Object Permanence Development in Infants with Motor Handicaps

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This study was an investigation of the effects of a motor handicap on the development of object permanence in the young child. Motor abilities were evaluated for 12 infants aged 13 to 29 months. Based on this evaluation, the children were described as manipulators or nonmanipulators in reference to their upper extremity skills. Their stage of object permanence was assessed using traditional and nontraditional assessments. Heart rate and visual tracking were recorded during the nontraditional assessment. Heart rate did not significantly relate to visual fixation or search response. There was, however, a significant difference (p < .02) between stage achievement with traditional testing and age-appropriate levels. There was no significant difference between the nontraditional assessment and the age-appropriate levels. In addition, there was no significant difference in the development of object permanence between infants described as manipulators and those described as nonmanipulators. The last two findings suggest that infants with motor handicaps may develop object permanence at the expected ages, according to a nontraditional assessment.

Key Words: Motor skills, Concept formation, Child development deviations, Evaluation studies.

This study was an investigation of the effects of a motor handicap on the development of object permanence in the young child. The theoretical framework that shaped the basis for this investigation comes from the work of the Swiss developmental psychologist, Jean Piaget. Piaget describes the first phase of intellectual development as the sensorimotor period. During this time (approximately the first two years of life), the infant exercises innate sensorimotor abilities, such as sucking, to adapt to the new external environment. Primitive reflexive behaviors are rapidly transformed into cognitive structures or concepts that incorporate the results of experience. These structures are again used and modified by the infant in a developing hierarchy to adapt to the ever-changing environment. Piaget views this sensorimotor period, with the evolution of functioning cognitive structures or concepts, as the very origins of intelligence. The child’s ability to manipulate objects in the world is an integral part of this evolutionary process and assists the child in the development of the object concept.

OBJECT CONCEPT

The object concept—the knowledge that objects have permanence even if not directly seen, touched, or heard—is an important developmental phenomenon in Piagetian psychology. Development of the object concept occurs sequentially in six stages during the sensorimotor period.

During stage one the infant looks at an object in the visual field; however, when the object is removed, the child resumes other activities. There is no visual search for the object. When an infant has developed stage two behavior, visual responses include staring at the spot of an object’s disappearance; however, the infant is still not actively searching for the lost object. During stages three and four the infant anticipates the position of a dropped object and searches visually and with bodily movements for a vanished object. The mental image of the object is fully formed during stages five and six. The infant will follow an object...
through visible displacements during stage five and through invisible displacements during stage six, inferring knowledge of the continued existence of objects.1-3

The object concept is fully elaborated as the child has experience acting on and with objects. Piaget suggests that sensorimotor experiences provide the environmental interactions essential for the development of the object concept.2 This concept has an intimate relationship with, and a presumed dependency on, sensorimotor experience. If development of the object concept is contingent upon sensorimotor experience, then children with a lack of this experience may show a delay in the development of the concept.

A child with a motor handicap may be deprived of the sensorimotor experiences necessary for the development of the object concept. For example, Gouin-Décarie has studied children with congenital anomalies caused by the drug thalidomide.4 The anomalies include the absence or shortening of the long bones of the extremities. Sensorimotor exploration of self, objects, and the environment was significantly altered in these children. Décarie hypothesized that this alteration would result in delay in the development of the object concept; however, 19 of 21 subjects tested (ages 24-31 mo when tested) reached stage six (the final stage) of object permanence.4 Stage six in the development of the object concept is usually obtained by 18 to 24 months of age. Inasmuch as Décarie’s subjects were slightly older than this, it is not possible to know if they achieved the concept at age-appropriate times or were slightly delayed. The importance of this finding, however, is the fact that children with severe motor handicaps developed the object concept, even if this development was slightly delayed.

Each of the subjects in Décarie’s study had sufficient motor skills to be tested for development of the object concept using the traditional method. This method involves hiding an object under a cloth with the expectation that the child will remove the cloth in search of the object. Some children with motor handicaps may not have the ability to remove a cloth from an object to demonstrate the necessary searching behavior. Testing for the development of the object concept in this type of child would directly test the theory that sensorimotor exploration is a prerequisite for the development of the object concept.

Thus, the hypothesis of this study is that infants with an inability or abnormal ability to manipulate objects will be delayed in their development of the object concept. In order to test this hypothesis, an assessment tool was needed that did not require a motor response. A means of assessing object permanence through stage five based on visual responses to hidden objects has been developed.5 The use of this nontraditional means of testing would allow investigation of the development of the object concept in children who lack manipulatory skills.

**METHOD**

**Subjects**

Subjects consisted of 3 girls and 9 boys with motor handicaps, ranging in ages from 13 to 29 months. Nine of the children had spastic quadriparesis, two had spastic diparesis, and one had hypotonic quadriplegia. The subjects were handicapped as a result of CNS dysfunction incurred in utero or within the first week of life. The subjects were patients in the physical therapy department of Children’s Hospital Medical Center, Boston, Massachusetts.

**Nontraditional Assessment of Object Concept**

The nontraditional assessment, adapted from the work of T.G.R. Bower, consisted of a puppet stage housing a conveyor belt apparatus.5 Objects placed on the conveyor belt could be moved to various points on the stage. A screen was located at midpoint on the stage, and objects could be moved behind the screen, first hidden from the infant’s view and then made to reappear. The subject sat in front of the puppet stage on the mother’s lap during the presentation of the objects. A videotape camera mounted on the wall behind the stage recorded the infant’s visual and postural responses as well as movement of the object on stage.

**Heart Rate Response**

The infant’s heart rate responses were recorded during the nontraditional assessment. A polygraph with a biotachometer coupler was used to record heart rate. Cardiac deceleration accompanied by behavioral signs of orientation may permit differentiation between an empty stare and active processing of a novel event.6-9 Because of their motor handicaps, the infants tested did not have reliable postural cues reflecting attention; consequently, heart rate responses were recorded to assist in describing attention and processing of the events the infant was observing on the stage. The polygraph record was marked whenever there was a stimulus change.

**Laboratory**

The recording equipment was located in a room adjoining the testing room. The investigator, the
equipment to power the testing device, and the polygraph were also located in this room. The subject was thus shielded from the sound of the motor used to power the conveyor belt and the equipment. The two laboratory rooms were separated by a one-way mirror allowing the investigator full view of the experimental situation. Verbal contact with an assistant positioned under the stage was maintained by the use of microphones and head sets. The assistant changed the objects on the conveyor belt during the testing.

Initial Assessment

Each child was initially seen at home, where a preliminary assessment was completed. This assessment was designed to gather information regarding the child's physical development and sensorimotor abilities. Interrater reliability for two raters was .90. Reliability was obtained by pretesting the assessment on children with CNS dysfunction. As a result of these assessments, the children were rated as manipulators or nonmanipulators of objects. The items used to make this distinction were taken from the Uzgiris-Hunt infant assessment scale. This assessment appears in Figure 1.

The infants rated as nonmanipulators performed only simple motor schemes with objects such as banging, patting, shaking, or waving an object or they merely held, mouthed, or visually inspected objects without manipulating them (Fig. 1: items 4a; 5a, b, c, or d). The infants rated as manipulators performed complex motor schemes including holding, turning, and manipulating objects while visually inspecting them (Fig. 1: items 4b, c, d, e; 5a, b, c, d, e, or f). The preliminary assessment was also designed to test for object permanence using the traditional method designed by Piaget (Fig. 1: item 2).

Within one week after the preliminary assessment, each child was evaluated using the nontraditional assessment. This assessment was performed in the Developmental Psychology Department of Boston.

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**Fig. 1.** Test items administered to each child in order to assign child to manipulator or nonmanipulator category.

**Fig. 2.** Lion moving on the conveyor belt through points A and B and stopping at C. It is hidden from view behind the screen at C. It then proceeds to D and stops.
University. The parents and child first came to a waiting area. While the child played with toys, recording electrodes were placed over the left nipple area and the left upper back. The ground electrode was attached to the child’s abdomen. After the leads were applied, the child was encouraged to play for 10 to 15 minutes in order to adjust to the leads and wires.

Presentations

The nontraditional assessment of object concept consisted of three different presentations (Figs. 2, 3, 4). After the subject and parent were positioned in front of the puppet stage, a one-minute base-line of heart rate was recorded. Each presentation was offered between one and three times, depending on the child’s cooperation. The parent was instructed to use verbal and gestural cues to assist the child in noticing objects. Videotape recordings were made of the child’s response to each presentation.

Analysis

The behavioral data (visual searching responses) recorded on videotape were translated into a stage level for object concept. The criteria for each stage appear in Figure 5. Criteria were adopted from Piaget and Bower and each criterion is identified with its source.\(^1\,^5\) Interrater reliability for two raters coding visual responses was .90. Chi-square was used to analyze visual fixation time. The Wilcoxon matched pairs signed-ranks test and the Fisher exact probability test were used to analyze the object permanence behavioral data.

The heart rate data was coded for initial trends after each stimulus change in the presentations. A trend was defined as a change of heart rate, either an increase or decrease, consisting of at least three beats in duration, occurring within the first four seconds after a stimulus change. Accelerations and declerations were the two trends that were scored. Interrater reliability for two raters coding heart rate was .89. Chi-square was used to analyze the cardiac response.

RESULTS

Results are presented in the Table. Of the 12 subjects, 8 were rated as manipulators and four as non-manipulators.

Acquisition of object permanence was significantly delayed in comparison with the age-appropriate stage.
when subjects were tested in the traditional way (Wilcoxon matched pairs signed-ranks test; \( t = 1, n = 8, p < .02 \)). Of the 12 subjects, 7 demonstrated stages of object permanence from two to four stages lower than the age-appropriate stage.

Laboratory data on one subject (#8) were not obtained because the infant became fussy during testing. The following results are reported for the remaining 11 subjects. Of these 11 subjects, 7 showed a delay in the development of object permanence when the traditional method of testing was used. Of these 7 infants, 6 were able to perform at a higher level of object permanence when tested with the nontraditional (nonmotor) method. Further, four of these six infants showed an age-appropriate stage of object permanence when the traditional method of testing was used. Of these four infants, two showed a delay in the development of object permanence when tested with the nontraditional (nonmotor) method. In addition, there was no significant difference in the development of object permanence between the manipulator and the nonmanipulator groups (Fisher exact probability test, \( p = .25 \)). A comparison of the results using the nontraditional assessment and the age-appropriate stage of object permanence was not significant (Wilcoxon matched pairs signed-ranks test; \( t = 0, n = 3, \text{NS} \)). The nontraditional assessment appeared to show that these children were performing at age level.

**Fig. 5. Criteria used to assign a child’s visual responses to stage 1 to 5 of object concept.**

Ten of the 11 children increased in stage level performance of object permanence when the nontraditional versus traditional testing was used. The num-

### TABLE

**Results**

<table>
<thead>
<tr>
<th>Subject</th>
<th>M*/NM</th>
<th>Age (mo)</th>
<th>Age-Appropriate Stage</th>
<th>Traditional Stage</th>
<th>Laboratory Stage</th>
<th>Motor Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NM</td>
<td>28</td>
<td>6</td>
<td>2</td>
<td>5</td>
<td>Spastic</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>18</td>
<td>5–6</td>
<td>4</td>
<td>5</td>
<td>Spastic</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>28</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>Diparesis</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>28</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>Spastic</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>25</td>
<td>6</td>
<td>6</td>
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<td>Spastic</td>
</tr>
<tr>
<td>6</td>
<td>NM</td>
<td>15</td>
<td>5</td>
<td>2</td>
<td>—</td>
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</tr>
<tr>
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<td>6</td>
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</tr>
<tr>
<td>8</td>
<td>M</td>
<td>19</td>
<td>6</td>
<td>2</td>
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<td>Spastic</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>29</td>
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<td>6</td>
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<td>14</td>
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<td>13</td>
<td>4–5</td>
<td>2</td>
<td>4</td>
<td>Hypotonic</td>
</tr>
</tbody>
</table>

* Manipulator.  
b Nonmanipulator.
ber who increased is statistically significant (binomial test, $p = .006$).

Although there was significant visual fixation during all three presentations ($\chi^2 = 104.6, 119.9, 115$, respectively; $df = 1; p < .001$), cardiac deceleration did not significantly relate to fixation in any of the presentations ($\chi^2 = 0.125, 0.120, .05; df = 1; NS$).

**DISCUSSION**

The original hypothesis of the study was that children who were deprived of sensorimotor experience as a result of a motor impairment would be aberrant in the development of object permanence. Of the 12 infants in this sample, 7 did appear delayed when tested with the traditional method. Four of these seven infants were not able to manipulate objects. This inability alone would suggest a delay as a result of lack of experience with objects. If these infants did not have the motor skill to manipulate objects, however, it is clear that they would be penalized in a testing situation that required the motor response of reaching out and removing a cloth to uncover a desired object.

Each of these four infants demonstrated a higher stage of achievement when object permanence was measured by visual-searching responses rather than by upper extremity motor responses. Two of the four subjects demonstrated age-appropriate levels. The object concept is a very important achievement in the sensorimotor period; however, the development of this concept does not appear to be contingent upon sensorimotor exploration with the body per se, inasmuch as there was no significant difference in the development of object permanence between the manipulator and nonmanipulator groups.

Perhaps the sensorimotor experience, if necessary at all, is obtained through vision. Certainly, moving the eyes to explore an object requires motor activity of the muscles controlling the eyes. Vision is obviously a sensory experience; consequently, visually exploring an object does constitute a sensorimotor activity. The normal child reaches out and grasps a visible object and then brings the object close to the face for inspection. The prerequisite activity for developing object permanence may not be the turning, twisting, and feeling of the object, but rather visual inspection. The roles of upper extremity motor activity in the normal child may be important in allowing visual sensorimotor experiences to occur. The turning and twisting activities may allow the infant to see all sides of the object and to see how the object changes in relation to the environment as the object is moved. Activities such as feeling, poking, and banging objects may allow the child to see the results of actions done to objects. If it is the visual experience that is critical, then providing sensorimotor visual experience might provide the prerequisites for the development of object permanence.

Although the laboratory method of testing appears valid based on results from four of the subjects, there was one exception to the congruence. One subject achieved a higher stage of object permanence with the traditional testing method. This subject did not perform at as high a level in the laboratory setting. There could be a number of reasons for this phenomenon. First, there was only a single criterion for achieving stage five of object permanence in the laboratory setting. Bower has suggested that if one object is replaced by another object, the child will demonstrate a belief in the existence of the original object by searching for it in the place where it was last seen. This subject did not show this particular behavior. Perhaps there are other criteria for stage five acquisition that were not observed. Each subject did not demonstrate all the criteria for each stage, and inasmuch as stage five had only a single criterion, other appropriate stage five behaviors may not have been recognized. A second possibility is that the appearance of the purple square was more interesting than the hidden lion, consequently, the subject continued to search for the purple square while still believing in the existence of the original object. If this subject had object permanence, she could have ignored the original object and chosen to pursue the more salient object, in this case the purple square. Many of the children became restless by the third presentation and no longer appeared interested in the lion. This child may have lost interest in the lion and have chosen to pursue the purple square.

The role of visual experience in sensorimotor development may be fruitfully investigated in blind or partially sighted children. The normal child appears to use a combination of vision and manipulation in developing the object concept. Perhaps in a child with dysfunction in vision or manipulation, one skill can compensate for the other.

The infants in this study had all been involved in physical therapy programs before participating in this investigation. A review of the treatment programs for these 12 children revealed a consistency in treatment that may be important to the development of object permanence. All the therapists had previously attempted to elicit motor responses from the children by offering them toys. Usually the child was shown the object and encouraged to track it visually. The desired response was a reaching out for the object once visual contact had been made. Parents were encouraged to stimulate interest in and interaction with toys both for cognitive and motoric facilitation.
Although 4 of the 12 children did not manipulate toys, they may have been provided with the necessary visual information to develop object permanence. Although this investigation was designed to study only those children who had previously been diagnosed as motorically impaired and were receiving physical therapy treatment, an alternate design might also be instructive. Infants could be tested before treatment is begun to assist in controlling for the increased emphasis on object interaction, both visually and motorically.

CONCLUSION

The results of this study suggest that manipulative ability may not be the most important prerequisite for the development of object permanence. Therapists might assist the development of object permanence by providing children with opportunities for stimulating visual sensorimotor experience involving appearance and disappearance of objects. In addition, therapists might teach parents to demonstrate interaction with objects so that the child might imitate this behavior or benefit from the visual observation of people-object interaction.

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REFERENCES