Parenting with the Brain in Mind

MODULE TWO

FACT SHEET 1

THE EARLY YEARS PART 1

by John Joseph

Fact Sheet 1, How the brain learns in the early years. Growing brain cells

What's this about?

Welcome to Part 1 of 4 articles that examine how brains and minds grow in specific ways during the infant and pre-school years. Building healthy emotionally powerful concepts is a life-long endeavour, beginning in the infant years. By establishing the basis for how the brain grows and develops we empower ourselves to understand the connections between what we do as parents and how our kids develop.

"The distance between a new-born baby to the five-year-old is a chasm. Between the five-year-old to me is just one small step." **Tolstoy**

And now for the science of learning! We are about to examine how a **trillion or so brain cells** (neurons and glia) grow and organise themselves into effective and **functionally active systems** that may last an entire lifetime.

Tucked snugly inside the skull lies the brain, an organ of about $1^1/_2$ kilograms of light-pink matter interspersed with white fatty matter, that is designed to learn. In my opinion, the mind is the conscious aspect of the brain's thinking process, existing interdependently with the brain. Neuroscientist, Susan Greenfield defines the mind as, '... the seething morass of cell circuitry that has been configured by personal experiences and is constantly being updated as we live out each moment' (2000, p 15). Together, the brain and mind combination intertwines our experiences to construct our lives. They are the interface between our inside world and the outside world.

At birth, the brain is less than 1/3 of its adult weight yet it has already undergone significant growth and development. Within a day of the mother's egg being fertilized by the father's sperm, it has divided into two cells. Two days later, it has divided into 64 cells in a sphere-shaped construction that by three weeks has again divided with the middle layer destined to become the cells of the brain. Working at a prodigious pace to meet its requirements of about 70 - 90 billion neurons by mid gestation, the fetal brain produces about 500,000 tiny neurons per minute! By 6 months gestation the rate has slowed to about a mere 250,000 per minute! Produced in the middle section of the brain, the cells must migrate upwards and outwards towards their final destination. Following trails and ladders laid down by cells called radial glia, they even stop occasionally for the glia cells to nourish the travelling neurons.

The travelling neurons are destined to form the cortex (Latin for bark) a pinkish outer covering of six layers of neurons. What happens next is simply amazing. The 100 billion or so nerve cells begin to blossom with branches, known as **dendrites** (to collect electrical and chemical messages from other cells) and sprout longish cables, known as **axons** (to send electrical and chemical messages to other cells so they can establish **functional interconnections** between each other. While is evidence of learning (interconnections between nerve cells) from experiences within the womb, these experiences pale into insignificance when compared to connections that occur once the child is born.

During the first 2 years of life, the brain will nearly double in size underscoring the significance of environmental influences in shaping each brain. The first of the two main factors contributing to the growth spurt is the construction of those interconnections between cells – **synapses** (the tiny gap between the end of an axon and junction points on dendrites from other nerve cells). The synapses construct the interconnections by crowding onto every possible tiny space on the wispy dendrites, which in turn grow at amazing rates to increase surface area in the brain for even more synapses. The second major growth factor is a fatty white substance that accumulates around the **axons** of these cells – **myelin**. Myelin insulates the axons that pass electrical impulses from neuron to neuron. Myelin helps to construct neural pathways that eventually become habits.

Key Points

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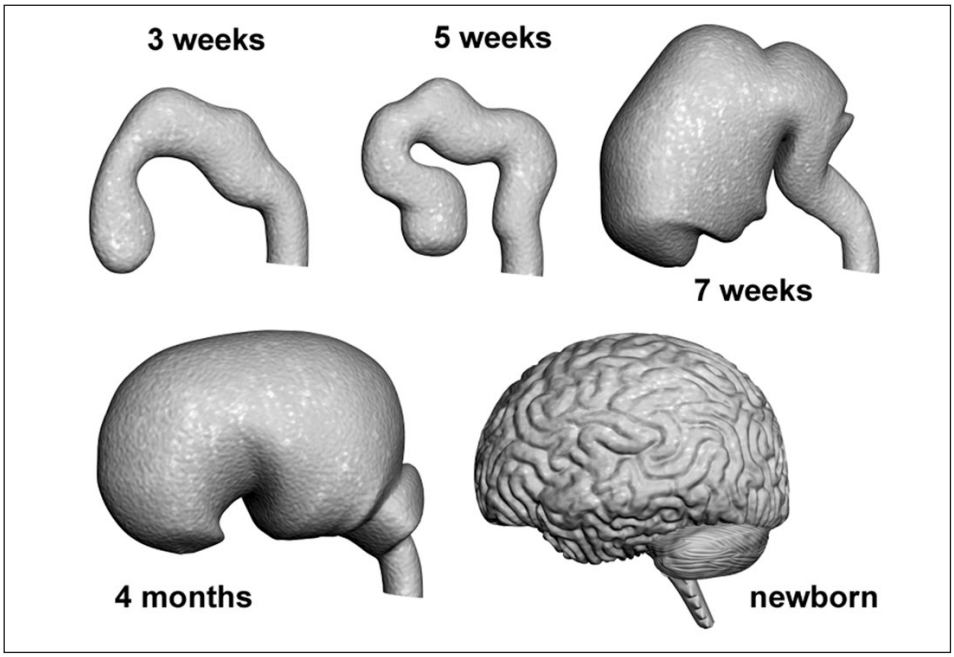
Figure.1 Brain Growth in the Womb



At birth, the spinal cord and brainstem are just about fully myelinated. That's important because those brain parts manage temperature, heartbeat, and reflexes such as suckling. Long neurons, such as those travelling from the brain down to the bladder will take two to three years to myelinate, coinciding with the end of toilet training. The final parts of the brain to myelinate are the frontal lobes, a characteristic of the adolescent brain.

In the young child's brain, learning is primarily achieved through a **staggering growth of new synapses** (functional interconnections) while in the older child's brain, learning is largely achieved through the **strengthening or weakening of existing synapses**. Thus, the early years provide a strong foundation from which each brain will develop. As children construct long-term memories, slight modification of their brains takes place. Since every child has a unique set of learning experiences, every child also builds a brain as unique as a set of fingerprints.

Growth and pruning

An over production of synapses occurs in the young child's brain due to the novelty provided by almost every experience. In other words, the neurons form too many connections at first. Many of these synapses are vigorously shed in a process known as paring back or pruning as the young brain eliminates redundant and improper sites that are underused or obsolete. The interconnections that are active and generate electrical pulses survive while those with little or no activity are lost (Society for neuroscience, 2004). Scientists once thought that the pruning of synapses indicated the end of critical periods for brain development and any learning not reached within these periods would be too difficult for the brain to master at later times. Such thinking has subsequently lost ground to new theories based on the idea of **brain plasticity** (the dynamic structuring and re-structuring of synapses). The term, critical period, is being replaced by a new term, sensitive periods (OECD, 2002). Therefore, the building of concepts, emotions, procedural skills and memories is a dynamic, life-long process for the human brain. No child is predestined by genes to fail to learn – albeit there will be genetic influences that help shape each person's potential. The brain learns constantly and through biological reflection it prunes, constructs and reshapes memory, continually recruiting obsolete neural networks for new learning.

This significant research finding destroys forever the myth that failure to master certain learning within a prescribed period shuts down associated learning mechanisms for life. Having said that, there is no doubt that milestones in physical developments associated with such areas as sight, hearing, movements and certain aspects of spoken language are subject to sensitive periods for development. Even so, as neuroscientists learn more about the functioning of brains, the development of remedial strategies may ultimately enable each brain to re-wire itself to fulfill its destiny.

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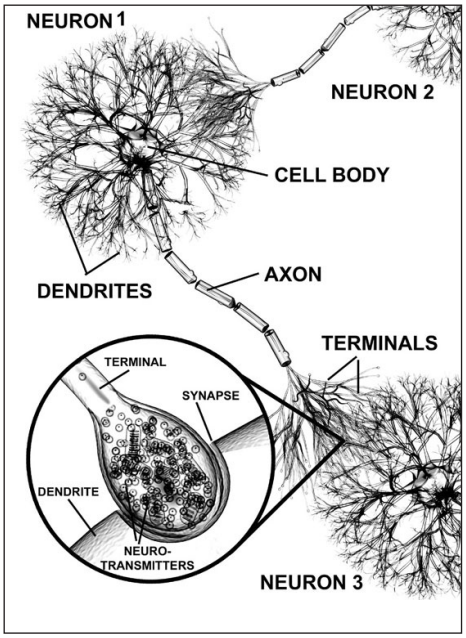
Neurons – tiny cells that learn

Neurons (from the Greek word meaning, 'bow') are specialised cells designed to transmit information to other cells. A neuron consists of a **cell body**, containing the nucleus, and an electricity-conducting cable known as an **axon**. The axon subdivides into **terminals**, which contain many brain chemicals, known as **neurotransmitters**.

Dendrites (from the Greek word meaning 'tree branches) grow as wispy tentacles from the neuron's cell body and are covered with synapses. **Synapses** (from the Greek word meaning to 'clasp together)' are the junction points between axon terminals and receiving dendrites.

Figure.2
Neurons, with a synapse (highlighted)



The illiterate child of the future will not be one who cannot read. It will be the one who does not know how to learn, unlearn and re-learn. Adapted from Alvin Toffler.

Summary

The least I need to know

Learning is the brain's biological imperative. The brain nearly doubles in size during the early years, making this period the most dramatic and important for the shaping of learning and personality traits. However, learning and personality development are life-long pursuits.

References

(Items marked * are available from Mind Webs). Log on to **www.mindwebs.com.au** or call Cathy Joseph for a catalogue (08) 8358 6993.

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Next Issue – part two:
The early years. Learning from experience.