

The Development of the Hand

by Jane Swain

This article describes some of the intricacies and the abundance of amazing stages through which infants and toddlers progress in their fine motor development, so that professionals familiar with the basic concepts of motor development can begin to recognize these movements in their work with children. I chose to use the female pronoun. I avoid giving specific ages for motor milestones, since each child will wisely progress at her own pace, and the quality of the movement is what is most important, not the timetable.

While each child develops uniquely, I am presenting an archetype of development. If the child skips a stage or two, all is not lost. All of us, at any age, have potential for further growth and development! I do not wish to support a deficit model or a fix-it mentality on the part of teachers and caregivers of infants and very young children, but rather to help them see the genius of the child at work in the unfolding of her fine motor development. I encourage professionals to concentrate on honing their observation skills for a short period of time each day.

Her position in the womb influences the newborn. It gets quite tight in the womb during the last several months so that at birth, the baby is overstretched on her backside and somewhat contracted in her arms and legs. Her shoulders are elevated toward the ears, so that it looks as if she doesn't have much of a neck! Her hands are generally held in fists when she is resting. Her head is rotated to either side with the neck extended. The newborn cannot keep her head in the midline position.

The newborn may have tremors, as myelination is not yet complete. Random movements of arms and legs are jerky, unsophisticated, and without voluntary control. The baby moves in undifferentiated total patterns. For example, if her arm moves out to the side with the elbow straight, the hand will usually open too, as this completes the total pattern. Similarly, when the baby nurses, occasionally the hands also perform a sucking pattern, as if the entire body is sucking. The grasp reflex is in full force; if one touches the palm of the hand, the fingers will curl. Her Moro and startle reflexes are also strong, so that if her head drops backward slightly or she hears a sudden loud noise, she will cry, her arms and fingers will extend (or open), and then flex (or close across the body) in a two-part response.

One really can't speak about the hand without commenting on the eyes and the breathing, because these are also related. The newborn's eyes can focus at about seven inches, which is the distance to the mother's face when she is being held in the nursing position. The newborn is a "belly breather." While breathing actually occurs in the chest, we see the in and out motion in the abdomen.

Time passes, and the baby is not so flexed up anymore. At rest, the arms and legs are more rolled out and a little farther away from the body, and the elbows are straighter. The arms are moving more, in a windmilling sort of motion. The hands are open more, although the grasp reflex still manifests strongly if something is placed in the palm of the hand. The baby still can't keep her head in the midline position, and the neck is still extended. In fact, the baby is even more asymmetrical than she was at birth. This is when the asymmetrical tonic neck reflex influences the baby's movements. In this reflex, if the head is turned to one side, the face-side arm and fingers straighten, and the skull-side arm and fingers flex, or curl. Now the baby begins to notice her hand and spends much time looking at it. What is this? Could this possibly be part of me? Gradually the vision and the movement become more integrated.

Time passes, and early stages of head control emerge when the baby is lying on her back and her head can come to midline and stay there. The baby learns to tuck her chin, instead of keeping it extended, as in the earlier months. This new head position is liberating! Now the eyes start to converge, better tracking occurs, and the baby can shift her gaze more easily between two objects. The shoulders come down lower, and the neck starts to be revealed! The hands come to the midline position. The grasp reflex fades; the hands are

predominantly open at rest, and the very early stages of a volitional grasp are starting. The baby still can't combine reaching out with grasping, however. Grasping is a flexion pattern, and reaching is an extension pattern. Combining the two is too complicated, but the baby can grasp at her clothes at her chest, because here the fingers and arm are both flexing.

As more time passes, the baby comes more fully into this glorious stage of symmetry and midline orientation, a noteworthy accomplishment. The head comes to the midline position for longer periods of time. The hands play together at the midline position, and everything goes in the mouth. The hands will also find the knees. In another few weeks they find the feet – which also go in the mouth! As the baby is playing with her knees and feet in the midline position, she may turn to look toward the side, and surprisingly plop over to lie fully on her side. This characteristically happens at first by accident, and then the baby learns to do it intentionally. Time passes and she will learn to roll all the way over into the prone position (on her tummy), and also from prone back onto her back.

At this time of symmetry and midline orientation, the baby reaches out for toys. The reflexive grasp fades as the volitional grasp comes more and more into the picture. This early volitional grasp is a primitive pattern whereby the baby grasps from the pinkie side of the hand with no involvement of the thumb (ulnar palmar grasp). She reaches with poor aim, and overshoots when she reaches. The cerebellum has not yet developed fully; it will later correct the reach in midstream and fine tune her aim. The reach is visually directed, i.e. she must see her hand and the object. She needs vision because her sense of where her body parts are in space and what they are doing (proprioception) is far from fully developed. Spending more time bearing weight through her hands in the prone position and in crawling will help her to develop this sense of proprioception. The baby now bangs objects with a strong downward motion. She can't yet control how hard the muscles are contracting. With all this activity of the hand, the baby begins to develop the concept of cause and effect: she purposely reproduces an interesting result that occurred initially by chance. This is a lovely example of the intimate relationship between movement and learning.

When she lies on her back and plays with toys, the baby starts to work on more complex hand skills. Transferring an object from one hand directly to the other is too hard, so she uses an interesting strategy with her mouth. She takes an object from one hand, puts it in her mouth, holds onto the object with her jaws, pulls her hand off the object, and then grasps the object with the other hand!

Once she has the capacity to roll to her tummy, the baby explores the prone position. She learns to push down into the supporting surface. It is very important to know where down is. In fact, it's vital! Think how disturbed we feel when we lose this fundamental relationship to gravity, for example, in an earthquake or on a carnival ride. Older children who have poor balance and are fearful of movement very often have difficulty finding their orientation to the supporting surface beneath them. Initially the baby pushes down through her forearms to come up on her elbows. With time she shifts her weight onto one side in order to reach for a toy with the other arm. After a while, she pushes down and comes up onto extended arms (straight arm). In this position, she experiences deep pressure into the base of her hand, and begins to work on wrist control. On extended arms, she gradually learns to shift more onto one side in order to reach with the other arm. Soon she pivots around in both directions.

All this work in the prone position lengthens and strengthens the muscles that stabilize the shoulder blades on the rib cage. The shoulder blades can gradually hold themselves in various positions on the rib cage, depending upon where the hand is used in space. This work in the prone position also provides the brain with wonderful deep pressure and joint sensation coming from the hand and especially from the thumb side of the hand. So the baby's brain knows more accurately where her thumb is and what it is doing, which in turn promotes more coordinated use of her thumb. Now the grasp changes from the pinkie side of the hand (ulnar palmar grasp) to the thumb side of the hand (radial palmar grasp), which also has no opposition of the thumb yet. With improved proprioception, she has less need for visually directed reaching.

The grasp is voluntary now, but the baby has no concept of pressure when she grasps. She will grasp objects

very tightly. This primitive pattern sometimes still remains in older school-aged children and can be observed when they grasp the pencil with excessive pressure. At this point the baby has mastered the extremes of grasping and reaching, i.e., she grasps too tightly, and she releases a toy with a fling of the entire arm (a total extension pattern.) Now she scratches at a surface – such as the crib sheet or the carpet – with her fingers, and this activity works on the midranges of grasp and release!

The baby employs her new hand skills by exploring toys and objects. She is using judgment, spatial perception and is learning about the qualities of objects. Cognitive development does indeed go 'hand in hand' with fine motor development.

As the baby masters rolling and uses rolling to get from one place to another, she rotates her trunk, activating the abdominal muscles. In the newborn, the ribs are initially horizontally oriented. As the abdominal muscles become more active, they pull on the ribs, and this changes the orientation of the ribs to slant downward (as in the adult ribcage). The activated abdominal muscles also stabilize the ribcage, and this alters the interplay of the breathing muscles. As a result, the baby's breathing gradually changes to a thoracic breathing pattern. We see the in and out motion of breathing now in the chest, rather than in the belly, and the baby's lung capacity increases. She can cry louder and longer! She also has more lung capacity for babbling, and this favorably influences speech development. All this work in the horizontal position helps the baby to control her trunk, so that she has a stable base from which to control her head. Good head control contributes to coordinated eye movements, which in turn affect eye-hand coordination.

The baby becomes more and more active in the prone position. She assumes the "airplane" position with arms and legs up off the floor, and then "swims" in this position. She crawls on her belly. She comes up onto extended arms, and pushes her body backwards. During this motion, the shoulder blades glide downward on the ribcage, and the muscles and tissues are further elongated. This is an incredible transformation when one remembers how the newborn's shoulders were elevated toward the ears.

The baby comes up into the hands and knees position and rocks. This rocking elongates the tendons at the wrist and develops wrist control. The baby plays freely on her side, on her elbow, and also up on her extended arm. Only now does she come into the sitting position on her own. She transitions through various positions, for example from sitting, to being up on her hands and knees, to lying on her side.

The baby starts to crawl, and tries a variety of crawling options. She may crawl using her arms in the normal way and bend her trunk to the side so that her legs are not really engaged. She may crawl with the same-side arm and leg moving together. And she will crawl reciprocally which involves a complicated counter-rotation in the trunk whereby the upper trunk rotates in one direction and the lower trunk rotates in the opposite direction. During all this work in the prone position and on her hands and knees, the weight of the body is transferred through the hand in various patterns. This weight transfer helps to develop the arches of the hand.

The reciprocal crawling especially, and the transitions through the various positions, shift the baby's weight through the thumb side of the hand. The shifting of weight "enlivens" the thumb; the brain receives further proprioception and deep pressure from the thumb, and now the baby begins to master thumb opposition in a variety of ways. In one pattern, the thumb pad opposes the side of the index finger (lateral pincer grasp). In another pattern, the thumb pad opposes the pad of the index (inferior pincer grasp). In a third pattern, the thumb pad opposes the pads of the index and long finger (three jaw chuck grasp). The baby now becomes very active in exploring and picking up every piece of fuzz around the house!

The crawling specifically elongates the index finger tendon, readying it for more coordinated work. The baby learns to point and poke with her index finger. She can isolate one finger from the others, rather than use the total patterns of the newborn period. The baby frequently crawls with a toy in her hand, which further stretches out the tendons of the wrist. Crawling also offers the opportunity to enhance coordination of the eyes. The baby looks from one hand to the other and back again when she crawls, in the same pattern that

the eyes use for reading. The baby looks down at her hands and then across the room and back down again in the same pattern that the eyes use for copying from the black board to the paper on the desk.

At this time, the baby picks up objects of different weights. Her arm initially falls and then readjusts according to the weight of each particular object. She can release an object into a container if her wrist is stabilized on the container's edge. She no longer needs to fling her arm or use her mouth. With more time, she releases an object in the air without needing to support the wrist.

The baby masters bear walking. She pulls herself up to a standing position, first using mostly her arms, and then increasingly using her feet. She cruises along a coffee table or other surfaces at a helpful height and then learns to walk freely. Her shoulders blades pull back with her arms out to the sides and her hands up in the air when she initially stands alone and walks freely. This helps to stabilize her in the upright position. Gradually the arms relax and come down as the child's balance improves, and the hands are freed for activity in the standing position. The toddler masters a more sophisticated form of opposition where the tip of the thumb opposes the tip of the index finger (superior pincer grasp) rather than using only the pads of the fingers.

Toddlers love to give an object to another person and then have it returned. This game celebrates the capacities of the hand. Giving and receiving are archetypal movement of the hands that she has worked so many months to master. Fine motor development continues as the child grows older, but at this point, she has achieved an incredible amount, and has laid a solid foundation for all that is yet to come.

FOOTNOTE

I write this article out of my experience as a physical therapist, and specifically out of my postgraduate pediatric training in the neurodevelopmental treatment approach, or NDT approach, as it is commonly referred to. Berta Bobath and Karel Bobath, MD, developed this approach, and I am indebted to their genius. I also gratefully acknowledge my NDT instructor, Judy Bierman. Additionally, the work of Emmi Pikler has deeply influenced me. Her work is a healing balm supporting infants and young children in the development of healthy fine motor skills. In Pikler's approach the caregiver gives the infant generous floor time for self-initiated gross motor and fine motor movement, because the caregiver understands that the child has an innate capacity to guide this unfolding motor development, if given the time and space to do so. I also acknowledge my Spacial Dynamics training under the direction of Jaimen McMillan, and my study of sensory integration, originated by Jean Ayres.

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