CHAPTER 1

Learning From Birth to Two Years

All children are learners. Learning to read can be especially hard. To determine why learning to read is so difficult, the human brain that accomplishes the task of becoming a reader is the focus of this book.

In this beginning chapter the infant brain is explored. Even in utero the miniature brain is functioning and directing activities of an ever so tiny, forming embryo. Immediately after birth there is rapid firing of individual or sets of neurons (nerve cells) as they connect to each other. Neurons fire when they are roused by sensory stimulation from the infant's environment. Maturation of the motor and somatosensory cortex, which will be explained later in this chapter, allow the developing brain to gain control of muscles throughout the body from top to bottom. Development of the five senses is of particular interest. It is essential for baby to receive information from the environment to stimulate the connections needed for each sense to establish itself.

Parents and care providers are encouraged to be aware of their important roles. Much of what parents do with their babies happens naturally: holding, swaying and patting, talking with elongated words, feeding, and making eye contact, to mention a few. If parents are inexperienced or unaware of baby's environmental needs, parent training classes may be attended at childcare centers or public schools. A continuum of developmental benchmarks located in this chapter, provides support to teachers as they help parents and care providers to follow an anticipated sequence for their child's growth and benchmark development.

Language begins with babbling and results in a recognizable word or two at one year. Phonemes, the sounds from a word when voiced in its smallest parts, and the language a child hears are practiced prior to 10 months of age. Repetition and reinforcement of sounds determines which sounds a baby learns. At 18 months many children begin adding recognized vocabulary at a rate of one new word every two hr or so. At this stage of brain development metabolic activity and neural connections are higher than at any other time during life.

Parents, who are aware of the important role they play in the child's eminent reading ability, make a conscious effort to "talk, talk, talk" to their infants. They encourage vocabulary development and build background information critical for comprehension through conversation and story reading. Nursery rhymes are valued for the development of abstract phonological sounds. Oral language development in early childhood is so important, along with genetic influences, that research reports there is a causal or continuing relationship with the forth-coming ability to read. (Hope Abilitation Medical Center, 2019; Dickinson et al., 2010).

SOME PIVOTAL QUESTIONS

SUMMARY QUESTIONS

Before learning to read can be understood in neurological terms, it must be acknowledged that children are born as learning creatures. Children begin learning at birth or earlier. Realizing the learning capacity that is present at birth allows a gateway of questions about building the reading brain. The questions identified here, are big picture understandings that are addressed throughout the book's chapters, are not addressed in order, and are summarized in Chapter 11.

1. Children learn to speak naturally, why is learning to read so difficult?
2. How does a baby's experiences shape the brain?
3. How can potential reading success be determined when a child is only three years old?
4. Why is there interest in cognitive skills for focus, concentration, and attention even for very young children at one and two years of age?

5. What is the importance of sounds called phonemes in terms of the child's cognitive development for reading?
6. Why are some teaching strategies for decoding less effective than others?
7. Why is there so much interest in teaching children to read in kindergarten? What helps to determine if a young child is ready to learn to read?
8. Why do some children experience difficulties when they try to read?
9. What is happening in the brain when children read with fluency and comprehension?
10. How do children move from learning to read to reading to learn?
11. How do students develop an understanding for word vocabulary?
12. What proficiency for reading is expected at the end of third grade? How do children's brains function during proficient reading?

Each of these questions has a comprehensible response. When the cognitive aspects of learning are understood, teachers can add this information to their ever progressing wealth of methodologies and materials. Understanding a child's brain function provides answers to questions teachers have about how much time to spend on a teaching skill, how much repetition is needed, or what ways the material can be presented to hold students' attention. The reader of this book is invited to start at the very beginning of a child's life, and to follow the progression of brain development needed for students to become proficient, skilled readers as eight year olds.

CHAPTER QUESTIONS

Questions are located at the end of each chapter. Readers may want to read the questions prior to reading the chapter to direct their thinking, and also to develop their own inquiries.

WHAT IS KNOWN FROM NEUROSCIENCE?

An infant is already becoming a learner as the brain rapidly builds itself. This is known, but the development cannot be seen without sophisticated imaging techniques. Advances have been made with systems that are non-invasive even for children under the age of one. For example, electrical field changes are measured through Event-related Potentials (EEG/ERP), a noiseless, inexpensive measure of temporal resolution to allow studies of early speech and language processing in young children. Another technique has a horrendously long name, Magnetoencephalography (MEG). This magnetic field testing, which is safe and noiseless, allows baby's head movement while it records phonetic discrimination in newborns and infants as they listen to speech. Neuroscientists have recorded Lexico-sematic word meaning, in the left frontotemporal brain areas. Lexico-semantics is the study to describe the meanings of words and how to account for the variability of meaning from one context to another. The fact that scientists are intent on obtaining measures through this type of sophisticated measurement and with several other available imaging devices validates the importance of social interactions and language advancement for very young children, even as infants (Kuhl, 2012; Reynolds et al., 2010).

Each child is progressing through developmental stages during the years from the womb along a pathway that culminates with adulthood. Every child has story to be told. One by one they contribute to a family and to the community. Eventually as they come to a classroom each is unique and comes packaged with an unimaginable potential for creativity. The entire education community scrambles to find answers about the neurological process behind learning, particularly, "What happens in children's brains as they learn to read?" It is discovered that children are not only programed to learn, but also that with specific instruction their brains can be coaxed and trained for proficient reading. Educators in all the various roles, caring parents, and involved child-care providers, embrace with a passion the goal of reading for all children.

THE HUMAN BRAIN AT ITS BEGINNING

The beginning is not birth, rather it is conception. What happens to a fetus' brain during pregnancy can impact the success a child has in school. It is known that pregnancy can be labeled by trimesters. Realize that at the end of merely four weeks of development in the first trimester the nervous system has already begun to form. The nervous system is *the brain, the spinal column, and the complete network of nerves* that connect the brain to all parts of the body. That means the brain is developed enough to direct the spinal cord, the heart, and the arms and legs, which are beginning to bud (Mayo Clinic

Staff, 2022). The embryo is 1/25 of an inch long. The brain is functioning. (Targonskaya, 2020).

At the eighth week of the first trimester all major organs have started to form. The heart is beating and pumping needed nutrients to the arms and legs, which now have fingers and toes. Even the tiny face has the beginnings of features. At this point in development, the baby is called a fetus at almost an inch long and weighing less than 1/8 of an ounce. At the end of the first trimester, which is about twelve weeks, the baby is able to use muscles and nerves together to form a fist. Eyelids close at this time to protect the developing eyes. They will not reopen until the 28th week. Although the head has been growing to keep up with the expansion of the brain, it will slow at this time to allow growth of the rest of the body parts. At this stage the baby is slightly less than three inches long and weighs about ½ an ounce (Mayo Clinic, 2022).

It seems unimaginable that a living being can be so small and still have most of its body parts developing under the direction of such a tiny brain. Certainly, the second trimester and third are equally interesting. Curious readers can find a continuation of conception to birth details at the OnHealth listing in the References (Stoppler, 2022). The first trimester is provided as the most dramatic example of the human brain's unimaginable administrative functioning and its capabilities. Although incredibly small, the brain becomes the CEO, Chief Executive Officer, of the miniature body as it develops itself according to the coded instructions of a unique individualized set of genes and chromosomes. In the womb the brain interprets complex DNA information to direct all the body's development and growth at the beginning and throughout life (Thomas et al., 1995).

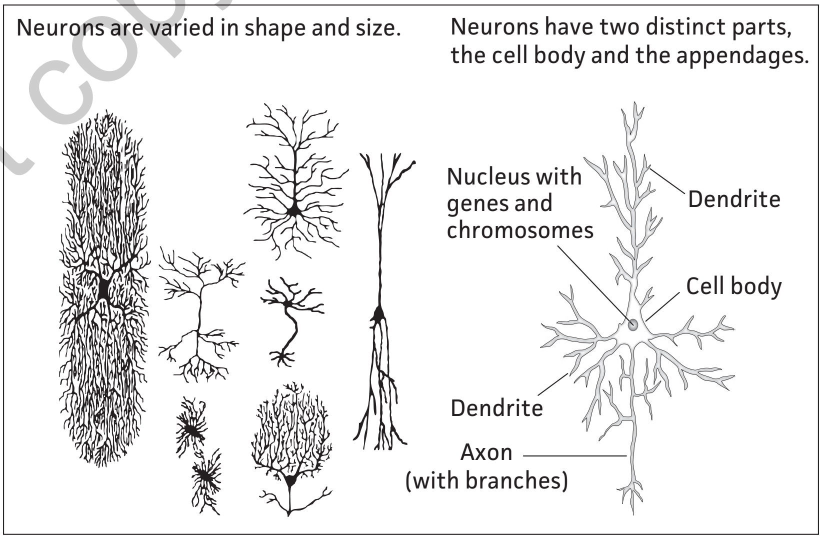
MICROSTRUCTURES OF LEARNING

It is asked, "When does a child start learning?" The answer is illusive, as even those versed in education may have a variety of responses as they define learning. A dictionary description from Oxford Languages reads like this "the acquisition of knowledge or skills through experience, study, or by being taught." It is known that a child at birth is ready to learn. Additionally, at the time of a natural birthing process an infant's reflexes and motor development are stimulated (Stanford Medicine, 2022). At this early stage the brain itself is wired sparsely, but it is expansive in its number of nerve cells. A baby's brain has about as many brain cells, **neurons**, as there are stars in the Milky Way. That is a huge, unimaginable number, 100 billion neurons.

A look at a single neuron gives meaning to what is happening microscopically in the brain. Neurons develop during the fetal stage at a rate of up to 250,000 per minute when the neural tube closes at about 7 weeks and then throughout the next 21 weeks prior to birth (Graham & Forstadt, 2011; Rakic, 1992) (Figure 1.1).

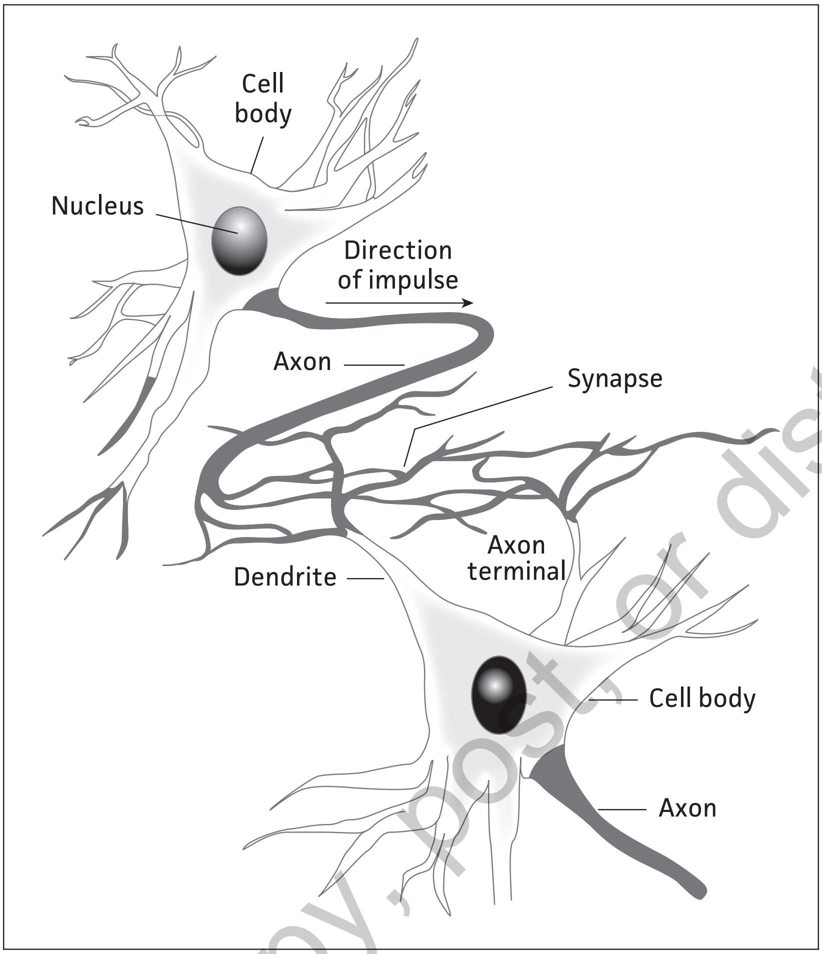
Connections between nerve cells occur as **dendrites** spread from a neuron cell body seeking other neurons. Dendrites, short, hair-like input fibers, pursue an **axon** branch to make a connection. One elongated axon, the output fiber, goes forth from each neuron's cell body sending impulses to other neurons. Each axon develops many branches to search for a dendrite from a neuron in the same general area of the brain. Neurons communicate by an electrical shock from the nucleus of an axon that flows down the axon to a **synapse,** a small space, where it spews its chemicals. A nearby dendrite uptakes the chemicals and sends them to the receiving neuron. Here the receiving neuron's nucleus responds again with an electrical charge that continues the journey down its axon. The process continues from one neuron's axon to another neuron's dendrite, until it loses its electrical and chemical responses. This is the complex process for one neuron to connect to another. Imagine the fireworks in the brain when tens of thousands of these connections are occurring at once.

FIGURE 1.1 ● Neurons are varied by shape and size depending upon their location in the central nervous system. Neurons have distinct parts: a cell body with a nucleus, and appendages. Here is a neuron with appendages: axon branches and a large number of dendrites.



Source: Nevills (2014).

AQ1 **FIGURE 1.2** ● Neurons communicate chemically across a synaptic channel and electrically within the neuron body.



Source: Nevills (2014).

The strength and re-occurance of the reaction determines the potential for learning and remembering.

A microscopic look inside any area of the brain soon after birth would reveal a rapid expansion of nerve cell networks. Realize neurons are differently shaped, depending upon where they are found in the central nervous system. (Refer to Figure 1.1.) During a child's growth years the number of neurons remains relatively stable, but each neuron grows more dense and heavier with a proliferation of dendrites and an expansion of synaptic connections.

THE DEVELOPING FIVE SENSES

An infant's brain is busy making sense of the space that surrounds it by receiving information from the five senses. Think about it this way. If a young child did not have environmental input from the senses, there would be no need to respond, no brain development, and furthermore, access to learning would not only be blocked, but also nonexistent.

As a child gains control over different body parts the senses are emerging: first smell and taste, followed by clearer vision, sharper hearing, and understanding the pressure or pain of touch. Everything is awakening. The child's brain is rapidly developing connections to make sense out of the world in which the child discovers himself or herself.

SMELL

Scientists have studied the five senses as they develop. It is well known that the sense of **smell** is completely functional at a full-term birth. Colleen de Bellefonds reports in *What to Expect*, 2021, that during the third trimester of pregnancy a baby can smell almost everything mom eats or inhales. The early maturation of the sense of smell is a survival issue, as it is observed that a full-term baby merely hours old will turn toward the scent of mother's milk or a bottle, and begin to suck. The infant has been practicing in utero to pucker the tiny lips, and to draw in the life-sustaining milk. This sense is so vital to the baby's feelings of security that parents and care-providers are advised to "keep the scents baby smells consistent." This means to avoid changing personal soap or lotions, and to refrain from washing baby's blankets or stuffed toys unnecessarily. The olfactory environment is best for a newborn baby when it is as stable, pleasant, and as comforting as possible. A place where the odors smelled are predictable during the early months, supports child-parent bonding and feelings of emotional security. *Hedonics*, the distinction between good and bad smells, does not complete development until around three years of age.

TASTE

There is a very early preference in **taste**, also. It is believed that flavors from the food the expectant mother eats are passed through the amniotic fluid, the life source for nutrition of the developing baby. Young children learn the "tastes of the culture" very early. Taste is terribly important for an infant, not only for its nutritional significance, but also as other senses and motor abilities are relatively underdeveloped. Chemical detectors on the tongue, roof, soft palate, and upper throat area detect four categories—sweet, salty, bitter, and sour. The tongue alone has about 4,500 taste buds, and each taste bud can have as many as forty taste receptor cells. Taste stimulation to the medulla at the top of the spinal cord unconsciously (no frontal lobe action from the brain required) activates salivation, swallowing, and tongue movements. Taste information controls motivation to eat and drink (Forestell & Mennella, 2017). Taste and smell combined allow the full appreciation of taste. Note that if sensations of smell are blocked up to 90% of the refined sense of taste can be lost.

VISION

At birth an infant's **vision** is of a relatively dark world with movement appearing through a long narrow tunnel centered on a line of sight. Eye movements are uncoordinated. A newborn can detect the difference between light and dark, but is unable to see colors. Some infant books consist of black and white patterns to respond to this stage of visual maturation. Visual resolution for a child at birth is one-fortieth of that of a normal adult, which equates to about eight to ten inches from the eyes out into space. From being able to focus on a human face, when held as a newborn, the infant's brain rapidly adjusts to environmental stimuli, and can see almost as well as an adult by the first birthday. Without environmental stimuli, which could be the result of low vision or no vision, neurons predetermined to build the visual system will atrophy or migrate to another area of the brain to help development of a different sense. This added neural support will mitigate the loss of one sense to make another sensory system more powerful. (UCLA, 2009)

Recognizing seen objects begins as neurons naturally migrate to different areas of the brain for visual interpretation. The process is complete through the formation of a refined map of neural wiring. The connections happen through seeing, which is determined by the nurture of the environment. There are sensitive periods in children's lives when specific systems are developed. Neurons for vision begin sending messages back and forth with rapidity during the second and fourth months of baby's life, and peak with intensity by eight months. At around two months of age baby develops obligatory looking, which becomes a "gaze-fest" between an adult and the child as they fixate on one another. Fixation engagement can be emotionally charged as love is fostered between child and parent.

Depth perception, color vision, fine acuity, and well-controlled eye movements are in place at six months of age. The child's brain is tasked to convert light information into electrical signals that map each color, shape, and point in a visual field.

Images are a series of dots that are filed, organized, and stored in the brain for interpretation. Different areas of each side of the brain are devoted to recording and saving the parallel process of visual stimuli for color, motion, shape, and depth.

HEARING

During pregnancy mothers notice that the fetus may kick or jump as a response to unusual or loud noises. The child may settle down after a time of activity upon hearing somewhat muffled soft voices, music, or calming humming. **Hearing** in utero begins about twelve weeks before birth and develops a definite preference for mother's voice. Hearing is routinely tested in the hospital prior to the baby's release. Infants need input from many different sounds in the home environment to stimulate the pathway from the ears to the auditory interpretation area. They prefer to hear language called "parentese", which is speaking with slower, higher-pitched words and strong intonation. This type of speech is naturally used by parents and care-providers in all cultures. Hearing is likely the most important sense for development of early reading skills. The variation of sounds allows an infant to experience the language of words, rhythm, rhyme, and music, which may be provided through singing, all stimulate the brain as it develops for both cognitive and emotional growth.

A small percentage of children are born with an inability to hear. If the loss is present at birth, it is called a congenital hearing loss according to ASHA, the American Speech-Language-Hearing Association. There are various causes for hearing loss including premature birth or genetic factors. Genetic factors can be present at birth or develop later in life. Both hearing and deaf parents can have a child with a hearing disability (ASHA, 2022). Information provided by CDC, Centers for Disease Control and Prevention indicates the prevalence of hearing loss in babies was 1.7 per 1,000 of those tested for hearing loss in the Unites States. Over 98% of newborns are screened (CDC, 2019). Most babies develop normal hearing during the first year of their lives.

TOUCH

The all-important **touch** sensation runs from the body parts via the spinal cord to the base of the brain where the thalamus routes the signal to the somatosensory cortex. The thalamus, which is located in the center of the brain and acts as a relay station, is described in Chapter X. After this instantaneous relay the baby can feel pressure, pain, heat, or coldness. Remember there are many, many more sensory receptors for human babies and adults around the mouth, hands, and fingers than are in the rest of the body.

Touching babies is an innately programmed parental behavior, a natural and loving activity that promotes health and normal growth. Newborn babies are comforted when a hand is placed on their belly or they are wrapped tightly (swaddled), and as they are cuddled. A caveat, pediatricians warn about swaddling infants after two months, as they need freedom to build the ability of rolling from their back to the stomach (WebMD, 2021). Because the sense of touch is so prominent babies respond to being in a sling or a carrier, which allows them to perceive closeness to another person.

The five senses become alert and activated and the young one responds in new and advancing ways through the months leading to the end of year one. Through the five senses very young children are always learning something.

MACROSTRUCTURES OF THE MOTOR CORTEX AND THE SOMATOSENSORY CORTEX

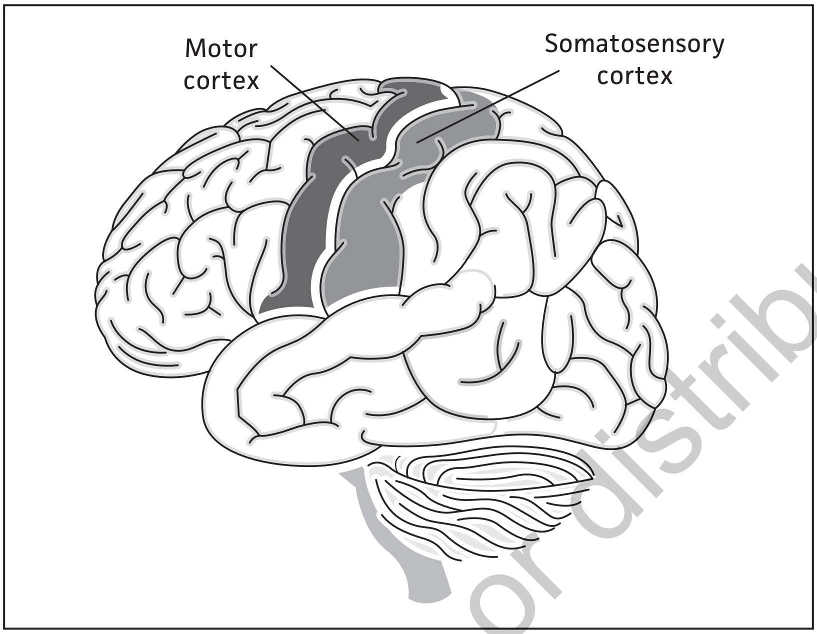
During the first few years of life the brain is wiring itself at a tremendous pace to learn to speak, move body parts, and to understand the setting surrounding the child. Trillions of connections are formed as the infant (in fantis, meaning “not speaking”) attempts to understand sounds, particularly those from people, and uses information from the five senses to comprehend the importance of the space around the small body.

In the brain the **motor cortex** and the **somatosensory cortex,** also called the sensory cortex, are macrostructures that are located next to each other, forming a headband at the top of the brain. The motor cortex follows a highly specific order of growth and development. First, it develops ability for head movement, followed by the arms and hands, and then connections become coordinated throughout the body. The movement extends to all four limbs. The legs and feet are the last to respond. It makes sense that a child has good control of the hands long before walking is accomplished.

THE MOTOR CORTEX

The motor cortex is adjacent to the sensory cortex, which was referred to previously as the somatosensory cortex. As an infant takes in information through the senses the motor area is stimulated to mature and respond. A look at Figure 1.3 provides an image of the brain, the **cerebral cortex**, with its

FIGURE 1.3 ● The brain showing the motor cortex and somatosensory cortex.

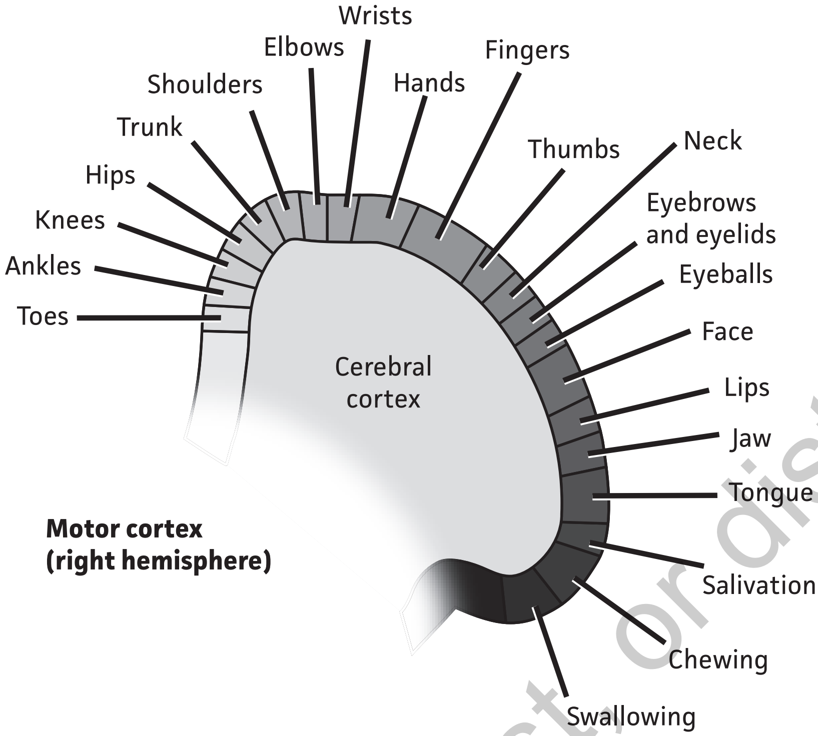


physical shape. Of specific interest is the motor cortex and the somatosensory cortex, which stretch across the top of the brain from ear to ear. The motor cortex controls all movement functions, which involve planning, muscle control, and execution. An exception is reflex actions, such as sneezing, blinking, or shivering, which are automatic responses from an area at the top of the spinal cord, where the brain stem is located. Of added awareness is the connection to the brain's CEO, mentioned earlier during the discussion of brain development in pregnancy. The brain's frontal area directs cognitive thinking by drawing information from all parts of the brain to make executive decisions and provide direction for movement. Different sections of the motor strip govern the movements of specific muscles in different areas of the body as seen in Figure 1.4.

Maturation of the motor cortex is noticeable as the infant begins to reach, move, and eventually become mobile through turning over, crawling and then walking. The first part of the motor strip to mature is in the center with movement of the head and neck. The sequence previously stated follows on both the right and left sides of the body For inquisitive readers the complete sequence is provided with this figure (table).

Parents and other adults can see this development with infants. Match what is physically possible with the Continuum of Developmental Benchmarks provided later in this chapter.

FIGURE 1.4 ● The Motor Strip with development of body parts.



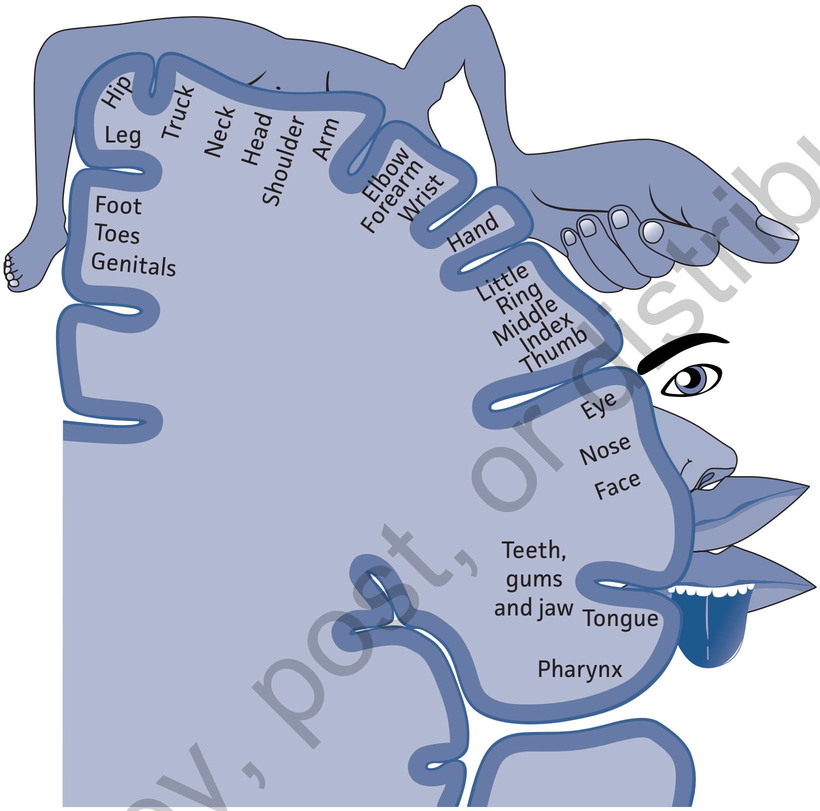
Source: CNX OpenStax. https://creativecommons.org/licenses/by/4.0/deed.en

THE SOMATOSENSORY CORTEX

Immediately behind the motor cortex lies the somatosensory cortex. While the motor cortex sends messages to the various muscles in the body about how and when to move, the somatosensory cortex receives information from the environment through the baby's rapidly developing senses and interprets the information with help from the **parietal lobe**, which is introduced later. Infants develop feeling and elicit responses to temperature, hunger, pressure, or pain. Also, developing is knowledge of where the limbs are in relation to the rest of the body. As with the motor cortex, each part of the body is represented by a specific area on the surface of the somatosensory cortex and maturation of bodily sensations follows a developmental sequence. Figure 1.5 gives the areas of the body as they are represented in the somatosensory cortex (Human Physiology Academy, 2020).

Notice the oddly shaped person in Figure 1.5. Upon careful observation the over-emphasized areas of the body are most populated with nerves in the very young child. Certainly, the size of the head, particularly the mouth area, and the enlarged hands give a good indication where the strongest sensations

FIGURE 1.5 ● The Somatosensory Cortex labeled for the body areas responsible for receiving signals and sending signals to the thinking areas of the brain for interpretation. Additionally, a figure representing the over-sensitivity of nerve cells in the developing infant.



Source: Anatomy & Physiology, Connexions Web site. http://cnx.org/content/col11496/1.6/ . https://creativecommons.org/licenses/by/3.0/

are experienced by the baby and sent to the somatosensory cortex for interpretation.

COGNITIVE GROWTH

Developmental benchmarks are observable, however cognition is not as easily identified. What happens in the human brain is more difficult to assess, but dynamic in process. Cognitive skills allow a child to think, explore, or solve problems. Consider the fields of *cognitive psychology* and *cognitive neuroscience*. Although they are intimately related, the way they are measured and their terminology differs. *Cognitive psychology*, according to Usha Goswami (2020), professor of Cognitive Developmental Neuroscience, can be identified by defining **mindfulness**.

Mindfulness allows a young child to hold thinking concepts in the brain for consideration. To assess cognitive concepts a psychologist presents a task, and then measures the infant's accuracy or response time. *These measurements provide insights into abilities of attention, concentration, memory, and organization (concept development),* which are increasingly important as the child approaches school age. In later chapters they are referred to as *Priming Skills*.

In contrast, assessment observations by a *cognitive neuroscientist* observes blood flow or electrical activity in the human brain with sophisticated laboratory devices. In this instance a task is given, such as pointing to objects or listening for sounds or words. Brain activity is measured before the task, as the child's brain is at rest, and then during the activity. This type of measurement becomes useful as neuroscience partners with education. Goswami asserts that together the two cognitive fields can determine what is happening in the brain when a child is unsuccessful with a developmentally appropriate task. Neuroscience can explain how a selected neural pathway can lead to successful reading, for example, and become nonproductive when those brain areas are not activated. This information becomes useful when educators are determining a course of study for reading with school-aged children and will be addressed in later chapters.

COGNITIVE GROWTH—LEARNING LANGUAGE

Even at an early age environment can encourage formation of cognitive skills Families can encourage their children to make choices, which will prompt thoughtful decisions with questions like these, "Do you want this frog?" Or, "Would you like to hold this toy?" Putting two or three different items in separate places away from a crawling child, allows the child to decide which one to pursue. A child who watches an adult hide an object, can be encouraged to find it. These examples can be expanded to develop cognitive skills of attention, self-control, and problem solving.

Everyday interactions for most infants pose a world rich with opportunities to explore and subsequently to stimulate cognitive growth. There are faces to recognize and voices to imitate, sights and sounds to remember, and problems to solve, such as "how do I get this big person to notice that I am hungry?"

The language-related mechanism that allows an infant, who is quickly becoming a toddler, is a sensitivity to **prosody**. The emotional qualities of speech, such as intonation and rhythm, which define prosody, occur discretely and rapidly. For the curious baby, as well as for all people, meaning is captured from conversations by tracing the rhythm and intonations of spoken language. In fact, these prosodic cues are probably more important to meaning than the actual words. The phrase, "that's great" or "look at you" for example, can be either positive or negative, based on how the comments are expressed. Humans determine meaning by reading facial cues and the intonation of the speaker. Infants develop the ability to recognize these cues as young as 3 months.

A CHILD'S BRAIN AND LANGUAGE

At 2 to 3 months, the areas of the motor cortex that control the larynx and vocal cords have matured sufficiently to allow babies to begin vocalization with what sounds like babbling. In babbling, babies appear to be experimenting with various ways of making sounds. Even when there are no listeners, they babble to themselves. While they make many different sounds, babies seem to show a preference for the sounds they experience repeatedly. Sounds that are not reinforced by the environment are pruned or experience atrophy in the brain to allow a child to focus on the language heard repeatedly. Babies who are born deaf also babble for a period of time. Ultimately when the sounds are not reinforced the babbling ceases.

PARENTESE

The language and accompanying emotional emphasis used by parents and caregivers as they talk to infants is often called *parentese*. This language, with its elongated vowels, repetitions, and over-pronounced syllables, appears to be just what the baby needs to develop language skills. It models and reinforces the prosody and sound structure—the phonology, syntax, and lexicon of the family's native language. Parentese may be more grammatically correct than normal speech. It is interesting that parentese is apparently innate, and is used quite naturally in virtually all of the world's languages (Eckart, 2020). Studies to advance children's language achievement through coaching parents in parentese have not had long term benefits. The process of speaking slowly and succinctly generally happens naturally as adults speak to babies in any language.

BABY SIGNS

Infants comprehend words and phrases long before they are able to say much of anything. Baby Signs is a system designed by Linda Acredelo and Susan Goodwyn, psychologists, for babies to communicate before their brains develop the ability to produce oral speech. Through this program babies as young as five months old are able to convey what they need through simple hand gestures or sign language. Baby Signs developers, Acredelo and Goodwyn conducted many studies regarding the advantages of using Baby Signs as they followed children well beyond the age of three. The results of their studies indicate that when parents use a systematic plan with hand signals or signs with very young children there is a lasting impact. The children tested had measurable advantages over children who did not learn baby signs in the areas of language and cognitive skills. In subsequent years the long term benefit of implementing Baby Signs was questioned (Kirk et al., 2012; Fitzpatrick et al., 2014; Seal & DePaolis, 2014). The following studies used stringent controls and found no evidence that babies whose parents had been trained in Baby Signs benefited in a lasting way beyond age three. Consequently, parents who use baby signs with or without training, have an increased advantage of improved communication with their very young children. The use of baby signs with children who are deaf is an understandable advantage.

Parents can relax; young normally developing children will learn to speak and communicate successfully with or without parenting classes for speaking with parentese or communicating with baby signs. Children learn language as their brains are powerfully programed to do so in an environment that is full of positive language opportunities. Families are encouraged to follow their natural inclinations of interacting with their young children.

A LANGUAGE EXPLOSION AT YEARS ONE AND TWO

Around the age of one children begin to speak their first words. Although they are beginning to produce speech, they do not understand linguistic rules. They are essentially parroting what others say. However, by 18 months, language comprehension begins to develop. The toddler can understand many statements, such as “Let’s put on your shoes,” or “It is time to get in the car.” Between ages one and two a rapid progression of receptive language occurs, due to maturation in the brain’s left hemisphere. The auditory brain area (temporal lobe) forms neural connections with other lobes of the brain, located in the upper and frontal brain areas. These areas of the brain are explained in Chapter 2. Simultaneously, vocabulary explodes with children being exposed to a new word at the astounding rate of one word every 2 hr or so. Realize, pronunciation may be only 25 percent intelligible. This period of rapidly expanding language development coincides with synapse formation and metabolic activity, which are at their highest rate for connections among neurons in the brain.

WHAT CAN PARENTS AND CHILD CARE PROVIDERS DO?

Those who care for infants are encouraged to know about infant development. Consider how the young child's environment is structured to stimulate and support all the tremendous work that is being orchestrated by the infant brain. An infant and a parent or a care provider bond with the infant through holding, cuddling, feeding, eye contact, elongated language, and even by keeping scents consistent. Parents are reminded that vision is limited for several months while at the same time smell is completely developed. An infant baby senses the primary adult in his or her life initially by the sense of smell.

As described, all parts of the small child's body are developing and responding to touch. It all begins at the head, next down the arms, and finally to the hands and fingers. Soon baby is acknowledging legs and feet. Notice at several months of age tiny hands reach for baby's own feet, and explore the little toes by touching. Parents hold babies close and often sway back and forth while lightly patting and comforting baby. That is all natural. Babies soon learn to roll, push up with their arms, roll over, sit, crawl, walk, and then run. To prop a child on one side or the other, or support and place the little one in a device or seat to hold them in a sitting position before the child is ready, is contrary to the natural developmental sequence. Holding the little one in the lap in a sitting position, as the child is ready, is an entirely natural thing to do. Remember: *There is no way to hurry through nurture the plan that is set up by nature.*

Parents are encouraged to listen to the sound environment in their home. Are people talking, singing, or yelling? Is a television screen on? Human voices are best for a young child to hear as the sense of hearing is becoming fine-tuned. The environment does not have to be perfect, but families can be aware of the sounds baby is hearing. Children need to hear all kinds of sounds. They also need to be exposed to lots of human conversation with some of it directed toward them.

Vision takes about a year to become focused for distance viewing. Child development experts almost unanimously agree that young children should not be looking at a screen, any screen prior to age two, and even then with restrictions.

Make certain digital media is high quality, such as music, movement stimulating, or stories (Mayo Clinic, 2022). Parents who wonder about this recommendation, might try this. Turn on a screen or television to a familiar program. Notice what is happening on the screen both with and without the sound, and think about how these images appear to the child under 2 years of age, knowing vision and oral language is under-developed. Neuroscience tells us that babies do not learn from voices that are not from actual people (Kuhl, 2012). Digital media cannot be a substitute for personal attention, individual play, or exploration time. Children sleep a lot due to the amount of energy they are using during this critical developmental time. Parents and families are encouraged to make baby's waking time meaningful, as it is possible.

A child's environment can contain different views and a variety of objects. Mobiles hung on a crib or infant seat can hold baby's interest for a period of time. Toys can be changed and used in different ways—adults and siblings can make stuffed animals talk, and have hand toys or plastic and wooden blocks for holding or stacking. Babies put toys to their mouths, but adults are advised make certain the object is too big to fit inside. This action of toys to the mouth is a precursor to self-feeding. Books with items commonly seen by the child can be used over and over. Accompanying these suggestions and cautions, a Continuum of Developmental Benchmarks has been collected to define how infants advance from birth to 2 years of age.

CONTINUUM OF DEVELOPMENTAL BENCHMARKS

A chart of benchmarks infants and toddlers follow during the first two years is provided next. This chart describes what is expected during the first two years of life. Parents and families may use this benchmark list to support their young ones as they attain new skills. Note that the lists of activities are cumulative, built one upon another.

Many, many sources were consulted to develop this continuum. The resources are located in the reference section at the end of the book. An example is CDC, Centers for Disease Control and Prevention's *Learn the Signs. Act Early*, 2021. The developmental characteristics also represent observations by the author, parents, grandparents, and child care providers. The benchmarks are predictive, not based on scientific evidence. Variance will be discovered even at this very young age, as children develop according to their own unique, predetermined timeline. Developmental Benchmarks will be added in following chapters. A complete continuum for ages one month to age 5 is located in Appendix A at the end of this book.

Developmental Benchmarks—Beginning at Birth

1 month	Watches objects and faces at twelve inches or more, even when moving. Movement by arching back, kicking legs or flailing arms when startled by noises. Hearing is developing. Sense of smell is the only sense that is fully developed. Turns head toward mother's breast. Recognizes scents such as hand washing fragrance.
2 months	Eyes follow an object, begins to recognize familiar people. Becomes fussy when awake and is unstimulated. Seems happy when parent approaches. Makes sounds other than crying. Holds head up when on tummy. Moves both arms and legs. Opens hands briefly. Looks at a toy for several seconds. Sense of vision becoming more acute.
3 months	Recognizes source of food: bottle or breast. Beginning to develop interest in taste. Turns head to identify sounds. Tries to push up when on tummy.
4 months	Communicates if happy, sad, or irritated. Watches faces, particularly during feeding. Good head control. Pushes up onto elbows/forearms when on tummy. Reaches for toys and can bring a toy to the mouth (sense of taste). Better motor control and the sense of touch is developing. Chuckles when others laugh. Opens mouth if hungry and sees food source (breast or bottle). Brings hands to mouth. Makes sounds back when talked to.
6 months	Good control of hands and hand to mouth activities. Moves items from one hrand to the other. Reaches for items that are out of reach. Knows familiar people. Looks at self in a mirror. Takes turns at making sounds with another. Makes the "raspberry" sound. Closes lips when does not want food. Rolls from tummy to back. Leans on hands to support when sitting.
9 months	Plays "peek-a-boo." Can pick up small items with precision. Turns pages of a book. Watches as an item is hidden and seeks it. Able to move arms and limbs to hold body in crawl position or picks self up when holding on to a table or chair. Is shy around strangers. Looks when name is called. Reacts when care provider or parent leaves and reaches for the person. Makes a lot of different sounds, such as "mamamama" and "babababa." Lifts arms to be picked up. Can move into a sitting position and sits without support.
12 months	Moves items from container to container. Points to pictures of words known and stored in long term memory. Claps and bangs items together. Can drink from a cup, pick up a book, brush own hair, and pokes with index finger. Can pick things up with thumb and pointer finger, like small pieces of food to eat or a crayon to make marks. Stands upright alone or with support. May be able to navigate walking or moving from one object to another. Waves "bye-bye," and understands "no."

15 months	Copies other children. Claps when excited. Hugs dolls or other stuffed toys. Shows signs of affection with hugs, cuddles or kisses. Tries to say one or two words for common items. Follows simple directions, "Clap your hands." Attempts to use common items, phone, cup, book. Can walk somewhat on own. Uses fingers to eat finger food, such as Cheerios. Scribbling and coloring may include blocks of color and more definite marks and patterns. Stacks at least two things or blocks.
18 months	Holds a crayon or pencil to scribble. Begins to identify body parts. Can follow one oral direction. For example, if an adult says "Stop" the child ceases the activity. Can identify by pointing to common objects: cup, spoon, brush, book, and phone. Enjoys singing, reading stories, and listing to simple stories without a book. Is interested in toys and can pretend play with a stuffed toy. Puts hands out to be washed. Walks without holding on. Climbs up on a chair or couch. Can drink from a cup without a lid. Tries to use a spoon. Crayon strokes represent something to the child. Swirly loops may be a puppy or bold lines may be daddy. May have a tantrum when does not get what is wanted. (Respond or not to tantrums, but be at eye level if a tantrum is addressed.)

CONCLUDING THOUGHTS ABOUT INFANTS TO AGE 2

Children can be stimulated when they are very young with activities and experiences that ultimately support them to become good readers in the years that follow. A most important activity for very young children is lots of family talk, and engagement with everyday language experiences, even if it is simply about what the family is doing. Babies love the sounds of words that they make, and how their mouths feel when they make sounds. Suggestions for parents and care providers include talking, communicating language through picture and other simple books, making words come alive through dance, gestures, and songs, and playing games with sounds.

The way children learn language, any language is very predictable. Deeply rooted language is in human biological makeup. As emphasized repeatedly, children are born with a brain programmed for language learning. Humans can't help but talk; it is the primary means of social interaction for a lifetime of learning. How do parents start their infants off on the right track to become a child who reads well? There is no formal program, rather families are encouraged to follow natural inclinations to talk to infants, smile at them, and express affection in positive ways. A very young child's mastery of language proceeds right on course with steady dialog from parents, other involved adults, and siblings.

The Developmental Benchmarks presented in Chapter 1 will continue in subsequent chapters to follow the dynamic growth of pre-school aged children's skills and abilities. The maturation of the infant's brain and the accompanying body development initiate a story that continues, amazes, and delights families and care providers, alike.

Reflective Questions

1. Neuroscientists are using scanning devices on children under the age of one. What information are they seeking and discovering?
2. As you study with a group, or individually keep the list of questions on page 3 and record answers during reading of the chapters. Take the challenge to fill in as many answers as you can to compare with the responses of the author in Chapter 11.
3. Give an "ah-ah" statement about the brain's capabilities, even at birth.
4. How would you explain the microscopic development of neurons and their connections to a parent? What might parents care to know about neurons?
5. What is new to you about the development of the baby's five senses?
6. The Developmental Benchmarks as a whole might be overwhelming to parents. How could this information be provided to parents in a way that is useful? Describe also how it could be a benefit for educators?
7. Talk and write about the explosion of language between birth and age two. What advice would you give new parents about how to stimulate their baby in the family's environment?