Brain Development

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What We Know About How Children Learn

Brain cells are “raw” materials — much like lumber is a raw material in building a house. Heredity may determine the basic number of “neurons” (brain nerve cells) children are born with, and their initial arrangement, but this is just a framework. A child’s environment has enormous impact on how these cells get connected or “wired” to each other. Many parents and caregivers have understood intuitively that loving, everyday interactions — cuddling infants closely or singing to toddlers — help children learn.

A brain is not a computer. The brain begins working long before it is finished. And the same processes that wire the brain before birth also drive the very rapid growth of learning that occurs immediately after birth. At birth, a baby’s brain contains 100 billion neurons, roughly as many nerve cells as there are stars in the Milky Way. Before birth, the brain produces trillions more neurons and “synapses” (connections between the brain cells) than needed. During the first years of life, the brain undergoes a series of extraordinary changes. Then, through a process that resembles Darwinian competition, the brain eliminates connections that are seldom or never used.

“Windows of opportunity” are critical periods in children’s lives when specific types of learning take place. For instance, scientists have determined that the neurons for vision begin sending messages back and forth rapidly at 2 to 4 months of age, peaking in intensity at 8 months. It is no coincidence that babies begin to take notice of the world during this period.

Scientists believe that language is acquired most easily during the first ten years of life. During these years, the circuits in children’s brains become wired for how their own language sounds. An infant’s repeated exposure to words clearly helps her brain build the neural connections that will enable her to learn more words later on. For infants, individual attention and responsive, sensitive caregiving are critical for later language and intellectual development.

Research does not suggest drilling children in alphabet songs from different languages or using flash cards to promote rote memorization of letters and numbers. Children learn any language best in the context of meaningful, day-to-day interactions with adults or other children who speak the language.

Schools can take advantage of this window of opportunity to teach language. If children are to learn to speak a second language like a native, they should be introduced to the language by age ten.

Early stimulation sets the stage for how children will learn and interact with others throughout life. A child’s experiences, good or bad, influence the wiring of his brain and the connection in his nervous system. Loving interactions with caring adults strongly stimulate a child’s brain, causing synapses to grow and existing connections to get stronger. Connections that are used become permanent. If a child receives little stimulation early on, the synapses will not develop, and the brain will make fewer connections.

Recent research on one of the body’s “stress-sensitive” systems shows how very stressful experiences also shape a child’s developing brain. When children are faced with physical or emotional stress or trauma, one of these systems “turns on” by releasing the hormone cortisol.

High levels of cortisol can cause brain cells to die and reduces the connections between the cells in certain areas of the brain.

Babies with strong, positive emotional bonds to their caregivers show consistently lower levels of cortisol in their brains. While positive experiences can help brighten a child’s future, negative experiences can do the opposite. Too much cortisol in the brain can make it hard for children to learn and to think. And they may have trouble acting appropriately in stressful situations.

Healthy relationships during the early years help children have healthy relationships throughout life. Deprived of a positive, stimulating environment, a child’s brain suffers. Rich experiences, in other words, really do produce rich brains.

The Brain in Brief

Brain Structure

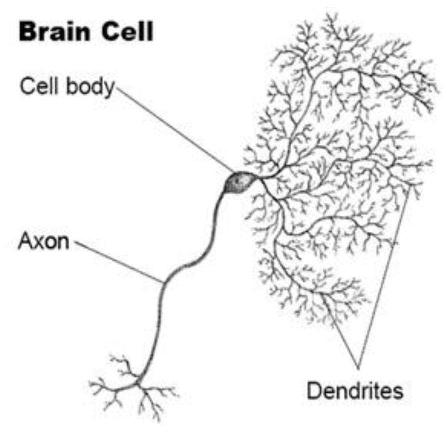
The brain is part of the central nervous system, and plays a decisive role in controlling many bodily functions, including both voluntary activities (such as walking or speaking) and involuntary ones (such as breathing or blinking).

The brain has two hemispheres, and each hemisphere has four lobes. Each of these lobes has numerous folds. These folds do not all mature at the same time. The chemicals that foster brain development are released in waves; as a result, different areas of the brain evolve in a predictable sequence. The timing of these developmental changes explains, in part, why there are "prime times" for certain kinds of learning and development.

Different parts of the brain control different kinds of functions. Most of the activities that we think of as "brain work," like thinking, planning or remembering, are handled by the cerebral cortex, the uppermost, ridged portion of the brain. Other parts of the brain also play a role in memory and learning, including the thalamus, hippocampus, amygdala and basal forebrain. The hypothalamus and amygdala, as well as other parts of the brain, are also important in reacting to stress and controlling emotions.

Brain Cells

The basic building blocks of the brain are specialized nerve cells that make up the central nervous system: neurons. The nerve cells proliferate before birth. In fact, a fetus' brain produces roughly twice as many neurons as it will eventually need — a safety margin that gives newborns the best possible chance of coming into the world with healthy brains. Most of the excess neurons are shed in utero. At birth, an infant has roughly 100 billion brain cells.



Every neuron has an axon (usually only one). The axon is an "output" fiber that sends impulses to other neurons. Each neuron also has many dendrites — short, hair-like "input" fibers that receive impulses from other neurons. In this way, neurons are perfectly constructed to form connections.

As a child grows, the number of neurons remains relatively stable, but each cell grows, becoming bigger and heavier. The proliferation of dendrites accounts for some of this growth. The dendrites branch out, forming "dendrite trees" that can receive signals from many other neurons.

Connections among Brain Cells

At birth, the human brain is in a remarkably unfinished state. Most of its 100 billion neurons are not yet connected in networks. Forming and reinforcing these connections are the key tasks of early brain development. Connections among neurons are formed as the growing child experiences the surrounding world and forms attachments to parents, family members and other caregivers.

In the first decade of life, a child's brain forms trillions of connections or synapses. Axons hook up with dendrites, and chemicals called neurotransmitters facilitate the passage of impulses across the resulting synapses. Each individual neuron may be connected to as many as 15,000 other neurons, forming a network of neural pathways that is immensely complex. This elaborate network is sometimes referred to as the brain's "wiring" or "circuitry." If they are not used repeatedly, or often enough, they are eliminated. In this way, experience plays a crucial role in "wiring" a young child's brain.

Source: Shore, R. (1997). *Rethinking the Brain: New Insights into Early Development.* New York, NY: Families and Work Institute, pp. 16-17.