Development of Motor Capacity in the Normal Child

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The ability of a child successfully to develop skilled use of his extremities is determined in large part by his attention patterns, his motor development and the presence or absence of neuromusculoskeletal defects. The typical juvenile amputee, whether congenital or acquired, differs little from the normal child in requiring these factors for successful use of his prosthesis. The fact—that is that the juvenile amputee differs not significantly from the normal—must be borne in mind by all persons working with the amputee. It follows, then, that one must have a basic understanding of the capabilities of the normal child at appropriate ages, if one expects to achieve success with the amputee. While a detailed consideration of neuromusculoskeletal abnormalities is beyond the scope of this presentation, some aspects of attention patterns and motor development of the normal child are presented.

Attention Patterns

In any situation, the child's attention patterns will invariably influence his actions. Attention patterns are determined by several factors—age and maturity, well being and temperament, visual and auditory experiences and finally simply the newness of the stimulus offered the child. It is these factors which may permit the prosthetist the best opportunities to attract and maintain the child's interest and cooperation. Let us see, however, how the child's attention patterns develop with increasing age.

At birth the child is attracted by three things only—a full stomach, a warm bath and exposure to light. By the time he is six or eight weeks old he is beginning to notice moving objects. Although it is barely perceptible, the child at this age does have an attention span, which must be measured in terms of only a few short seconds.

At three or four months of age the infant attains the ability to raise the head, and his attention patterns expand quite evidently. While at this age the infant may seem to stare at one object or in one direction interminably, one must not interpret this as true attention, but rather recognize it as simply one manifestation of persistent inability to coordinate eye movements. Attention patterns continue to be restricted to a given situation because of poor head-eye coordination as well.

By the time he reaches the age of six or seven months, the infant has begun to sit up and his attention becomes even more evident. His attention might be termed selective yet restrictive. He can, for a brief period, sustain

attention to an object in front of him, but when confronted with a second object he plays with it or the first, but not yet with both together.

The child of ten months of age can begin to keep in mind two or three playthings at a time. He now actually prefers several objects to just one. Adding an additional two months to the child's age permits him to include a whole room in his attention scope, and the attention becomes much more durable. It usually remains, however, related to objects, events or persons in front of him.

As the child begins to walk, between twelve and eighteen months of age, his attention is highly diversified. He is very easily distracted, his interest shifts rapidly, and he is quite difficult to work with. After he has become relatively secure in walking, and the newness of the experience is fading—usually in about six months more—his attention becomes fixed again. By the age of two years he can keep one object in mind while he surmounts an intermediate one to get to it. He will cross a room to get a toy from the corner, and his attention span now reaches approximately two minutes. It is extremely important to realize that while children of this age may keep themselves entertained and seem to play by the hour alone, the attention span for a given object or goal still remains only two or so minutes—a very short period in which to attempt meaningful cooperation and understanding.

Even when the child reaches the age of five years, his attention span remains at or slightly under five minutes for a given goal. As this time limit is reached, it becomes necessary to introduce something new, if attention is to be maintained. Of course, at all times the other factors which were mentioned earlier must be considered, particularly fatigue. Finally, it should be remembered that a child's attention will invariably be better if the task is one which he has selected, rather than one selected by another.

Motor Development

The motor development of the child is another factor which is to be understood when working with the juvenile amputee, since this will influence the manner in which the prosthesis can be used. Upper extremity patterns of prehension and release offer an interesting example of motor development, since they reflect not only function of the hand but of the arm as a whole.

Until the child reaches the age of six or seven months he mobilizes every resource he has in the hand and arm to grasp an object—usually in a poorly coordinated fashion which is sometimes termed total hand prehension. At this age of six or seven months he begins to use the index and middle fingers more obviously together with a more well-developed pattern of opposition by the thumb. Some call this radial-palmar grasp, recognizing a combination of early palmar prehension, using the radial side of the hand. Also at this age the child begins to demonstrate the rudiments of handedness, usually evident by his almost immediate one-handed approach to objects. Another function which becomes evident at about this stage of growth is the element of true release. Prior to this age, he will simply pull the object from his hand—now he will pass it from hand to hand.

At the age of eight months the child begins to show what is commonly termed connection grasp. While he is holding a block or cube in each hand, he cannot release only one to pick up a third—both blocks are released.

As nine months of age is reached, more true release is evident, and connection grasp disappears. The pattern of grasp is much more mature as well, but still sufficiently incoordinated to be clumsy at times. This must not be interpreted as being due to finger function alone, since it is a more direct relationship between brain and hand, and requires nerve development. For this reason, it can be anticipated that children of nine months of age or

younger cannot reasonably be expected to operate a terminal device.

By the age of ten months, the child is beginning to show specialization of the individual digits. For the first time he uses a particular finger to point. He no longer simply drops an object; he is able to place it just about where he wants—his concept of release is more mature.

As the child reaches the age of eleven months an early sense of depth and dimension is becoming apparent. While he can reach into a cup to pick up a cube, he cannot yet drop the cube back in the cup. Typically he will put the hand holding the cube into the cup, then release the cube and remove the hand from the cup. One month more—twelve months of age—he is able to drop the cube into the cup. Now he begins to try and build a tower of cubes, but the coordination between eyes and hand has not developed sufficiently to permit this. This, of course, is true for the child with a prosthesis or with a normal hand.

Attaining the age of fifteen months allows a remarkable increase in proficiency. His release is under sufficient voluntary control so that he can begin to build a tower of two, sometimes three, cubes. His finger and eye coordination has also developed to the point at which he can put a small pellet in a bottle. The attention span is of importance now, because it is sufficiently long so that he can put four or five cubes in a cup at one time.

By the time the child reaches eighteen months his eye-hand coordination movements have become sufficiently skillful so that he can build a tower of three or four cubes. At this time, more control of rotary movements of the forearm has come, so that he can rotate the forearm to spill a pellet from the bottle. His attention span has increased to the point where he can fill a whole cup with cubes before becoming distracted.

At two years the child can build a tower of six or seven cubes. His sense of vertical dimension is developing along with a concept of horizontal dimension—he can put the cubes in a line. The three-year-old child has a much more complex sense of vertical and horizontal dimension. He begins to show some concept of coordinated movements of the shoulder girdle musculature. He can copy a cross, a triangle and even more complex designs when he elects to do so.

At four years of age the child can throw a ball overhand, indicating even more skilled control of shoulder and arm movements. His sense of dimension is excellent. By the age of five, he has an attention span of about five minutes, and for very limited periods can be treated as an adult.

Ambulation

As most authorities agree, walking is simply alternately losing and successfully regaining one's balance. Balance, therefore, is the keynote to successful ambulation—whether on two normal lower extremities or with prosthetic replacement. Balance does not come easily to a child, hence some understanding of its development also will lead to more appropriate demands placed on a juvenile lower extremity amputee.

Until the child reaches somewhere between the ages of twelve and twenty months his balance is rigidly restricted—he cannot stand alone on one foot except during ambulation. Beyond this age, and for the next few months, he begins to be able to stand on one foot with some external support. By the age of three years, he can balance on one foot independently for momentary periods. At four years this time is increased to several seconds, and by the age of five years, approaches the normal adult in independent balance times. To require more than these usual accomplishments of the normal child from an amputee is certainly not justified.