Developmental Sequences in Prehension-related Movements

Though Observation of an Infant.

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Key Words: Motor development, Prehension, Human development.

SUMMARY: Motor development of an infant from 6 to 18 months of age was observed to assess: (A) motor development of upper extremity in (grasp, reach, hand coordination, and the direction of development (proximal to distal)), (B) the effect of development on, prehension such as: (a) size, form, position of manipulated objects, (b) type of prehension patterns, and (c) relationships between reach patterns. It was found that this child's development of grasp, reach, and hand coordination agreed with standard developmental theories. However, in the direction of development (proximal to distal), a discrepancy with standard theories was observed. Prehension patterns partially depended on place, size, and shape of object. Various relationships between reach and prehension were also confirmed. The author believes this study can be helpful in the occupational therapy clinic for the development of treatment goals and to grade therapeutic activities.

INTRODUCTION

There are several basic theories developmental sequence in physical function. Cephalocaudal progression, proximal to distal direction, gross to fine movements are commonly stated. Several motor development evaluations depending on these developmental theories were made and used in rehabilitation clinics,
such as the Itou evaluation, the Fuchu Rehabilitation Form, the developmental motor function check form of the Newington Crippled Children's Hospital, Infant motor development evaluation of the Western London Cerebral Palsy Center and Enjoji's hand motor developmental evaluation forms. These forms are based on the development of grasp, reach, and coordination of both hands.

There are several research papers on the development of prehension. H.M. Halverson researched the pattern of block grasping in infants, which considered a classical work in this field. There are transverse studies of the development of the pattern of pencil grip for the ages of 3 to 6 and 6 to 7. Kojima surveyed hand prehension in reach movements, concluding that asymmetry of hand preferences in reach is a result of the higher hemispheric function of the human brain. Ueda surveyed the sequence of motor development of the upper extremities and the relationship to age and individual and social environment.

This present paper was conducted on an infant from 6 months of age to 18 months of age to assess the following theories: (A) motor development, hand coordination, and the direction of development (proximal to distal). The reason this study was conducted originated from this observation that the studied infant demonstrated use of radial side fingers to manipulate toys instead of the ulner side fingers. This seems to contradict the theory of developmental sequences. (B) In addition, the author intends to confirm the effect of developmental sequences related to some other aspects of prehension such as (a) size, form, position of manipulated objects, (b) type of pattern of prehension (depending on a type of classification), (c) relationships
between reach patterns.

The author believes this study can be helpful in the occupational therapy clinic for the development of treatment goals and to grade therapeutic activities.

METHOD

1. Subject: MT is a female infant (born Jan. 21, 1990). Suction birth at 41 weeks of pregnancy. Weigh was 3864g, and height 51cm at birth. Neck stability was observed at 3 months, sitting at 6 months. There was no apparent physical or mental developmental abnormalities.

2. Living environment: Living at city suburbs. The family is a typical family. The grandparents live next door.


4. Observation method: Observation was done when the child played naturally. No artificial handling or placement of toys was done. Frequency of observation period with the observation of a new movement or activity, resulting in possible research error.

5. Contents of observation: Date, play objects, playing method, player's attitude, reach pattern, joint and motion, movement direction, grasp pattern, non-prehension pattern, purpose of hand use and total body movement during observation period were recorded. The author used the enjoi infant development evaluation monthly.

RESULT AND DISCUSSION
A. Agreement with motor development theory (grasp, reach, hand coordination, and direction (proximal to distal) of development).

1. Motor development of prehension:
   a. The standard power grip was observed, that is, the fingers were flexed fully into the palm and the thumb covered the fingers. No other grip pattern was seen.

   The wrist joint changed from ulnar deviation to the neutral position at prehension during the total observation period.

   b. A grip that falls between precision grip and power grip was noted at 8 months of age when the infant could perform a lateral grip, but this grip was performed in an incomplete pattern. This incomplete pattern consisted of flexion of the thumb IP joint and adduction of the MP joints of the fingers. Grasp was done at the finger tips of the radial fingers but between the thumb and palm. At 9 months an incomplete palmar prehension was observed. At the same time, the lateral grip became refined. Palmar prehension was complete at one-year of age, and at this time, the subject was able to bring the midline of the body toward the objects for grasping, whether sitting at a desk or on the floor. During palmar grasp, the IP joints were used in an extended position.

   c. Prehension grip, from 9 months of age, circular mild flexion grip was observed. Form one-year of age, a parallel mild flexion grip was noted. Tip grip and parallel extension grip were not used.

   d. Non-thumb grip was not used during this period. There results agree with standard theories of development.

2. Reach development:
At 4 months of age, the hand nearest to the object was used, and objects near the body were grasped. Elbow extension was the main movement. At 10 months, the speed of reach begins to be controlled. At 11 months, reach for small of objects is done slowly and carefully. At 15 months, the subject could reach for objects on the floor after squatting. At 16 months, the child could reach while squatting.

It was concluded that this child's development of reach agreed with standard developmental theories.

3. Development of hand coordination:

At 6 months, the child could use right and left hands symmetrically. At 7 months the subject could transfer an object from one hand to the other. At 10 months, the child could bang blocks together. At 12 months, the child could preform different activities with the left and right hand while not grasping an object. At 16 months, different movements could then be preformed while grasping objects.

This development too agreed with standard theories too.

4. Direction of development:

This subject's proximal arm joints development preceded the distal development. At 6 months, when playing with toys, thumb abduction and adduction was noted when flexion and extension of the other MP joints were performed. From 6 to 7 months shoulder movements was seem when a rattle was shaken. At the same time, fingers were used to move a roller or rolling column on a play
board (toys attached to a large board), which shows that elbow joint movements were developed later than the finger in this movement.

This result points out a discrepancy with standard theories.

B. Other Aspects of Upper Extremity Motor Development

1. Effect of form, shape, and size of objects in prehension:

Even though the child is capable of performing palmar prehension, the child does not necessarily always use this grasp. At 12 months, the child could not use a palmar grasp on an electrical cord, so a raking grasp was used. For an acorn, a lateral grips was used, and up until 15 months, a lateral grip was used for money. After that, palmar prehension was used for money. At 7 months, a coin was held in a palmar prehension between the thumb and middle finger, and the index finger were used to push the coin down into a box.

As result of these observation, prehension patterns seem to partially depend on place, size, and shape of the object. For example, a 1cm cube can be grasped using palmar prehension when it is a desk, but when it is hanging on string, palmar prehension is no used. The same results are noted when the size different.

In occupational therapy, in grading difficulty of grasp pattern, palmar grasp is more difficult than lateral grasp. It is said that grasping large objects is easier than small objects. But it may be necessary to change our ways of thinking about these theories. In prehension and control of prehension in order to control movement of small joints, fixation of large joints is essential. The development of this child's upper extremity motor
move is shown in table 2-1. Observed joint movements was catego-
rized into nine subtype (Table2-2). Wrist joint movements can be
seen in all types of movements. Forearm movements can be seen in
8 types of joint movements.

At first, during prehension, the shoulder and finger joints
were used to play with toys, but later on elbow joint and fore-
arm supination were used. Fixation of the shoulder joint at first
involved excessive tension in adduction, then the shoulder was
held up in the air and fixated-as for as the relationship between
prehension and shoulder fixation, when the child can perform a
lateral grip, shoulder fixation is incomplete. At 12 months, when
palmar prehension is possible, shoulder fixation starts to become
complete. At the time, the forearm begins to be used, and
pointing and walking be begin(Table 1).

2. Non-grasping Prehension(As categorized by Kamakura)93:

Non-grasping prehension development can be seen in table 3.
From 10 months on, a non-grasping prehension can be seen in the
manipulation of objects. The seven types of non-grasping prehen-
sion is as follow: flat use of hands (spatula type, spoon type,
stick index, stick thumb, plate type, rake type, and hand cup-
ping). The stick index develops at the same time as index finger
pointing develops. The stick index is use not only for pointing
but also to manipulate objects. Hand cupping was observed when
the child played the piano. When the child cannot use the stick
index finger, the middle finger is used to fulfill the same
purpose. When a child play with toys, the hand is used for pur-
pose other than grasp a well.

It is hard to predict when the child will use the hand for grasp or other functions. Therefore, the development of non-grasping hand functions should be clarified.

3. Reach towards the body:

Up to 12 months of age, if food sticks to the face, the child usually unconcerned, but at 13 months of age, the child begins to push the food on the face toward the mouth, using the dorsal surface of the hand or fingers. At this time, the child can supinate the forearm, but the forearm when used is in the pronated position. Therefore, reaching away from the body seems to be easier than reaching towards the body.

The subject had total body eczema and could only scratch certain parts of the body at 6 months of age. With development, the area that could scratched increased. At 6 months of age, the child could scratch her hand. At 16 months of age she could scratch the lateral surface of the upper arm with the opposite hand. At 17 months of age, in standing, she could scratch the lateral side of the lower leg.

Again at 6 months the child the laying position could reach the head, upper torso, and upper extremities. Limitations resulted from the child not being able to cross the midline and lack of wrist control. At 16 months, the child developed the ability to cross the midline, resulting in the ability to scratch the upper arms. At these time, the child was in the long-sitting position and not able to kneel or side-sit. Therefore, she could not scratch the lateral side of the lower legs. At 18 months of age,
she could balance herself in the standing position and bend forward to scratch the lateral sides of her lower legs.

In daily activities in addition to grasp, reach towards objects and toward the body and manipulation are extremity frequent and important functions. Therefore, it is important to study the development of reach towards the body. If there is a specific sequence in the development of direction of reach, the use of this sequence may be very useful in treatment in occupation therapy.

REFERENCES
### Table 1: Motor Development (6M-18M)

<table>
<thead>
<tr>
<th>Month</th>
<th>6M.</th>
<th>7M.</th>
<th>8M.</th>
<th>9M.</th>
<th>10M.</th>
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<tr>
<td>Motor</td>
<td>roll over</td>
<td>sitting</td>
<td>sitting</td>
<td>crowing</td>
<td>sitting up from supine</td>
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<th>Month</th>
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<th>13M.</th>
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<tbody>
<tr>
<td>Motor</td>
<td>walking (10 steps)</td>
<td>walking indoors</td>
<td>walking outdoors. She can point at man and something</td>
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<th>Month</th>
<th>14M.</th>
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<th>17M.</th>
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<tr>
<td>Motor</td>
<td>Stands on tip of toes. She decreases frequency of falling. She is able to walk with caution.</td>
<td>Running. She stand up and squats without hand rail. She walks in half-rising posture when she passes through loop.</td>
<td>Jumping. She can upon unstable base.</td>
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### Table 2-1: Observed Movement Pattern and Period

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<th>TYPE 1</th>
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Table 2-2 Categorization of movement pattern.

Sutabiraized joint (■)
Movement joint (○)

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<th></th>
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<th>TYPE 3</th>
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<th>TYPE 5</th>
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<th>TYPE 7</th>
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<td>Shoulder J.</td>
<td>■</td>
<td>○</td>
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<tr>
<td>Elbow J.</td>
<td>■</td>
<td>■</td>
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<td>■</td>
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<td>Forearm</td>
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<td>Wrist J.</td>
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<td>Finger J.</td>
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Table 3 Observed Non-Grasping prehension patterns and period

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<td>Stick-Index</td>
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