



Brain development in young children

How the Brain Develops

A number of factors influence early brain development. These important factors include genetics, food and nutrition, responsiveness of parents, daily experiences, physical activity and love. In particular, parents should be aware of the importance of furnishing a healthy and nutritious diet, giving love and nurturing, providing interesting and varied everyday experiences, and giving children positive and sensitive feedback.

In the past, some scientists thought the brain's development was determined genetically and brain growth followed a biologically predetermined path. Now we know that early experiences impact the development of the brain and influence the specific way in which the circuits (or pathways) of the brain become "wired." A baby's brain is a work in progress. The outside world shapes its development through experiences that a child's senses — vision, hearing, smell, touch and taste — absorb. For example:

- The scent of the mother's skin (smell)
- The father's voice (hearing)
- Seeing a face or bright colour toy (vision)
- The feel of a hand gently caressing (touch)
- Drinking milk (taste)

Experiences that the five senses take in help build the connections that guide brain development. Early experiences have a decisive impact on the actual architecture of the brain.

Recent equipment and technological advances have allowed scientists to see the brain working. What scientists have found is that the brain continues to form after birth based on experiences. An infant's mind is primed for learning, but it needs early experiences to wire the neural circuits of the brain that facilitate learning.

Imagine that a child's brain is like a house that has just been built. The walls are up, the doors are hung. Then you go to the store and buy electrical wiring, switches, a fuse box and other electrical supplies. You bring these supplies to the new house and set them on the floor. Will they work? Definitely not. You first must string the wiring and hook up all of the connections. This is quite similar to the way our brains are formed. We are born with as many nerve cells as stars in the Milky Way galaxy. But these cells have not yet established a pattern of wiring between them — they haven't made their connections.

What the brain has done is to lay out circuits that are its best guess about what is required for vision, language, etc. Now the sensory experiences must take this rough blueprint and progressively refine it. Circuits are made into patterns that enable newborn infants to perceive their mother's touch, their father's voice and other aspects of their environment.

Normal sensory experiences direct brain cells to their location and reinforce the connections between brain cells. **We are born with more than 100 billion brain cells or neurons**; we will not grow more. That's about 10 times the number of stars in the entire Milky Way, and about 20 times the number of people on the planet.

Neurons are the functioning core of the brain. Each cell body is about one-hundredth the size of the period at the end of this sentence. A neuron has branches or *dendrites* emerging from the cell body. These dendrites pick up chemical signals across a *synapse* and the impulse travels the length of the axon. Each axon branch has a sac containing neurotransmitters at its tip. The electrical impulse causes the release of the neurotransmitters, which, in turn, stimulates or inhibits neighbouring dendrites, like an on-off switch.

These connections are miracles of the human body. But to understand their power, you have to multiply this miracle by trillions. A single cell can connect with as many as 15,000 other cells.

This incredible complex network of connections, that results often are referred to as the brain's "circuitry" or "wiring." Experience shapes the way circuits are made in the brain.

A remarkable increase in synapses occurs during the first year of life. The brain develops a functional architecture through the development of these synapses or connections.

For example, if a parent repeatedly calls a child a certain name, then connections will form that allow the child to recognize that name over time as referring to him and he will learn to respond. From birth, the brain rapidly is creating these connections that form our habits, thoughts, consciousness, memories and mind.

By the time a child is 3 years old, a baby's brain has formed about 1,000 trillion connections — about twice as many as adults have. A baby's brain is super dense and will stay that way throughout the first decade of life. Beginning at about age 11, a child's brain gets rid of extra connections in a process calling "pruning," gradually making order out of a thick tangle of "wires."

The remaining "wiring" is more powerful and efficient. The increase in synaptic density in a child's brain can be seen in Figure 2. The interactions that parents assist with in a child's environment are what spur the growth and pattern of these connections in the brain.

As the synapses in a child's brain are strengthened through repeated experiences, connections and pathways are formed that structure the way a child learns. **If a pathway is not used, it's eliminated based on the "use it or lose it" principle.** Things you do a single time, either good or bad, are somewhat less likely to have an effect on brain development.

When a connection is used repeatedly in the early years, it becomes permanent. For example, when adults repeat words and phrases as they talk to babies, babies learn to understand speech and strengthen the language connections in the brain.

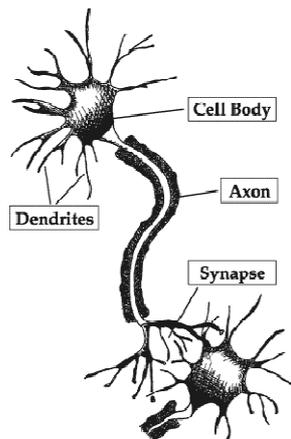


Figure1: Neurons and connections

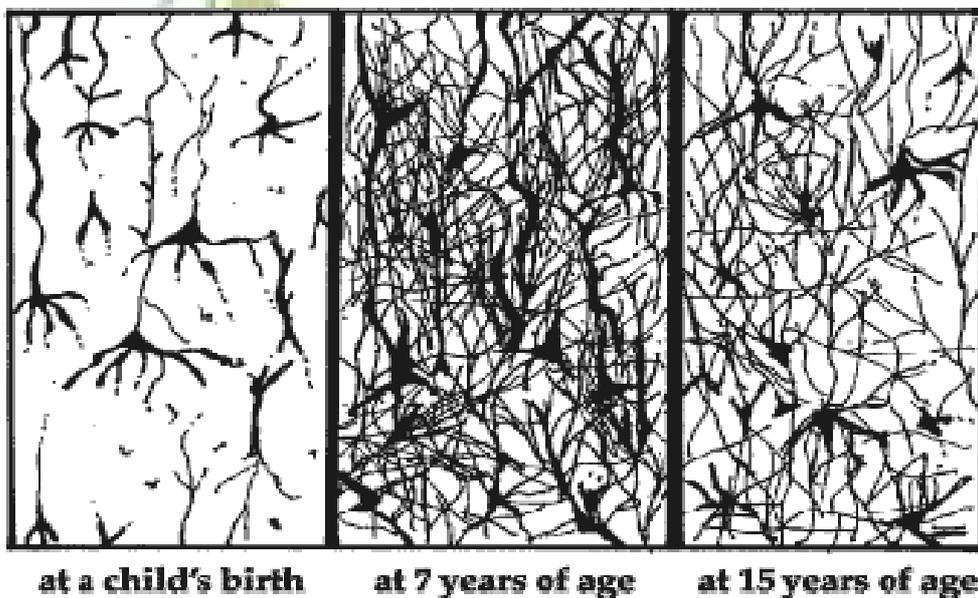


Figure2: Synaptic density in the human brain

Brain Development: Myth or Fact?

Myth At birth the brain is fully developed, just like one's heart or stomach.

Fact - Most of the brain's cells are formed before birth, but most of the connections among cells are made during infancy and early childhood.

Myth The brain's development depends entirely on the genes with which you are born.

Fact - Early experience and interaction with the environment are most critical in a child's brain development.

Myth A toddler's brain is less active than the brain of a college student.

Fact - A 3-year-old toddler's brain is twice as active as an adult's brain.

Myth Talking to a baby is not important because he or she can't understand what you are saying.

Fact - Talking to young children establishes foundations for learning language during early critical periods when learning is easiest for a child.

Myth Children need special help and specific educational toys to develop their brainpower.

Fact - What children need most is love, care and new experiences, not special attention or costly toys. Talking, singing, playing and reading are some of the key activities that build a child's brain.

Construction of the Brain

We have explored how the brain develops at the cellular level with neurons and connections. Understanding the different parts of the brain as a whole and how it functions and develops also is useful.

The brain grows in sequential fashion, from bottom to top, or from the least complex part (brain stem) to the more complex area (cortex). If you draw a line from the forehead to the chin and open the brain for a side view, you would see the brain as it is shown in Figure 3.

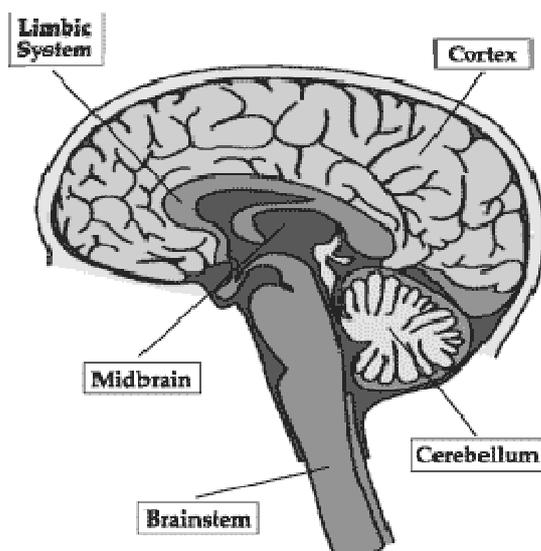


Figure 3. Brain: side view

The basic elements of the human brain include the following:

1. The **brainstem** is at the base of the skull and it controls most basic life activities, including blood pressure and body temperature.
2. The **midbrain** is at the top of the brainstem and it controls motor activity, appetite and sleep.
3. The **cerebellum** is behind the brainstem and it coordinates movement and balance.
4. The **limbic system** is in the central part of the brain and it controls emotions, attachment and memory.
5. The **cortex** is the top layer of the brain and is about the depth of two dimes placed on top of each other. The cortex is the "executive branch" of the brain that regulates decision-making and controls thinking, reasoning and language.

The cerebral cortex contains 80 percent of the neurons in the brain. Because it is the least developed part of the brain at birth and keeps developing until adolescence and even beyond, the cortex is more sensitive to experiences than other parts of the brain.

Construction of the brain is somewhat like the construction of a house. A house is built from the foundation up and different parts of the structure have different functions. Also, like the brain, once the architecture is in place, you can continue learning and "add on" or "decorate." But, if you have to move a wall or add a window, it is more difficult and expensive than if you had done it earlier in the building process.

Critical Periods of Brain Development

Brain development proceeds in waves, with different parts of the brain becoming active "construction sites" at different times. The brain's ability to respond to experience presents exciting opportunities for a child's development.

Learning continues throughout life. However, "prime times" or "windows of opportunity" exist when the brain is a kind of "super sponge," absorbing new information more easily than at other times and developing in major leaps. While this is true especially in the first three years of life, it continues throughout early childhood and adolescence. For example, young children learn the grammar and meaning of their native language with only simple exposure.

While learning later is possible, it usually is slower and more difficult. Some improvement in most skills is possible throughout life. However, providing children with the best opportunity for learning and growth during the periods when their minds are most ready to absorb new information is important.

Visual and Auditory development

The "prime time" for visual and auditory development, or a child's capacity for learning to see and hear, is from birth to between 4 and 5 years old. The development of these sensory capacities is very important for allowing children, especially babies, to perceive

and interact with the world around them. During the first few months, especially, babies need to see shapes, colours, objects at varying distances and movement for the brain to learn how to see. Babies also need exposure to a variety of sounds so their brain can learn to process that information and allow for responsiveness by hearing something.

Language development

The "prime time" for language development and learning to talk is from birth to 10 years of age. Children are learning language during this entire period. However, the "prime time" for language learning is the first few years of life. Children need to hear you constantly talk, sing and read to them during these early years. Respond to their babbling and language efforts.

Children vary in their language development during these first years, so parents should allow for some variation in children's abilities at different ages. They should encourage language development, be patient and seek assistance from a qualified professional if concerns arise about a child's progress in this area.

Physical and motor development

The "prime time" for physical and motor development in children is from birth to 12 years of age. Children become physically ready for different aspects of motor development at different times. Large motor skills, such as walking, tend to come before the refinement of fine motor skills, such as using a crayon.

A child needs several years to develop the coordination skills to play catch with a ball easily, and even then refinement of such skills continues into a child's early adolescence. Parents should monitor a child's motor development but be patient since children vary in their rates of development.

Emotional and social development

The "prime time" for emotional and social development in children is birth to 12 years of age. Differing aspects of emotional and social development, which incorporate higher capacities, such as awareness of others, empathy and trust, are important at different times. For example, the real "prime time" for emotional attachment to be developed is from birth to 18 months, when a young child is forming attachments with critical caregivers. Such development provides the foundations for other aspects of emotional development that occur as children grow.

Emotional intelligence is critical to life success. The part of the brain that regulates emotion, the amygdale, is shaped early on by experience and forms the brain's emotional wiring. Early nurturing is important to learning empathy, happiness, hopefulness and resiliency.

Social development, which involves both self-awareness and a child's ability to interact with others, also occurs in stages. For example, sharing toys is something that a 2-year old's brain is not fully developed to do well, so this social ability is more common and positive with toddlers who are 3 or older. A parent's efforts to nurture and guide a child will assist in laying healthy foundations for social and emotional development.

Conclusion

The development of a child's brain holds the key to the child's future. Although the "first years last forever" in terms of the rapid development of young children's brains, the actual first years of a child's life go by very quickly. So touch, talk, read, smile, sing, count and play with your children. It does more than make both of you feel good. It helps a child's brain develop and nourishes the child's potential for a lifetime.

