca<sub>1</sub>, direct and inverse order, Ca<sub>2</sub>, one reversal, and Ca<sub>3</sub>, two reversals

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