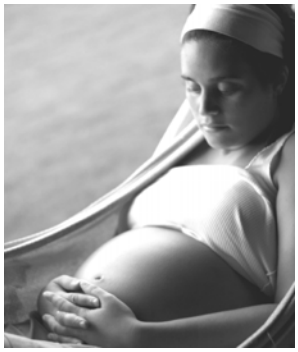
# The SCIENCE of EARLY CHILD DEVELOPMENT

BRIEF



## Introduction: The Long Reach of Early Experiences

The science of early child development encompasses the fields of neurobiology, genetics and the social sciences, including psychology, social work and medicine. Research conducted over the past few decades gives us a much better understanding of human brain development and the impact of experience from conception onwards. The first phase of life is one in which there are both great opportunities and great risks that can set trajectories across a lifetime. Early experiences affect how genes are expressed and how brain connections are built. Thus early life has a long reach forward.

## Studying the Brain

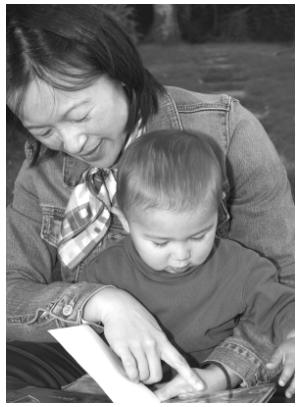
Neuroscience, the study of the brain and biological pathways, allows researchers to understand how the brain develops. The human brain is a jelly-like mass composed of billions of nerve cells, also called **neurons**, and glial cells. [1]

Before birth, neurons in some parts of the fetal brain start to sprout axons, the long branches that carry nerve impulses away from the cell body, and dendrites, the shorter branches that receive impulses from the axons of other neurons. Synapses, the connections between neurons connect to form millions of neural pathways in our brain and in the central nervous system. This is the brain's communication system throughout the body.[2]

At birth, a full-term baby's organs and brain structure are fully developed, but the brain's circuitry continues to develop long after birth. During the first few years of life, this development takes place at an incredible rate, with the brain tripling in size by the time a child reaches three.[3]

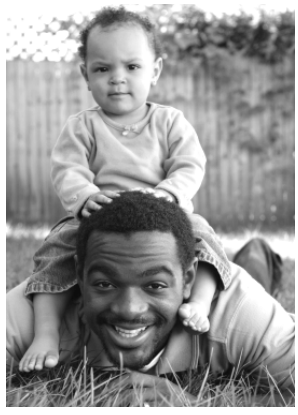
## Epigenetics: Experience Matters

One of the most dramatic discoveries in molecular biology over the past generation involves the interplay between early experiences and environments that impacts how, where, and when genes work.



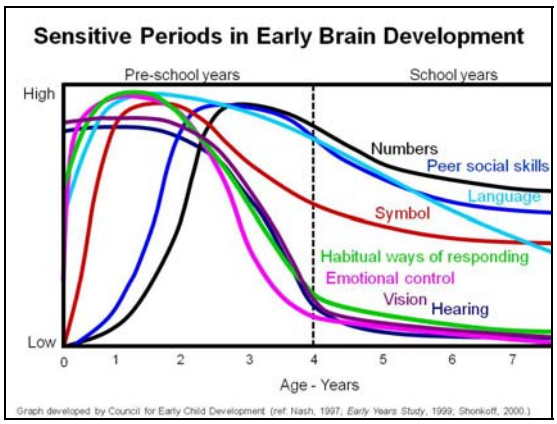
Most brain scientists no longer consider "nature vs. nurture," but instead focus on the effects of both nature and nurture. In other words, brain development is not determined solely by either genes or the environment, but rather through an interaction between the two.

***Epigenetics*** describes how environmental factors affect genetic activation and expression.[1] Everything in the infant environment contributes to her experience and brain development—noise, light, changes in temperature, nutrition and the touch, voice and smell of her caregivers. The quality of exchanges between caregiver and infant serves as the foundation for the infant's brain and biological systems and influences the child's subsequent mental and physical health. The relationship between caregiver and infant plays a pivotal role in the child's capacity to interact with others and influences neural pathways for language and higher cognitive functions. [1]



# Sensitive Periods: The Sequencing of Brain Development

How brain connections develop depends upon their use. Repeated use leads to strong connections, while connections used infrequently weaken and can be lost. This process is often called *synaptic pruning,* or ***wiring and sculpting*** of the brain. [1]




Wiring and sculpting are possible because of the brain's ability to change, also known as **brain plasticity**. All parts of the brain change as a result of experience, but not all parts of the brain are equally plastic. As illustrated in the "Sensitive Periods" diagram, some parts of the brain, such as those that govern hearing and vision are highly plastic at, or shortly after, birth. Wiring and sculpting in response to early experiences is very active as new neural connections build the neural circuitry for these functions. Other neural circuits, such as those related to peer social skills, are highly plastic several years after birth. Experience during critical or **sensitive periods** when the brain is highly plastic modifies the brain's circuits in fundamental ways, causing neural pathways to become highly stable and therefore difficult to change later on. [1]

### A Critical Period in the Development of Vision

The development of vision is one example of how experience can shape the brain's architecture and how important experience during sensitive periods can be.

A baby can be born with perfect eyes, but what happens during her first year of life will affect how well she will be able to see. The baby requires appropriate experiences of light, shape, colour and motion for the proper development of the part of her brain that controls the coordination of her two eyes and how she understands & interprets what she sees.

Studies have demonstrated how visual stimulation builds the neural circuit that transfers signals from one part of the brain to another. In animal experiments, it was found that if signals did not pass from the eye to the visual cortex within a set period, the neurons would not develop normal functions for vision.

Further research provides evidence of a critical period for the development and wiring of the brain for vision. All studies confirm that when visual stimulation is not available in the critical period and deficits occur in the development of the region of the brain responsible for vision, these deficits are not correctable later on in life. [1]

Developmental neurobiology has revealed that these sensitive periods occur in a sequence, with what happens in earlier ones affecting what happens in later periods. Thus, the formation of neural pathways is a hierarchy: the pathways that develop early are crucial for the next stage of neural pathway development. For example, the development of the visual and auditory areas of the brain precedes receptive language systems, which in turn precede speech.[1]

# Early brain development affects lifelong health, learning and behaviour

As described above, early experiences influence the development of the visual system in the brain. Early experiences and brain development also affect a number of other senses and abilities. A large body of research points to the fact that what happens in the prenatal period and in the first few years of human development set trajectories for lifelong health, learning and behaviour.

**Health**

Scientists have determined that a part of the brain called the hypothalamus, as part of the limbic hypothalamus-pituitary-adrenal (LHPA) axis, plays a key role in physical health. Brain circuitry and the LHPA axis, which are established early in life, are implicated in adult health and disease. For example, a Swedish longitudinal study found that when compared with children in healthy environments, children who experienced neglectful and abusive early environments were seven times more likely to develop cardiovascular problems. Studies of the Kaiser Permanente program in California found that children who experienced neglect and abuse were at high risk for drug and alcohol abuse in adult life. Other health problems associated with negative early experiences include coronary health disease, hypertension, Type II diabetes and mental illness. [1]

**Learning**

There is much evidence that the effects of early experiences on the brain influence later learning. For example, numerous studies demonstrate that language exposure in very early life has a significant effect on later verbal skills. Research shows that a baby's ability to distinguish between phonemes (speech sounds) is greatest before he reaches seven months. After this point, it becomes increasingly difficult to distinguish between these different sounds, making the acquisition of new phonemes—and entire languages—all the more challenging. There is also evidence that the quality of early experiences, including the types of nutrition and stimulation a child receives impact upon literacy later in life. [1]

**Behaviour**

Early brain development also influences later behaviour. One example of this is the "natural" experiment that occurred among children raised in orphanages in Romania. Researchers compared the outcomes for those orphans who were adopted by Canadian families before they reached four months with those who were adopted after at least eight months in an orphanage. Those adopted earlier exhibited relatively fewer developmental problems than did those orphans who were left for longer periods in orphanages. At eleven years of age, those Romanian orphans who had been adopted later experienced abnormal brain development (small brain, low metabolic activity, abnormal EEG), social and cognitive problems (IQ loss) and high vulnerability to behavioural problems (ADHD, aggression, quasi-autism).[3]

## Citations


1. McCain, M., Mustard, F. & Shanker, S. (2007). *Early Years Study: Putting Science Into Action.* Toronto: Council for Early Child Development.
2. Jamieson, J., Bertrand, J. & Ibrahim E. (2008). *The Science of Early Child Development, 2nd Edition*. Red River College. Available at: www.scienceofecd.com.
3. Kolb, B. & Whishaw, I.Q. (2006) *Introduction to Brain and Behavior, 2nd Edition*. New York: Freeman-Worth.


## Further Reading & Resources

### General

- Centre on the Developing Child. (2010). "How Early Experiences Alter Gene Expression and Shape Development." Available at: www.developingchild.harvard.edu/library/multimedia/interactive_features/gene-expression/.
- Cloud, John. (2010). "Why Your DNA Isn't Your Destiny" in *Time*.
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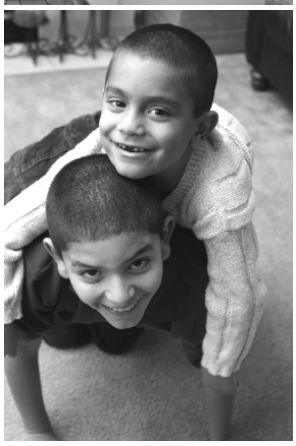
### For Parents

- Canadian Association of Family Resource Programs. (n.d.) *Play for the Brain.* Available at: www.frp.ca/_data/n_0001/resources/live/Play-for-the-brain_ENG.pdf
- Centre of Excellence for Early Childhood Development. (multiple dates). *Key messages: Information sheets for parents and service providers*. Available at: www.child-encyclopedia.com/en-ca/key-messages-list.html.
- Eliot, L. (2000). *What's going on in there? How the brain and mind develop in the first five years of life*. New York: Bantam Books.
- Fraser Mustard Chair in Childhood Development. (2010). *Supporting your baby's brain development: What Can Parents Do?* Available at: www.frasermustardchair.ca/2010/03/supporting-your-babys-brain-development-what-can-parents-do.

### Websites - For Parents & Professionals

- Changing Brains, University of Oregon (www.changingbrains.org). [*This website offers free video clips, illustrating various aspects of brain development, including brain plasticity, vision, the motor system and attention.]*
- Invest in Kids (www.investinkids.ca) [*Translates the science of parenting and child development into engaging, easy-to-understand, relevant resources for parents.*]
- Zero to Three (www.zerotothree.org)- [*Offers free resources about children's development in the first three years of life (USA).*]



## The Council for Early Child Development

The Council for Early Child Development is a not-for-profit, charitable organization. Founded in 2004 by Dr. Fraser Mustard, the Council's mission is to close the gap between what we know about early human development and what we do for children in their earliest years. For more information please visit: www.councilecd.ca.