The Developmental Steps

Now let us trace the major steps in the path of sensory integration. We shall follow them from the first month after birth up to age 7.

THE FIRST MONTH

Touch. A newborn infant can already interpret some of his body sensations and respond with built-in reflex movements. His sense of touch has been operating fairly well for several months in the womb. If you gently touch his cheek, he is likely to turn his head toward your hand. This reflex is an adaptive reaction that nature designed to help infants find a meal. Place a cloth over his face as he lies on his back and he will try to get it off by moving his head and arms. Although these innate reactions are automatic, the sensations must be integrated for the reflex to occur in a meaningful and purposeful way.

The caregiver's nurturing touch and rhythmic movements are essential in early development.

The sensations from a wet diaper make the infant uncomfortable, while the touch of his mother's hand is comforting. However, the child cannot tell very well where he is being touched, because his brain cannot differentiate one spot from another. At this age, touch sensations are more important as a source of emotional satisfaction. The touching between an infant and his mother is essential for brain development and the development of the mother-child bond.

During his first month, a baby will automatically grasp any object that touches the palm of his hand. This reflex is designed to help the child hang on to something so that he doesn't fall. Because the newborn does not have the ability to open or extend his fingers, his hands often remain curled into loose fists for the first few months of life.

Gravity and movement. The newborn also shows responses to the sensations of gravity and movement that come from his inner ears. If you hold him in your arms and suddenly lower him a foot or so, he will show alarm and his arms and legs may move outward as though to grasp something. The messages from his inner ears tell him that he is falling and that he better try to do something to protect himself. This clinging or flexion movement of the entire body is the first total-body motor pattern.

You might think that a human infant does not need automatic reactions to protect himself and find a meal since his mother takes care of him. However, these reflexes evolved in animals that needed them for infant survival. Evolution occurs very slowly and nature does not readily give up a form of behavior that has served survival for millions of years. Thus the operations of our nervous system are based upon the needs of the animals from which man evolved, and also the needs of man before he became civilized. These built-in responses provide building blocks for the development of more advanced abilities.

When the 1-month-old child is held up with his

head resting on his parent's shoulder, he will intermittently try to lift up his head. This happens because the pull of gravity stimulates the part of the brain that, in turn, activates the neck muscles that raise the head. Over the next few weeks, this adaptive response will develop so that the baby can lift his head while lying on his stomach. The same neural mechanism holds an adult's head upright without deliberate effort. At 1 month, however, it is still immature and the infant's head wobbles and needs support.

Every mother quickly learns that carrying or rocking a child brings him comfort and usually quiets him. The sensations of gentle body movement tend to organize the brain, and this is why the image of a cradle brings back so many fond memories. In addition to calming the baby, carrying and rocking provide sensations that are essential building blocks for other sensations and for self-determined body movements. Although you cannot actually see this happening in the brain, you can easily see that your child wants to be carried and rocked. Sensations that make a child happy tend to be integrating.

Muscle and joint sensations. The average 1-month-old child will adjust his body to fit nicely into the arms and body of the person holding him. He senses how to do this through his muscles and joints. Later on his muscles and joints will tell him how to use a knife and fork and how to climb a jungle gym. The child must practice and organize many, many movements to develop adult skills. In his first few months, therefore, the infant makes many movements that appear random and haphazard, but that later become well organized. When lying on his back he thrusts his arms and legs out playfully. On his stomach, he makes alternating crawling motions. These movements occur because the sensations from his muscles and joints and inner ears stimulate his nervous system to produce movements. Meanwhile the child's inner drive helps him to organize these sensations and movements.

Muscle and joint sensations also tell the brain when the head is turned to one side. This activates a reaction known as the *tonic neck reflex,* which makes the arm on that side tend to extend or straighten while the other arm tends to bend at the elbow. Notice the words *tends to.* This is only a tendency; it does not always happen when the infant's head is turned. During the first few weeks of life, this reflex plays a major role in determining arm movements, so the infant lying on his back often looks toward his extended arm while his other arm is bent. Although the tonic neck reflex influences the muscle tone in our arms for our entire life, its influence should become negligible by the sixth year. In children with poor sensory integration, the reflex is often overactive, so therapists may look for overactive tonic neck reflex responses as a sign of poor sensory integration.

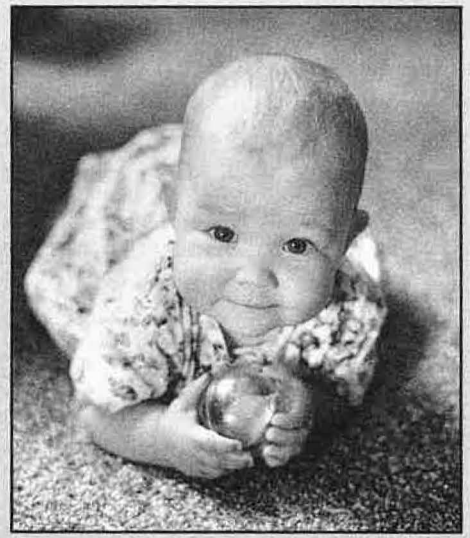
Sight. The 1-month-old infant's sense of sight is not very well organized, although he does recognize his mother's face and other significant objects. His focus is vague and he cannot differentiate complex shapes or color contrasts. He can sense danger in movement or in touch, but not from sight. His first step in developing vision is to learn to follow a moving object or person with his eyes and then his head. This adaptive response requires sensations from the muscles surrounding the eyes and in the neck, in conjunction with gravity and movement sensations from the inner ears. Notice how an infant becomes alert and happy when he sees movement in people or animals or toys, and can practice his ability to follow them with his eyes.

Sound. The 1-month-old child will respond to the sound of a rattle or bell, and also to the human voice, although he cannot understand what these sounds mean. He may turn his head or smile. Simply responding to sounds is the first building block in the development of speech. He also makes small throaty sounds. The muscular contractions in the throat that

cause these sounds also produce sensations that help to develop speech areas of the brain.

Smell and taste. Another sense that is probably well organized at birth is the sense of smell. It may play an important role during the first month of life. Like the senses of gravity, movement, and touch, this sense appeared early in the evolution of animals from which man evolved. The sense of smell is not further developed and refined in the older child in the way that sight and hearing are. The infant can also taste well. Sucking is the adaptive response that comes from taste and smell, and the infant usually has the reflex at birth.

So at 1 month, the infant has already performed a considerable number of adaptive responses to sensations, particularly to the sensations from his own body and from gravity. Many of these responses are built into his nervous system before birth and are turned on by the sensations of gravity and movement and touch. Without the integration that occurs in this simple sensorimotor activity, adequate development would be impossible later in life.



In the third month, the child is driven to raise her head and upper body in a way that helps her to see and explore her world.

THE SECOND AND THIRD MONTHS

The eyes and neck. The infant's motor functions develop from head to toe. The eyes and neck are the first body parts he learns to control. Keeping the head and eyes stable is a fundamental ability that has very important survival value. Visual perception involves more than just looking at something; in addition, the eyes must hold a steady image of the object and the neck must keep the head steady, otherwise the object would appear to blur and flutter, like a photograph taken by a camera that is not held steady. For this, the brain must integrate three types of sensations: (1) the gravity and movement sensations from the inner ears; (2) the sensations from the eye muscles; and (3) the muscle sensations from the neck. The brain puts these three types of sensations together to know how to hold the eyes and neck steady.

As the infant scans the room and looks at people and objects, his brain is busy working to integrate the sensations from his inner ears, eye muscles, and neck muscles. Through this integrative process, he learns to "take a clear picture" of his environment even when his head or whole body is moving. This development will continue for several years and is a vital building block for learning to read. It also helps the child learn balance and overall body movement.

Rising up. When you think of how consistent and powerful gravity is, you realize how much inner drive the child must have to rise to a standing position in just 1 year. After he learns to hold his head up with his neck muscles, the infant uses the muscles in his upper back and arms to lift his chest off the floor. This development occurs in the prone position (lying face downward). The infant's urge to lift his chest comes mainly from the sensations of gravity, which stimulate the brain to contract the muscles in the upper back. The child also learns to sit upright with his head balanced if you support his lower back. Some challenge is necessary for any learning. Supporting his entire back eliminates the challenge,

while giving no support to the lower back makes the challenge too great for the child at this age.

Grasping. The 3-month-old infant's hands are open most of the time. He reaches for objects and people but lacks the eye-hand coordination necessary to make his reach accurate. As he integrates body sensations with what he sees, he finds out how to aim properly.

When he grabs, he does not use his thumb and forefinger; instead he holds the objects with his three other fingers and the palm of his hand. He grasps a rattle in this simple way, and his sense of touch sends messages to his brain that help him to hold on to the object. At this age, grasping is still an automatic reaction to the touch sensations in the palm of his hand, and he cannot voluntarily release his hold on the rattle. Over the next few months he will integrate these touch sensations with the sensations from the muscles and joints in his hands and gradually develop a more efficient pincer motion with this thumb and forefinger.

THE FOURTH TO SIXTH MONTHS

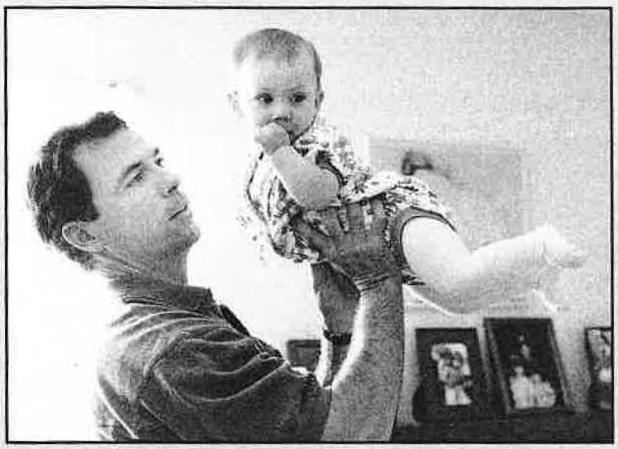
The arms and hands. Now the baby makes big movements, such as banging a spoon against a table, and experiences the thrill of having an impact on the physical world. This very simple emotional satisfaction is a building block toward the more mature emotions that develop later on.

He now begins to touch and look at his hands, and thereby develops an awareness of where his hands are in space. He needs touch and muscle and joint sensations along with vision to learn to use his hands accurately in conjunction with what he sees. He has to coordinate the parts of his brain that "see" with those parts that "feel" the hand and arm. He begins to use the thumb and forefinger, but his grip lacks precision. He is apt to reach with one hand more often than with both together since he can now control his urge to reach.

One of the most important developments at this age occurs when the child spontaneously brings his hands together in front of his body so that they touch each other. This is the beginning of coordination between the two sides of the body. Another step in this development occurs a few months later when he holds a toy in each hand and bangs them together. These actions require an important type of sensory integration that must develop long before the child can know his right and left. Infants who do not touch their hands together and bang toys are more likely to show signs of poor sensory integration when they are older.

By the sixth month, the child's wrist rotates so he can turn his hand and manipulate objects and play in many new ways. Most of the movements in the first 6 months were automatic, but now the infant begins to do things that he must plan. Each new play activity involves more of this "motor planning" and more sensory integration. He can also sit alone for a short time without losing his balance. The automatic muscular reactions that keep him upright are guided by the sensations of gravity, movement, and sight. If these sensations are not well integrated, the infant will have difficulty sitting or may not even try to sit.

The airplane position. At about 6 months, the infant's nervous system becomes particularly sensitive to the pull of gravity on his head while he is lying on his stomach. This sensitivity produces a strong urge to raise the head, upper back, arms, and legs all at the same time. The baby balances his whole body on his stomach, and looks a little bit like an airplane. Therapists refer to this as the *prone extension posture*. This position is a vital step in developing the muscles that are used for rolling over, standing up, and walking. Older children who cannot hold this position often have problems integrating gravity and movement sensations.



By about 6 months, a baby automatically moves upward away from the pull of gravity, orienting her head and body in space.

The joy of being moved. The 6-month-old child also likes to be rocked, held up, swung in the air, turned over, and moved about. These are among the most satisfying experiences of infancy. The joy comes from experiencing stronger gravity and movement sensations, which the child can now integrate. If the movements are too rough or the child cannot integrate the sensations, they will disorganize his nervous system and cause him to cry.

THE SIXTH TO EIGHTH MONTHS

Locomotion. One of the most important aspects of development during this period is locomotion, or movement from one place to another. Locomotion greatly increases the number of things and places the infant can explore. Crawling and creeping on hands and knees contribute many sensations to be integrated and also give the child a concept of himself as an independent being.

First he must get himself into the prone position, on his stomach. A reflex known as the *neck righting reflex,* which has been active since birth, helps him turn over from his back onto his stomach. This is the same reflex that enables a cat to land on its feet even when it is dropped with its back down and feet up. The sensations that activate this reflex come from gravity and the muscles and joints of the neck. These sensations activate the neck righting reflex for much of the time at this age, and so the normal infant tends to spend a lot of time lying on his stomach.

Spatial perception. Locomotion gives the child knowledge about space and the distance between himself and objects in the environment. It is not enough merely to see things to judge distance; the brain must also "feel" the nature of distance through the sensations of body movement. As he crawls and creeps from one place to another, he learns the physical structure of space, and this helps him to understand what he sees. Good distance judgment also helps the child to know how large things are. If the child at this age has difficulty integrating the sensations of crawling and creeping, he may have trouble later on judging distance and size.

By 8 months, the child is learning about space and distances as she crawls from one place to another in a way that helps her to navigate the world around her.

The fingers and eyes. The child can now use his thumb and forefinger in a scissors or pincer action to pick up small objects or pull a string. He can also poke his forefinger into a hole. The sensations of touch, and those from his muscles and joints, provide the basic information and guide these movements. For fine hand motions, however, he needs precise information from his eyes. He must have fine control over his eye muscles to direct his eyes precisely to the place he needs to see. To develop precise eye control, the child must already have the simple eye control that developed as he lay on his stomach and raised his head, crawled, and crept about in his environment.

Motor planning. At this age, the child begins to plan his hand movements well enough to ring a bell or put simple things together and take them apart. Movements must be planned inside the brain to complete a series of actions in the proper sequence. Sensations from the body provide the information necessary for planning movements.

This is also the age when the child begins to look for an object that has been covered up or dropped out of sight. By touching and moving around objects, he learns that they still exist even when he cannot see them. This is the beginning of the mental ability to visualize objects.

Babbling. The 8-month-old child listens to sounds well enough to hear details. He recognizes familiar words and knows that some sounds mean one thing and others mean something else. He may repeat simple syllables such as "ma" and "da," although this is not really speech. Babbling sends sensations from the jaw joint, muscles, and skin of the mouth to the brain. As the brain integrates more and more of these sensations, it learns how to form more complex sounds. If the child has difficulty with babbling, he may have trouble learning to speak.

THE NINTH TO TWELFTH MONTHS

This is the time for major changes in the way the child relates to the earth and the space around his body. He creeps for longer distances and explores more places in his environment. This stimulates his nervous system with many sensations from the muscles that hold up his head and body and the bones that support his weight, and also from the pull of gravity. These sensations help him to coordinate the two sides of his body, learn how to motor plan, and develop visual perception. He spends a lot of time just looking at things and figuring out what they are. The greater the variety of things he experiences as he roams about, the more practice he gets in integrating sensations and forming adaptive responses to those sensations.

Toward the end of the first year, the child refines coordination and hand skills through play.

Play. Watch your child banging things together, pulling them off a table, throwing them about, and so on, and try to see the importance of what he is doing and sensing. Very often one of his hands reaches across to the other side of his body. These motions develop his ability to *cross the*

midline, a very important ability that is sometimes poor in children with sensory integrative dysfunctions. Every time he puts something together or takes it apart, his brain learns to plan and carry out a series of movements in proper sequence. Every time he makes a mess of his food with a spoon or scribbles with a crayon, he learns something about tools and how to use them.

Standing up. One of the biggest events in early childhood is standing up alone. Few adults realize the significance of this magnificent achievement and what it means to the child's self-concept. It is the end product of all the integration of gravity, movement, and muscle and joint sensations of the months before. Standing up requires the integration of sensations from every part of the body, including the eye and neck muscles, which continue to be essential. Standing up is quite a challenge, since a relatively tall body must balance itself on two small feet. It is best to allow the child to practice standing up on his own, so that he masters that challenge by himself.

One of the biggest events in early childhood is standing up alone—a magnificent, gravity-defying feat that contributes to the child's self-concept.

Words. The child can now understand a fair amount of what his parents say but can speak only a few simple words, like "mama" or "dada." It appears that the sensations arising from body movement help to stimulate the part of the brain that is involved in making these sounds.

THE SECOND YEAR

Now the child learns to walk, to talk, and to plan more complex actions and perform them more effectively. It is quite certain that without all the sensory integration that took place during the first year, it would be very difficult for the child to learn these things. And in turn, without the integration that occurs in this second year, all subsequent development would be difficult.

Localization of touch. The ability to plan movements depends upon the accuracy of the child's touch system. At birth, the infant knew that he was touched, and touch affected his emotional state, but he did not know where he was touched. He moved his head in response to the touch, but this was an automatic reflex rather than a consciously directed action. By the second year, he can tell roughly where he is touched and also direct his responses somewhat voluntarily. We can see that touch sensations make it feel good to hold things; they tell the brain something about those things that seeing does not tell. The sensations from his skin also tell him where his body begins and where it ends. This sensory awareness of the body is far more basic than visual knowledge of the body.

Children who cannot integrate these sensations well are not able to feel exactly how their bodies are structured or what each part is doing. Therefore they have trouble learning to do things. They may learn to sit, stand, and walk all right, but they have trouble

playing with toys or using buttons, zippers, and kitchen utensils. If you see a child fumble around with things or drop them more often than other children his age, he is probably not getting good, precise touch information from his hands.

Moving. During this year, the child practices countless variations of movement to gain additional sensory awareness of how his body functions and how the physical world operates. He picks up things and throws them, pushes and pulls toys, walks up and down stairs, explores his home and the world outdoors, and gets into everything, often to his parents' distress. However, parents should be more distressed if the child does not get into everything. A child needs opportunities to interact with the physical environment as much as he needs food and love.

Mapping the body. Children at this age enjoy roughhousing, piggyback rides, and swinging. These activities provide a lot of sensory input from the body and from the gravity receptors in the inner ears. They give him a feeling of how gravity works, how the different parts of his body move, how they interact with each other, what they cannot do, what feels good, and what hurts or feels uncomfortable. All of this sensory information forms an internal sensory "picture" of the body inside the brain. We shall call this a *body percept*. To understand the body percept, it may be helpful to think of a world atlas that contains maps of every part of the world. As the child moves and experiences the consequences of his movement, he "maps out" his body. His brain stores countless bits of information that he can later use to "navigate" his body movements.

During the second year, the child's sense of touch enables him to perform precise hand movements.

Climbing. Children have an inner drive to explore space not only horizontally, but also vertically. Children climb some things even before they walk. In order to climb, the child must have well-organized gravity and movement sensations, and climbing further integrates these with body sensations and visual information. Climbing requires a great deal of "sensorimotor intelligence" and is an important step toward the development of visual space perception.

Two-year-olds also learn to understand and follow directions and instructions. Most children learn to say a number of things during this year; others wait until the following year for their major speech development.

Selfhood. If the sensations from the child's body are making him feel like a secure and competent individual—a being separate and distinct from his mother and every other person and thing—then he is well on his way to developing a satisfactory self-concept. Establishing *selfhood* becomes an important task as the child approaches the age of 2. He is an individual person, because he feels his body as a physical whole and can move well by himself. He is no longer a slave to gravity; he can stand upright, walk long distances, go up and down hills, jump, and climb. He can hide and reappear because he knows the dimensions of his body, and peek-a-boo is an important activity at this age. By having an impact on his environment, he furthers his sense of self; and so he enjoys pulling pots and pans out of cupboards, knocking things over, and making marks with crayons and paint.

As he approaches his second birthday, he begins

to feel that he can be in command of his own life, and he lets others know this. Many children at this age use the word "no" to express their new-found independence. This may be frustrating to parents, but it is a necessary stage in the development of social skills. It takes a lot of patience and wisdom to accept the child's need to resist his parents' wishes.

The child can be in command of his life only to the extent that his body sensations allow him to move freely and effectively. His life is still mostly feeling and moving, in addition to eating, sleeping, and relating to family members. The integration of sensations provides the foundation for good relations with people. If a child behaves poorly with other people, this may be a reflection of his inability to deal with sensations.

Although the child has taken the first steps toward being a self-reliant person, he is still a long way from being on his own. He needs a great deal of support, encouragement, and comfort. A lot of this comes from being hugged, held in someone's lap, rocked, cuddled, and kissed. Comforting sensations are integrating, and they help to organize a child when he is temporarily disorganized.

In the second year, the child develops a sense of self and newfound independence.

THE THIRD THROUGH SEVENTH YEARS

During these 5 years, the child becomes a mature sensorimotor being who can talk and relate to many different people. Higher intellectual functions will develop after age 7, and they will develop better if the sensorimotor functions are well developed. The third through seventh years are a critical period for sensory integration. Nature intended this to be the time when the brain is most receptive to sensations and most able to organize them. The child's inner drive makes him very active and he learns to do many, many things with his body. His adaptive responses are more and more complex, and each adaptive response expands the child's capacity for sensory integration.

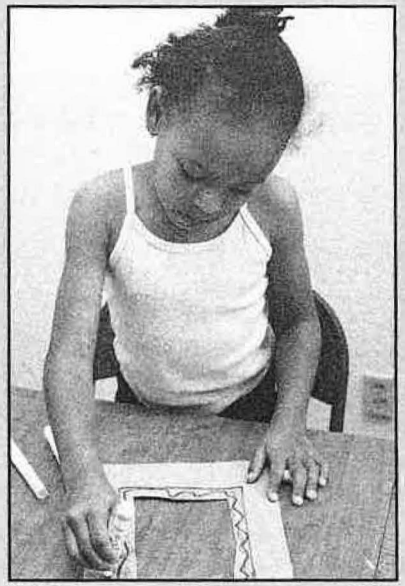
Watch a child run, jump, hop, skip, roll, wrestle, climb, and swing. He does these things because they are fun; and they are fun because they further sensory integration. Notice the improvements in balance, eye-hand coordination, and planning of a sequence of movements. Notice how the child tries things that are dangerous so that he learns the limits of his sensorimotor ability. Notice how he pits himself against gravity and comes to terms with that powerful and unforgiving force. Playgrounds are popular with children because swings, slides, merry-go-rounds, monkey bars, seesaws, tunnels, and sandboxes fill the needs of the developing nervous system.

Using tools. Between the ages of 3 and 7, a child learns to use simple tools such as knives, forks, shovels, pails, needle and thread, scissors, crayons, pencil and paper, shoelaces, zippers, buttons, and all the other devices that make up a home. Each task requires all the sensory information that has been stored in the brain during earlier activities.

Adults take it for granted, but sensations from the body are absolutely necessary to tell the brain how to put on a pair of pants, butter a piece of bread, or dig a hole in the ground.

Toward the end of this period we see, especially in girls, a final "polishing" of motor skills through complex games such as hopscotch, jacks, hula-hoop, jump rope, and cat's cradle. Boys usually work more on feats of strength and sports.

By the time a child is 8 years old, his touch system is almost as mature as it will ever be. He can almost always tell with great accuracy where he is being touched. His sense of gravity and movement is also almost fully mature. He can balance himself on one foot and walk a narrow surface. Most of the sensations from his muscles and joints should be well integrated, and his ability to plan a sequence of actions is good, although it will improve in the next few years. He understands and speaks language well enough to communicate his needs and interests.



Between the ages of 3 and 7, the child learns to use tools adaptively and with increasing complexity of skill.

Jean Piaget, the famous observer of children, found that they do not begin abstract thinking and reasoning until they are 7 or 8 years old. Piaget suggested that the human brain is not designed to process abstractions until it has a "concrete" knowledge of the body and the world and its physical forces. Seven or 8 years of moving and play are required to give the child a sensorimotor intelligence that can serve as the foundation for intellectual, social, and personal development.

But sometimes this development does not occur the way nature intended. We cannot tell why things go wrong in a particular child, but we do know what the child is like when his brain has difficulty integrating sensations. We cannot take the place of nature and make everything all right, but we can do some things to help the child organize himself a little better. The ability to help a child to organize his brain comes from watching children follow their own inner drive toward sensory integration. The more you watch your child, the more you will be able to help him.

Note: *For expert commentary by Susan H. Knox, Ph.D., on the issues raised in this chapter, see Appendix A.*