Learning with the brain in mind - the early years

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Between 1998 and 2008, John Joseph has presented keynote addresses, conferences and workshops to more than 300,000 people, representing more than 3,000 schools and hundreds of corporations across 17 countries. Week after week, he facilitates workshops for student groups where he challenges young people to learn about learning, behaviour and emotions. John uses stunning computer-generated graphics and actual brain dissections to engage kids. He has facilitated the dissections of more than 100,000 sheep brains! Little wonder that people refer to him as "The Brain Man!" John has presented sessions to teachers, students, parents, judges, business leaders, accountants, the medical profession, community service organisations, government departments and tertiary education staff. He has written more than 100 published articles, five books and a number of CD Roms. His websites generate over 100,000 downloads every month. John is currently Director, Focus Education Australia Pty Ltd and Director, Mind Webs Pty Ltd.

"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

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 two 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.

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.

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 overproduction 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, lifelong 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 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 development 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. Neurons look a little like uprooted trees. There are the branches at the top (dendrites), the longish trunk where the body of the cell is located (axons) and the roots (terminals) which branch out of the axons to make contact with other neurons or muscle cells.

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.

At its most basic level, the terminals of one neuron connect with the dendrites of another neuron. The connection, known as a synapse, is a tiny gap where the brains chemicals (neurotransmitters) flow from terminals on axons to receptor points on dendrites. It is at those points that our experiences become flesh. The synapse has both pre-connection points (transmitters) and bulb-like post-connection points (receptors). As neurotransmitters flow into the synapses, due to making or retrieving memories, the tiny receptors they latch onto cause electrical or biochemical messages in the receiving neuron. Thus the input to a neuron occurs at the synapse and the output is a series of electrical blips firing down its axon in pre-determined (or learnt) patterns.

Within thousandths of a second, neurons which are part of sending and receiving networks can make sense of our world and, remarkably, remember the patters of inputs and outputs so we can recall the memory later.

Why are some things easier to learn than other things?

The human brain is born with a pre-programmed expectation to learn a whole array of skills such as eating, walking, talking, simple number facts, toileting, bonding and so on.

The human brain, however, does not expect to learn certain other things and therefore requires intense coaching and long periods of practise. Such learning includes reading, writing, complex mathematics, playing sports, driving a car and so on. Whatever the brain learns, it needs experiences to build interconnections between neurons to enable the construction of memories. Scientists call these interconnections, synapses and the growth of new synapses enables the construction of more memory networks, known as synaptogenesis. We now know that synaptogenesis occurs throughout life, a feature known as brain plasticity.

What is experience expectant learning?

Neuroscientists have divided synaptogenesis (the growth of new synapses) into two major categories. Category 1, is experience expectant plasticity, which is characterised by learning that occurs species-wide and within predictable periods. Category 2, is experience dependent plasticity, which is not constrained by age or time but does require relatively high degrees of motivation and effort to master. This latter type of learning is undertaken by pre-schools and schools and requires a structured curriculum and regular, specific feedback.

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Most experience expectant learning occurs within the early years of life and with little formal instruction. Most young children learn to talk and walk easily (experience expectant) compared to learning to write their names (experience dependent). A young child masters the grammar of a language more easily during the early years while the vocabulary of the same language is subject to lifelong modification. Therefore, second language learners need exposure to the grammar of the language early on if they are to speak it without an accent.

Experience expectant learning occurs when the brain encounters the relevant experience and motivation at the appropriate time (OECD, 2002).

A vocabulary of 50 or so words by around age one, learnt primarily by pointing, labelling and naming items blooms into perhaps 2,500 words by age five. Wide-spread, stiff-legged movements of the toddler mature in the second year of life into running, jumping, hopping, kicking, climbing and riding. During the third year of life many children learn to tip-toe, balance on a narrow beam, catch items and even make rudimentary-looking drawings that represent people and environments.

By around age four, most children have already developed awareness of their own minds and those of others. The child can, for example, invent the personalities for two dolls – one that acts mean and another that acts nice – then enact a scene between them (Diamond and Hopson 1998). This awareness of other people's lives and influences is crucial to children because they will model their attitudes, dispositions and behaviour on the significant adults and children with whom they regularly interact.

By around age six, most children can count to 30 or more, name several colours, write their own name, understand the meaning of prepositions (in, on, above, over, around, under) and many comparative states (biggest, smallest, tallest, widest). Running, laughing, chattering, exploratory young children require little formal instruction to master such learning. But, they do require high levels of interactions with loving, caring adults and the scope to explore and make mistakes without criticism. This is the main reason why working on children's strengths and from where the child is 'at' is more beneficial than trying pressure youngsters into matching their peers' outcomes or to manage their behaviour. Some youngsters are punished for not meeting adult demands and for acting out their frustrations through behaviour. Children find it very difficult to articulate their needs. Theirs is the world of emotions and associated behaviour. The emotions associated with punishment weaken relationships between young children and adults to the point where punishment itself has virtually no effect on behaviour. Punishment reduces risk-taking and risk-taking is a critical factor in learning during the early years.

A child is more likely to attempt learning when encouraged and guided, than when threatened, constrained or punished when things didn't work out so well. In fact, children's emotional states are far more significant in their intellectual development than previously thought (OECD, 2002). Emotion creates the shifting sands for the development of attitudes associated with formal learning.

The feeling of satisfaction accompanies successful mastery of learning. It's an emotion that strengthens children and feeds into the brain's natural disposition for learning. The early years require, above all else, the development of emotional competencies – to be self-aware, to have self-control, the ability to resolve conflicts, to cooperate with others, to delay gratification and to seek satisfaction. Many scientists assert that young children have brains that learn better than at any other time in their lives. Add high motivation to this wonderful window for learning, time-frames that reflect actual development rather than norms, and learning strategies based on individual learning styles to ensure an unbeatable combination for every child's growth and development.

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

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