

# Family Issues Facts

A FACT SHEET FOR FAMILIES AND PEOPLE WHO WORK WITH FAMILIES

## Brain Development

Bulletin #4356

### 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

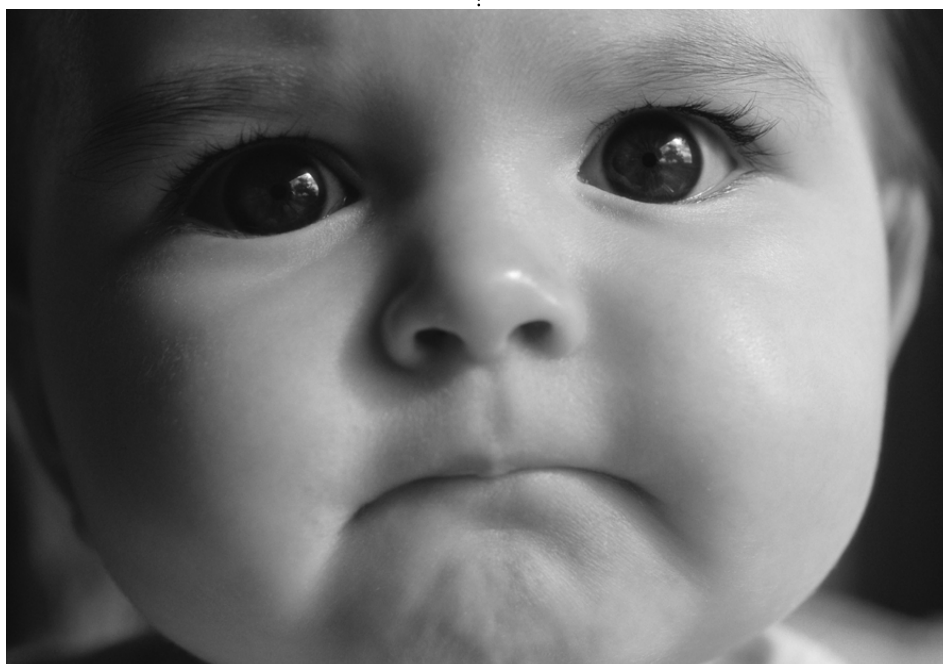
understood intuitively that loving, everyday interactions — cuddling infants closely or singing to toddlers — help children learn.

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



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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.

	<b>What's Happening</b>	<b>What You Can Do</b>	<b>Window of Learning</b>
<b>Connecting Vision</b>	Babies can see at birth, clearly and with discrimination, especially objects (like human faces) eight to 10 inches away. Focusing both eyes on a single object farther away, the development of depth perception and hand-eye coordination all take more time. Brightness and movement are visible at any distance.	You don't need to buy fancy or high-contrast black-and-white toys to stimulate vision. But regular eye exams, starting as early as two weeks of age, can detect problems that, if left uncorrected, can cause a weak or unused eye to lose its functional connections to the brain.	Vision needs to be exercised early on for good development. Visual acuity develops from birth to about age 6 or 7; binocular vision develops between ages 1 and 3.
<b>Connecting Feelings</b>	Some of the first circuits the brain builds are those that govern the emotions. The first two emotions are opposites: feeling calm and relaxed and feeling distress. Beginning around two months of age, these start to evolve into more complex feelings.	Provide loving care, which will give baby's brain the right kind of emotional stimulation. Neglecting a baby can cause brain-wave patterns that dampen happy feelings. Abuse can produce anxiety and abnormal stress responses.	Emotions develop in layers, each more complex than the last. The stress response develops from birth through age 3; empathy and envy begin to develop during the second year through about age 10.
<b>Connecting Language</b>	Before birth, an infant learns the "melody" of its mother's voice. During the first six years, its brain will set up the circuitry needed to understand and reproduce complex language. A six-month-old can recognize the vowel sounds that are the basic building blocks of speech.	Babies are born interested in listening to human voices and the tendency to produce babbling sounds. Talking to a baby, especially in the high-pitched, singsong speech style known as "Parentese," speeds up the process of learning new words and helps babies connect objects with words.	Language skills are sharpest early on but grow throughout life. Recognition of speech begins at birth through ages 6 or 7; vocabulary starts growing during the second year and continues through adulthood.
<b>Connecting Movement</b>	At birth, babies move in a jerky, uncontrollable way. Over the next four years, the brain will refine the circuits needed for reaching, grabbing, sitting, crawling, walking, running and jumping.	Give babies freedom to explore within safe limits. Reaching for objects helps the brain develop hand-eye coordination and helps muscles learn patterns of actions. As soon as your child is ready for them, activities like drawing and playing a violin or piano will help develop fine motor skills.	Motor-skill development starts with the larger muscles (like the neck, arms and legs) and moves to increasingly smaller muscles (like fingers and toes). Basic motor skills start developing shortly after birth; fine motor ability begins developing in the second half of the first year. Musical fingering ability opens up about age 5.

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.

Sources:

Nash J. M. "Fertile Minds." *Time*, February 3, 1997, pp. 48-51.

Newberger, J. J. (1997). "New Brain Development Research: A Wonderful Window of Opportunity to Build Public Support for Early Childhood Education." *Young Children* 52 (4), pp. 4-7.

## 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.

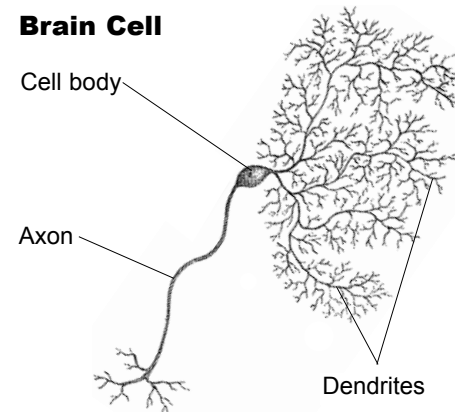
Every neuron has an axon (usually only one). The axon is an "output" fiber that sends impulses to other neurons. Each neuron also has many dendrites — short, hair-like "input" fibers that receive impulses from other neurons. In this way, neurons are perfectly constructed to form connections.

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

### Brain Cell



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.

# Day-to-Day Care of Young Children's Brains

Research on early brain development and school readiness suggests the following guidelines for the care of young children:

- **Ensure health, safety, and good nutrition:** Seek regular prenatal care; breast feed if possible; make sure your child has regular check-ups and timely immunizations; safety-proof the places where children play; and use a car seat whenever your child is traveling in a car.
- **Develop a warm, caring relationship with children:** Show them that you care deeply about them. Express joy in who they are. Help them to feel safe and secure.
- **Respond to children's cues and clues:** Notice their rhythms and moods, even in the first days and weeks of life. Respond to children when they are upset as well as when they are happy. Try to understand what children are feeling, what they are telling you (in words or actions), and what they are trying to do. Hold and touch them; play with them in a way that lets you follow their lead. Move in when children want to play, and pull back when they seem to have had enough stimulation.
- **Recognize that each child is unique:** Keep in mind that from birth, children have different temperaments, that they grow at their own pace, and that this pace varies from child to child. At the same time, have positive expectations about what children can do and hold on to the belief that every child can succeed.
- **Talk, read, and sing to children:** Surround them with language. Maintain an ongoing conversation with them about what you and they are doing. Sing to them, play music, tell stories and read books. Ask toddlers and preschoolers to guess what will come next in a story. Play word games. Ask toddlers and preschoolers questions that require more than a yes or no answer, like "What do you think...?" Ask children to picture things that have happened in the past or might happen in the future. Provide reading and writing materials, including crayons and paper, books, magazines, and toys. These are key pre-reading experiences.
- **Encourage safe exploration and play:** Give children opportunities to move around, explore and play (and be prepared to step in if they are at risk of hurting themselves or others). Allow them to explore relationships as well. Arrange for children to spend time with children of their own age and of other ages. Help them learn to solve the conflicts that inevitably arise.
- **Use discipline to teach:** Talk to children about what they seem to be feeling and teach them words to describe those feelings. Make it clear that while you might not like the way they are behaving, you love them. Explain the rules and consequences of behavior so children can learn the "why's" behind what you are asking them to do. Tell them what you want them to do, not just what you don't want them to do. Point out how their behavior affects others.
- **Establish routines:** Create routines and rituals for special times during the day like mealtime, nap time, and bedtime. Try to be predictable so the children know that they can count on you.
- **Become involved in child care and preschool:** Keep in close touch with your children's child care providers or teachers about what they are doing. Occasionally, especially during transitions, spend time with your children while they are being cared for by others.
- **Limit television:** Limit the time children spend watching TV shows and videos as well as the type of shows they watch. Make sure that they are watching programs that will teach them things you want them to learn.
- **Take care of yourself:** You can best care for young children when you are cared for as well.

Source: Shore, R. (1997). *Rethinking the Brain: New Insights into Early Development*. New York, NY: Families and Work Institute, pp. 26-27.

For more information on family issues, contact your county Extension office or the University of Maine Cooperative Extension family living office, 5717 Corbett Hall, Orono, ME 04469-5717  
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