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Learning with the Brain in Mind – from Birth to six

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 with a biological imperative to learn. The brain consists of about one and a half kilograms of soft, light-pink matter, equating to about 2% of the body mass. In my opinion, the mind is the thinking process – the interface between our inside world and the outside world. Neuroscientist, Susan Greenfield's 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 with our experiences to construct our lives.

At birth, the human brain is less than one third of its adult weight yet it has already undergone significant growth and devlopment. 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. By six months gestation the brain is producing its cells at an astonishing rate of 250,000 per minute! The cells are produced in the middle section of the brain and migrate upwards and outwards towards their final destination. Connections link the cells within the brain and while there is evidence of learning 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. Two main factors contributing to the growth spurt include the construction of interconnections between cells – synaspses, and a fatty white substance that accumulates around parts of these cells – myelin. In the young child's brain, learning is primarily achieved through a staggering growth of new synapses 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. The other key growth factor, myelin insulates the fibres (axons) that pass electrical impulses from neuron to neuron. Myelin helps to construct neural pathways that eventually become habits. As information enters the long-term memory of children, a 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.

Between the ages 2-6, the mind is extremely active in developing neural networks in the brain. To function well during this time, the physical brain will consume about 20% of the oxygen a child breathes, and between 20% and 30% of their food intake. Making memories at fantastic speed, its billions of learning cells, called neurons, burn about twice the glucose of an adult brain (Gopnik et al, 1999). The neurons obtain glucose through a network of blood vessels that transport between 32 and 35 litres of nutrient-rich blood to the brain every waking hour. That's about 800 litres each day or about 290,000 litres per year! There is a strong link between what and when a young child eats and the efficiency of their brain. Whilst there is considerable debate about brain-compatible diets, there are some basic guideleines: protein breakfast, snacks such as fresh fruit and low GI carbohydrates during the day, and carbohydrate with smaller protein serves for dinner (read Joseph, Food for Thought).

Growth and pruning

The early years sees an overproduction of synapses due to the novelty provided to the young child by almost every experience. These synapses are vigorously shed in a process known as pruning as the young brain elimates memory that is underused or obsolete. 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 notion of brain plasticity (the dynamic structuring and re-structuring of synapses). The term 'critical period' has been replaced by 'sensitive periods' (OECD, 2002). Therefore, construction of concepts, emotion, procedural skills and memory 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 introspection, 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 but even so, as neuroscientists learn more about the functioning of brains, the development of remedial strategies will ultimately enable each brain to re-wire itself to its current needs.

Experience expectant learning

Cognitive neuroscience has divided synaptogenesis (the growth of new synapses) into two major categories: experience expectant plasticity which is characterised by learning that occurs species-wide and within predictable time-frames, and experience dependent plasticity, which is not constrained by age or time but does require relatively high degrees of motivation and effort to master.

Most experience expectant learning occurs within the early years and with little effort. A young child learns to talk and walk easily (experience expectant) compared to learning to write her name (experience dependent). The grammar of a language is more easily mastered during the early years while the vocabulary of the same language is subject to life-long 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 fifty 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 six, most children can count to thirty 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).

The running, laughing, chattering, exploratory pre-schooler requires 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.

How concepts affect engagement in life

Young children develop concepts (internal ideas based on external experiences) about themselves and their place in the world. Those concepts are affected by four key factors:

- confidence as a learner
- level of motivation
- strategies to learn about the world
- time taken to master learning so it becomes automated.

A child who lives with criticism learns to be critical. A child who lives with encouragement learns to encourage. The early years are foundational for developing concepts. The child who takes longer than his sister to learn to read (experience dependent) may have his confidence and motivation shattered if derogatory comparisons are made. The human brain develops more as a pattern-seeking organ, rather than a creative, imaginative one. As this occurs through the early years some children create a kind of glass-ceiling for themselves which prevents them from moving beyond their self-concepts as learners. Hence, children seek to find or create environments that match their concepts. Self-concept is a powerful driver of performance.

The inherent danger is that children begin to develop behaviour to ensure that their environments and concepts match. For example, a child who holds a concept that she cannot write her own name is unlikely to be motivated enough to even attempt writing it, and if ‘pushed’ she will typically resort to escalating behaviour in order to avoid the situation. At such moments, adults often enter the realm of behaviour management – the use of coercion such as threats or rewards. Such efforts are largely a waste of time and do more to de-motivate than to inspire.

By around age four, 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. Working on children’s concepts is more beneficial then trying to manage their behaviour because the former is based on encouragement while the latter is based on power. The emotions associated with punishment weaken relationships to the point where punishment itself has

virtually no effect on behaviour. The child is more likely to attempt better learning strategies when encouraged and guided. 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 new concepts.

Successful mastery of learning is always accompanied by the feeling of satisfaction, an emotion that strengthens children and urges them into new learning territories. 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 a brain that learns better than at any other time in their lives. Add to this wonderful window for learning high motivation, time-frames that reflect actual development rather than norms, and learning strategies based on individual learning styles ensures an unbeatable combination for every child's growth and development.

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References and further reading

OECD (2002). *Understanding the Brain: Towards a New Science of Learning*. OECD Publications: France.
Diamond, M. and Hopson, J. (1998) Magic Trees of the Mind. New York: Penguin Books.
Greenfield, S. (2000). *Brain Story.* London, BBC.
Gopnik, A., Meltzoff, A. and Kuhl, P. (1999). *The Scientist in the Crib – Minds, Brains and How Children Learn.* New York: Morrow and Co.
Clinch, R. (2000). *Secret Kids Business.* Hawker Brownlow.
Joseph, J. (2002). *Brainy Parents – Brainy Kids* (2nd Ed). Adelaide: Focus Education Australia.
Joseph, J. *Food for Thought* www.focuseducation.com.au