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Circuits and Circumstances.

The Consequences of Early Relationships:

A View From Interpersonal Neurobiology.

Legal Aid Board Dublin.

Family Law Conference. 21st June, 2011.

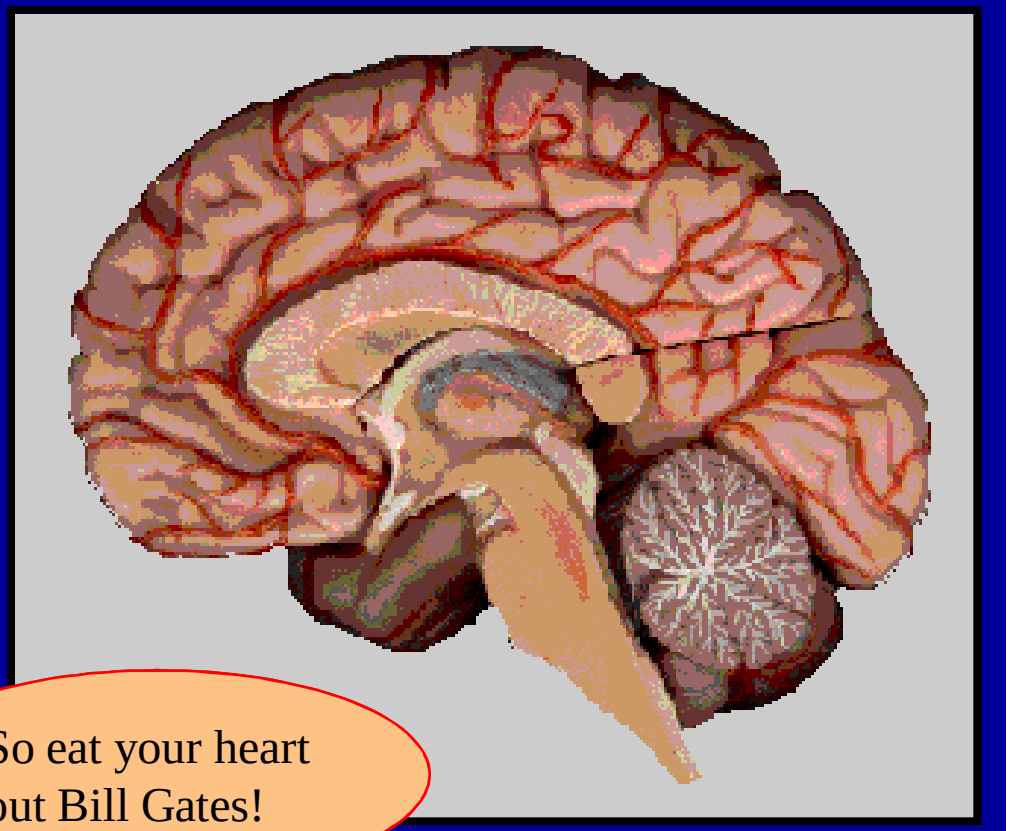
Early caregiving lays a foundation.

Positive predictable interactions with responsive, nurturing caregivers profoundly stimulate and organize young brains.

The quality of early caregiving has a long lasting impact on how people develop, the ability to learn, and their capacity to both regulate their own emotions and form satisfying relationships.

The brain is the only ‘computer’ that can:

- adapt to input by changing both its own software and hardware;
- automatically scrap unnecessary, unused components;
- dictate the interests and skills of the operator;



So eat your heart out Bill Gates!

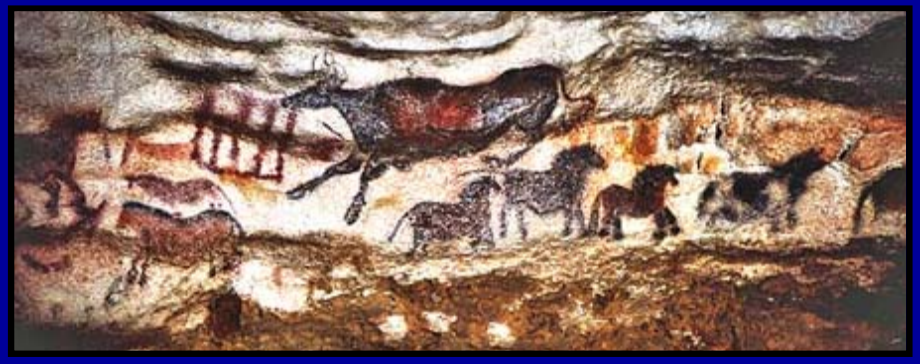
- **and, crucially, never exist on its own.**

This is simply how humans have evolved.

"The evolution of human beings has consisted largely of adaptation to one another." (p. 27)

(Wright, R. (1996) *The Moral Animal* London: Abacus.

Here there was a crucial change.



"Our brains coevolved with culture and are specifically adapted for living in culture – that is, for assimilating the algorithms and knowledge networks of culture." (p.11)

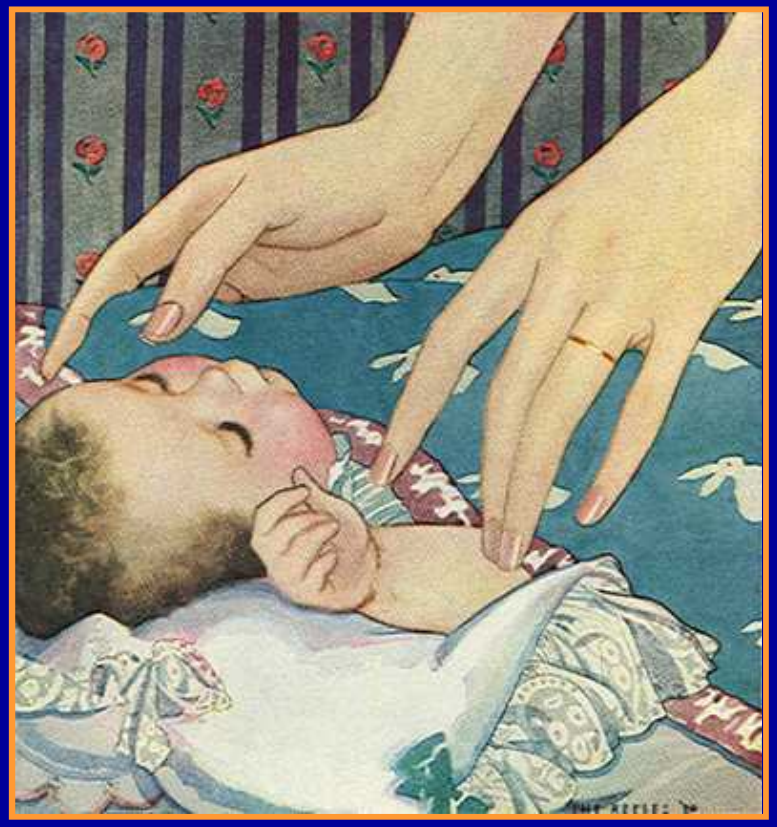
"The human brain is the only brain in the biosphere whose potential cannot be realised on its own. It needs to become part of a network before its design features can be expressed." (p.324)

Merlin Donald (2001) *A Mind So Rare.* W.W. Norton & Co.

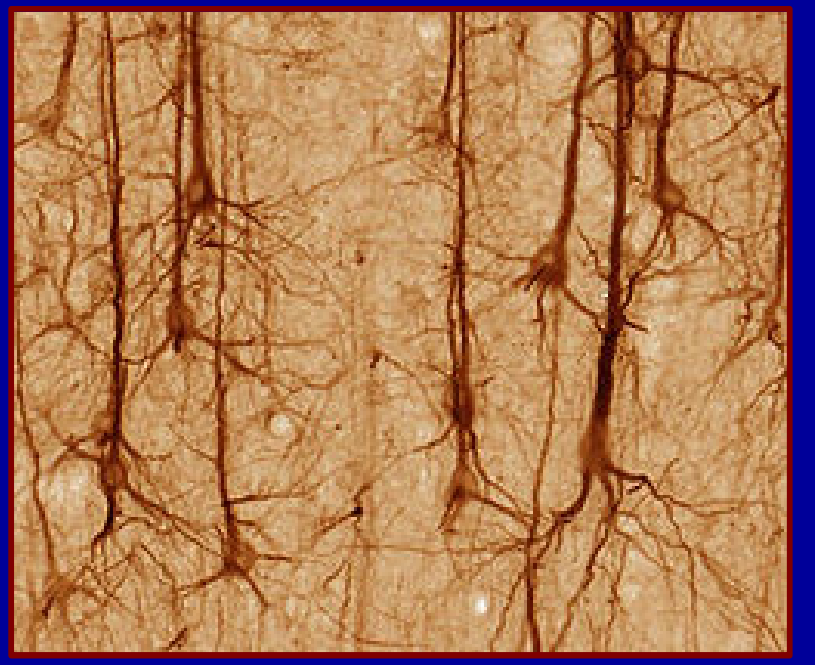
So, what do we adapt to?

"For the developing infant the mother essentially *is* the environment." (p. 78)

(Schore, A. N. (1994) *Affect Regulation and the Development of the Self: The Neurobiology of Emotional Development.* New Jersey: Erlbaum.



And how do we adapt?



"By initially overproducing connections that have been spread to a variety of targets, and then selecting from among these on the basis of their different functional characteristics, highly predictable and functionally adaptive patterns of connectivity can be generated with minimal prespecification of the details." (p. 202) Deacon, T. (1997) *The Symbolic Species.* London: Penguin.

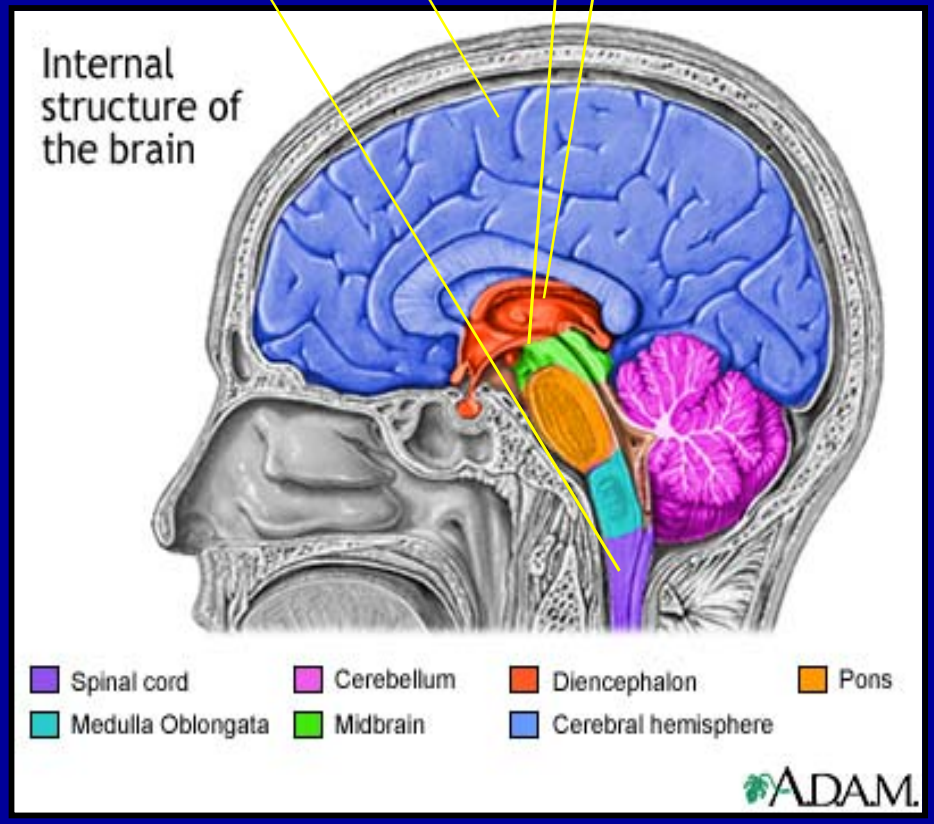
The brain is comprised of four areas.

diencephalon

limbic system

cortex

stem



Growth of the brain occurs from the inside out and the bottom up.

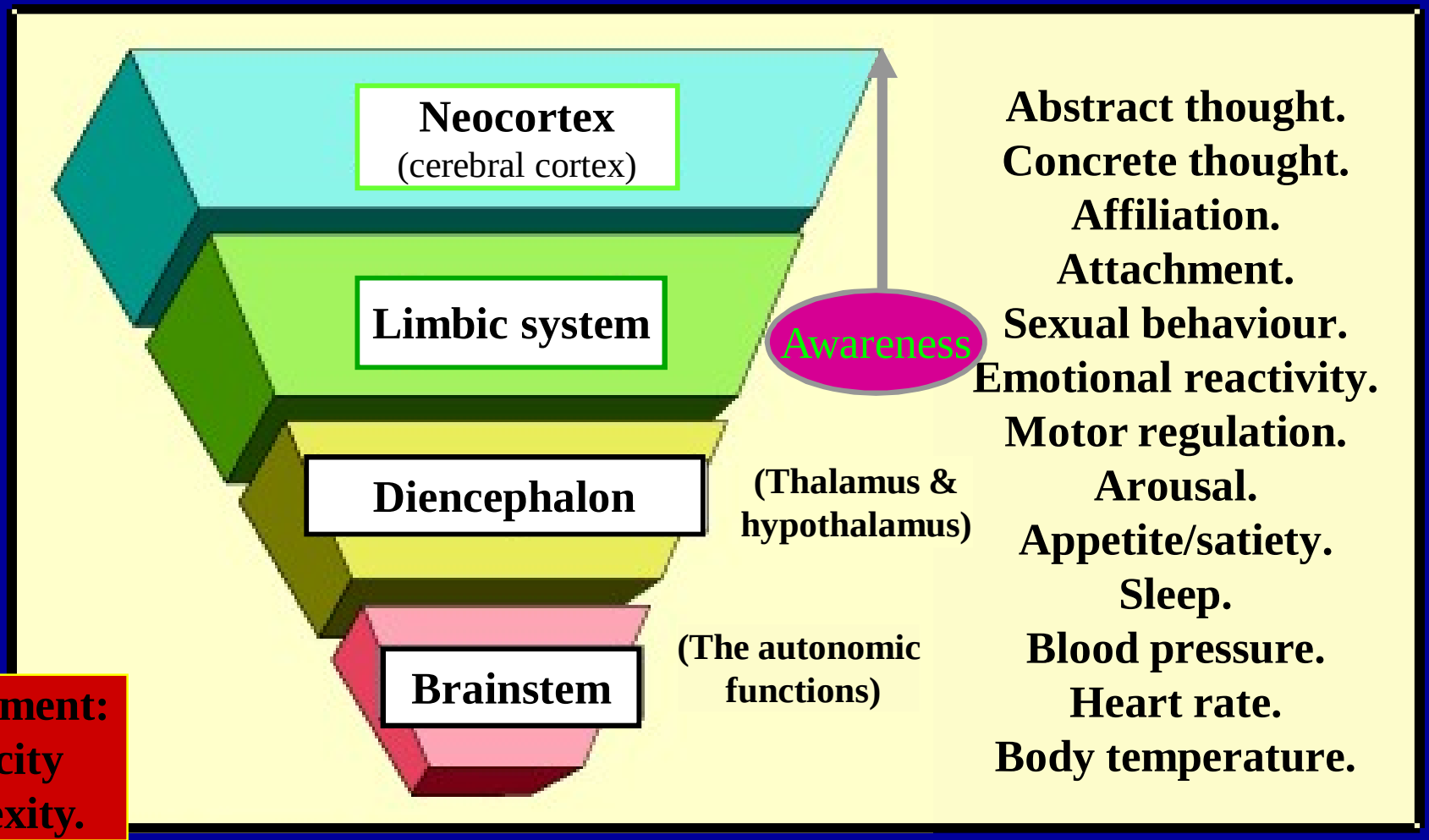
You are born with 100 billion brain cells, neurons, but these are largely unconnected.

There can be about 15,000 synaptic connections for each cell.

They can wire up at the rate of 1.8 million per second!

You have more than 2 million miles of neuronal fibres!

Growth from the bottom up and inside out.



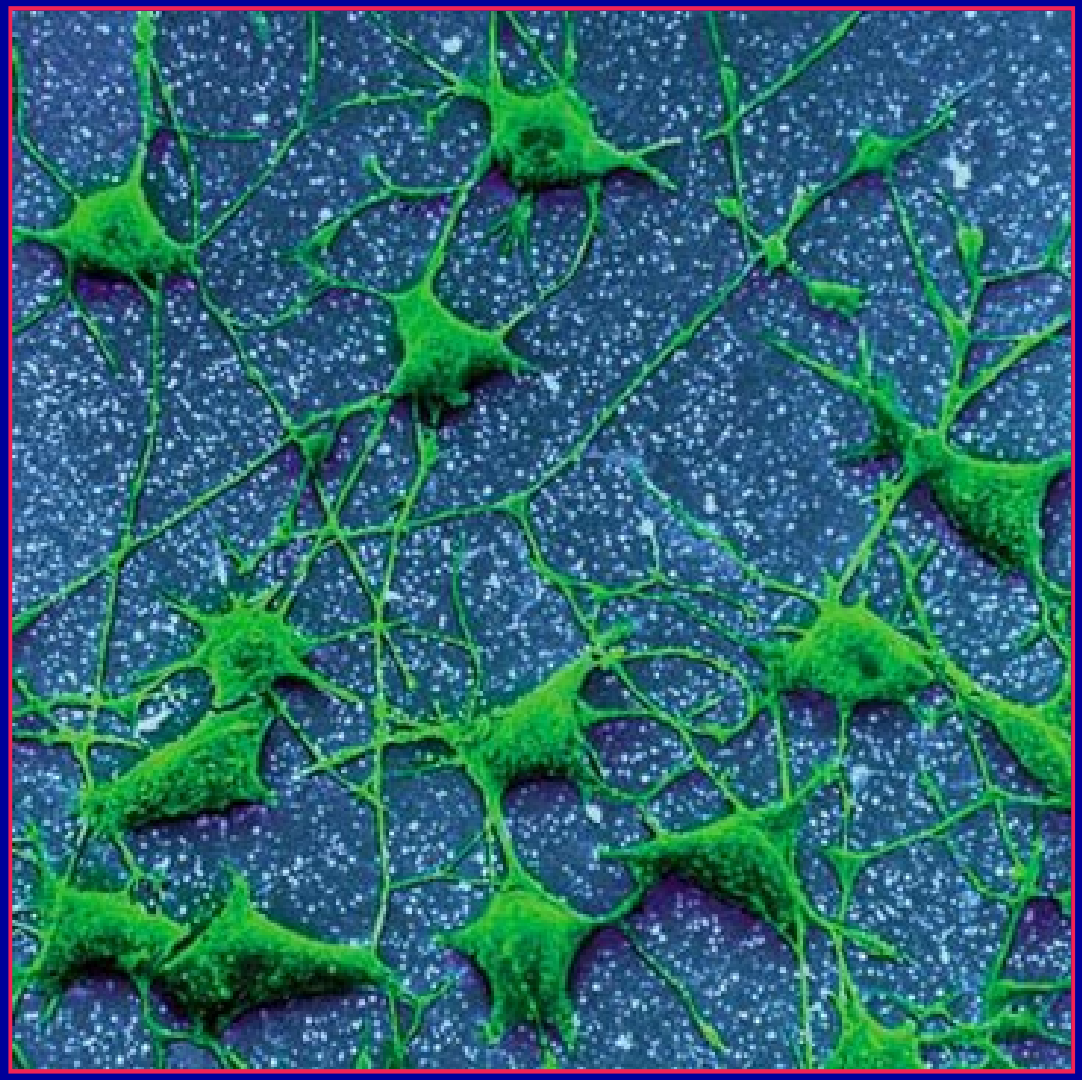
Development: plasticity complexity.

Any developmental insult may have a cascade effect on the growth of all 'downstream', later maturing, brain areas that will receive input from the affected neural system.

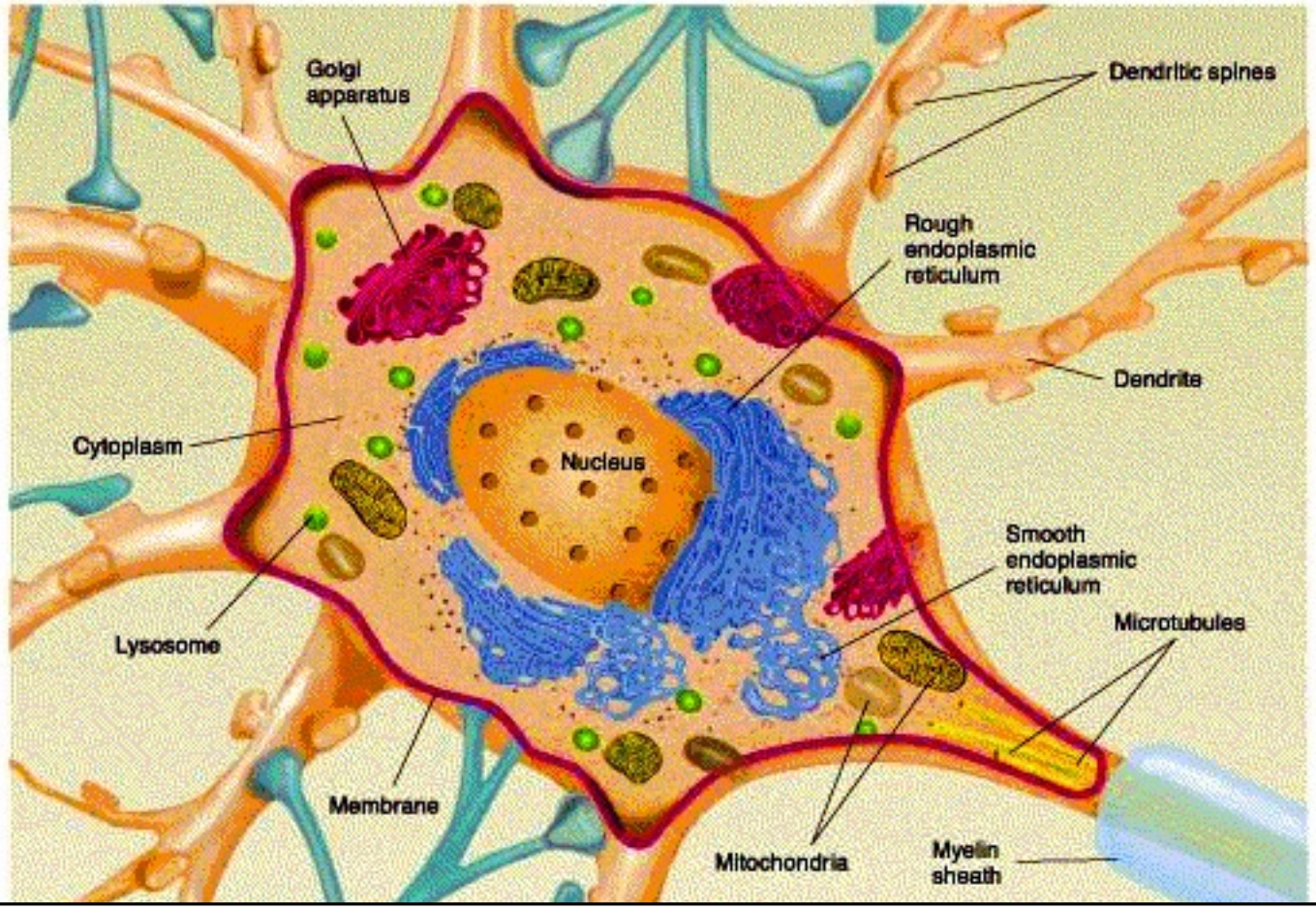
Neurons.

Many intrauterine and perinatal insults can alter migration of neurons and have a profound impact on functioning.

e.g. infection, lack of oxygen, malnutrition, psychotropic drugs, lead poisoning, ionising radiation, stress and alcohol.



Principal internal structure of a Multipolar Neuron.



Neurons have 3 sequential levels of information exchange, or messenger systems: 1) The communication across the synapse, that - 2) changes the internal biochemistry of the cell, which - 3) activates mRNA (messenger ribonucleic acid) & protein synthesis to change brain structure.

View of a **synapse**.

It is the process of synaptic transmission that stimulates each neuron to survive, grow and be sculpted by experience.

"During brain growth there is a constant sorting and juggling of nerve cells and connections. Those that make a match with their environment thrive, and the others wither." (p.124.)

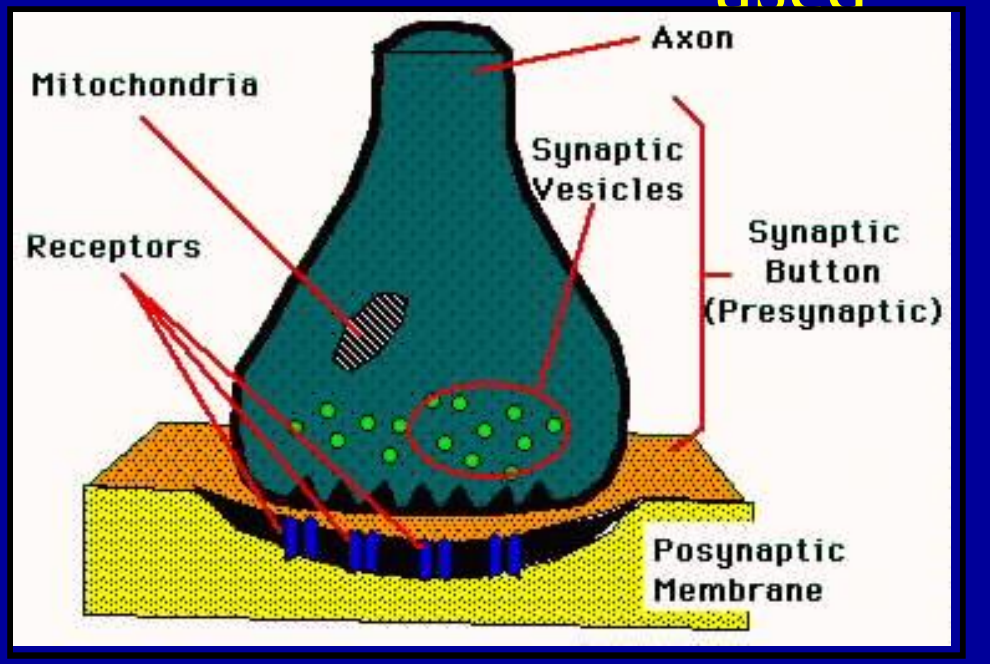
And so:

"Impoverished environments appear to have the opposite effect of rich and varied surroundings. They suppress brain development." (p. 158)

Bownds, M. D. (1999) *The Biology of the Mind.* Bethseda: Fitzgerald Science Press.

Experience dependant brain growth.

- Since the brain over-produces synapses they are ‘forced’ to compete.
- *Neurons that fire together wire together.*
- The ‘fittest’, or most used and useful, selected; development this is defined by the level electrical activity.



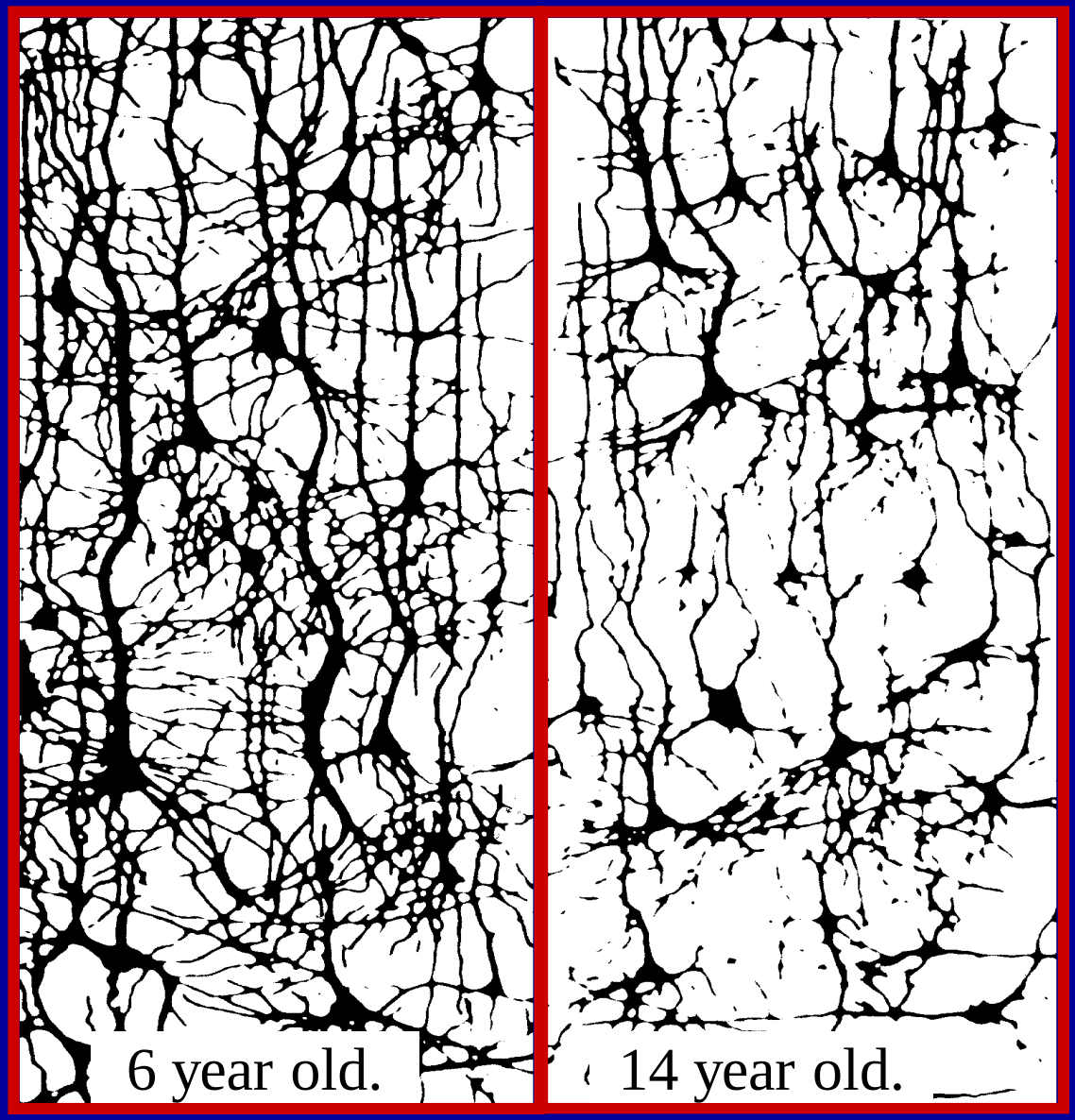
Initial growth of synapses.

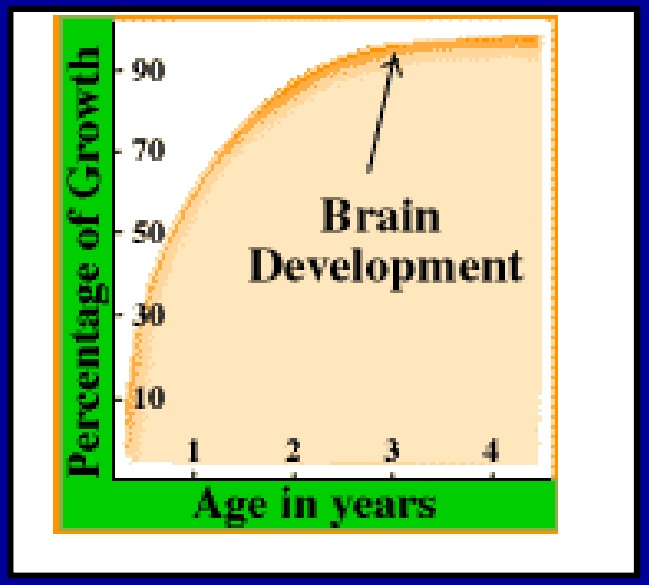
Birth.

15 months.

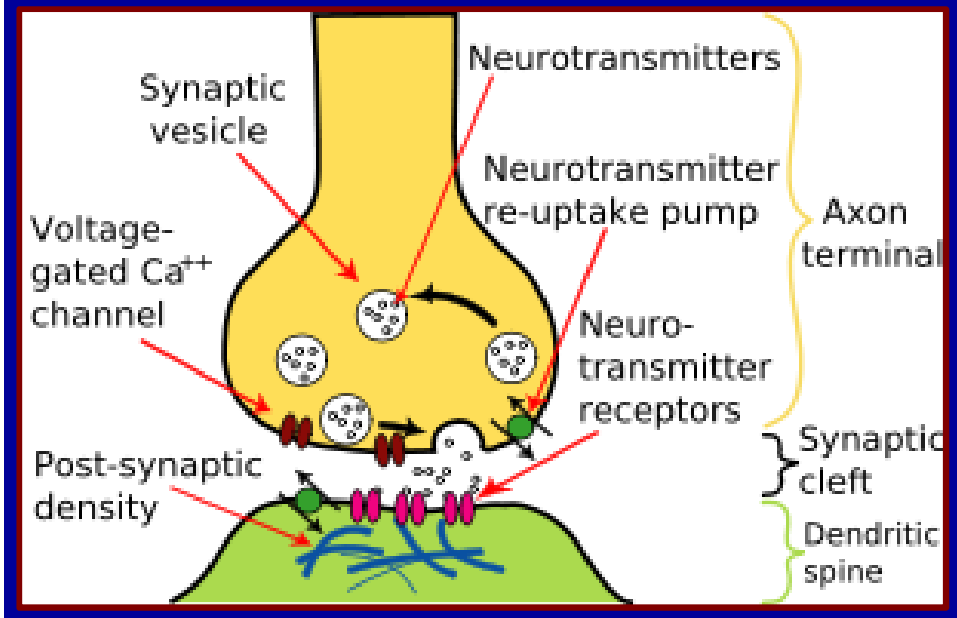
2 years.

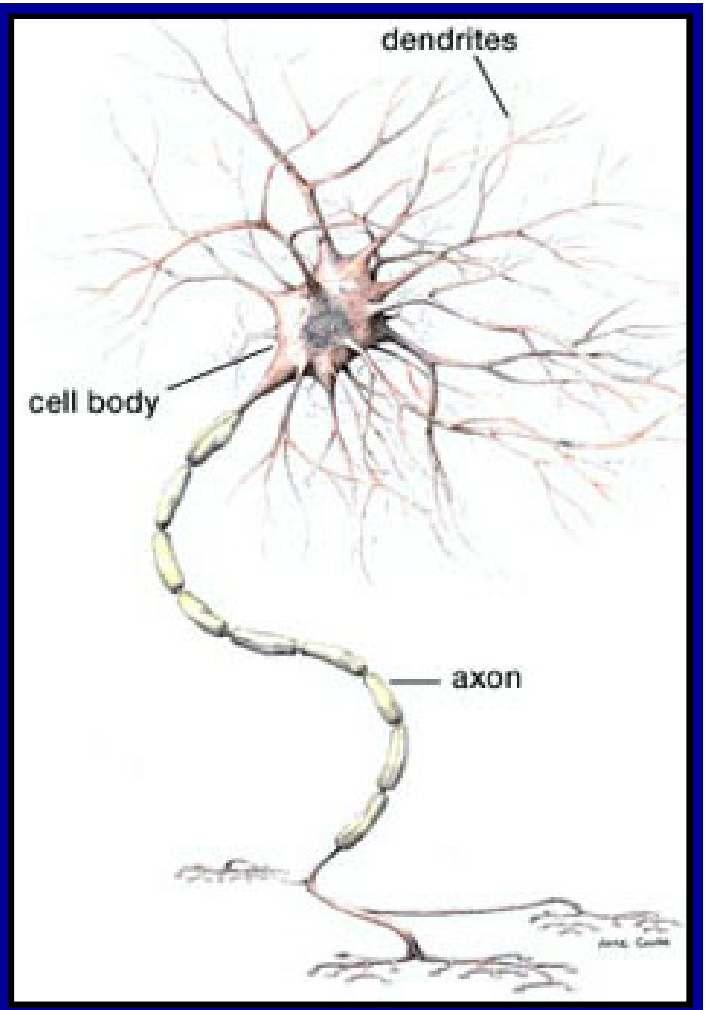
And then it is all downhill!





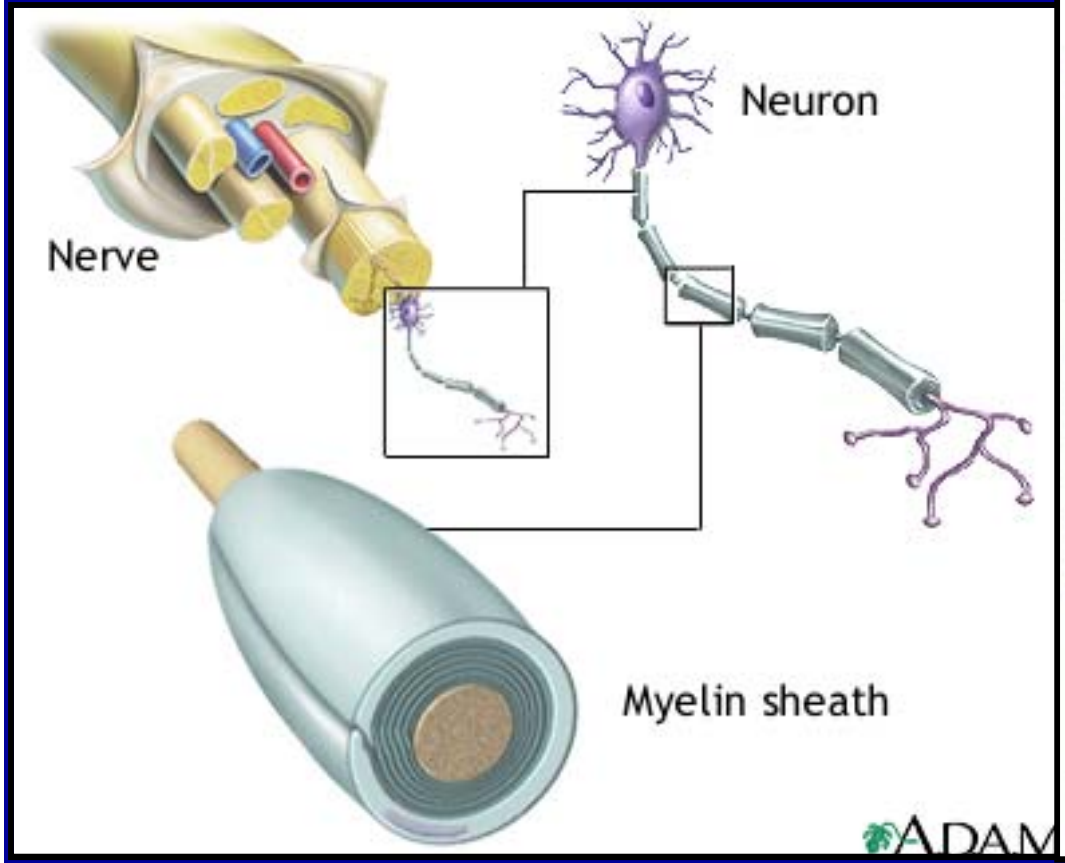
Highly active synapses – receiving more electrical impulses and releasing a greater amount of neurotransmitters – stimulate their post-synaptic targets more efficiently.

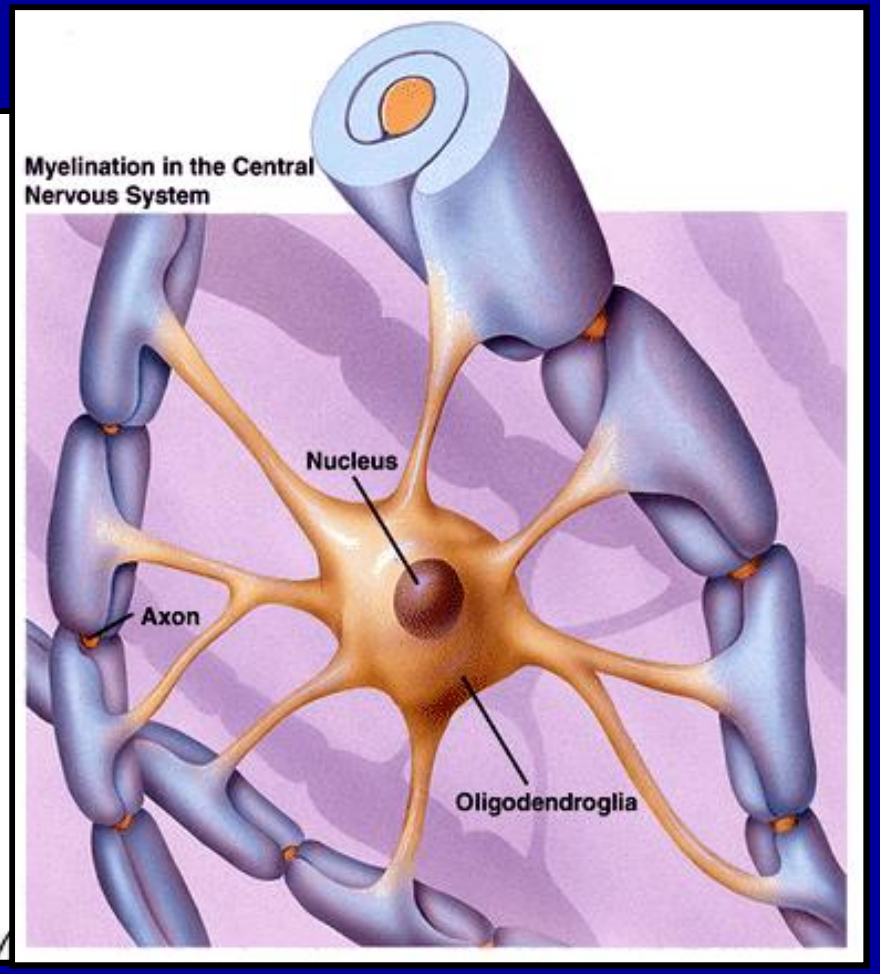




This heightened electrical activity also triggers molecular changes that stabilise the synapse.

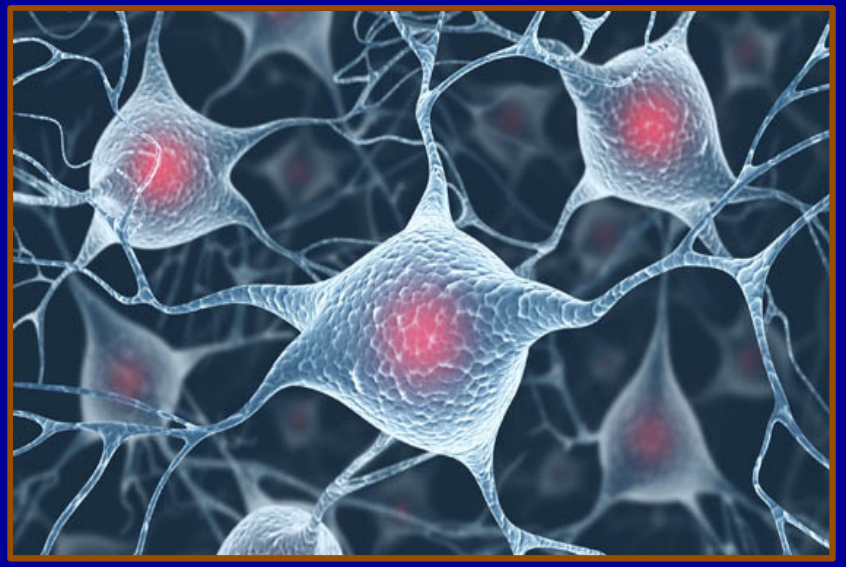
The axons of stabilised neurons become coated in myelin, an electrical insulator. It plays a role in the transfer of energy to neurons and may also support neuronal functioning.





This shows by an increase in white matter and a decrease in grey matter.

Less active synapses fail to stabilise, and so eventually regress. It is a matter of: “Use it or lose it!” right from the start. Synaptic pruning fine-tunes the functional networks of the brain.



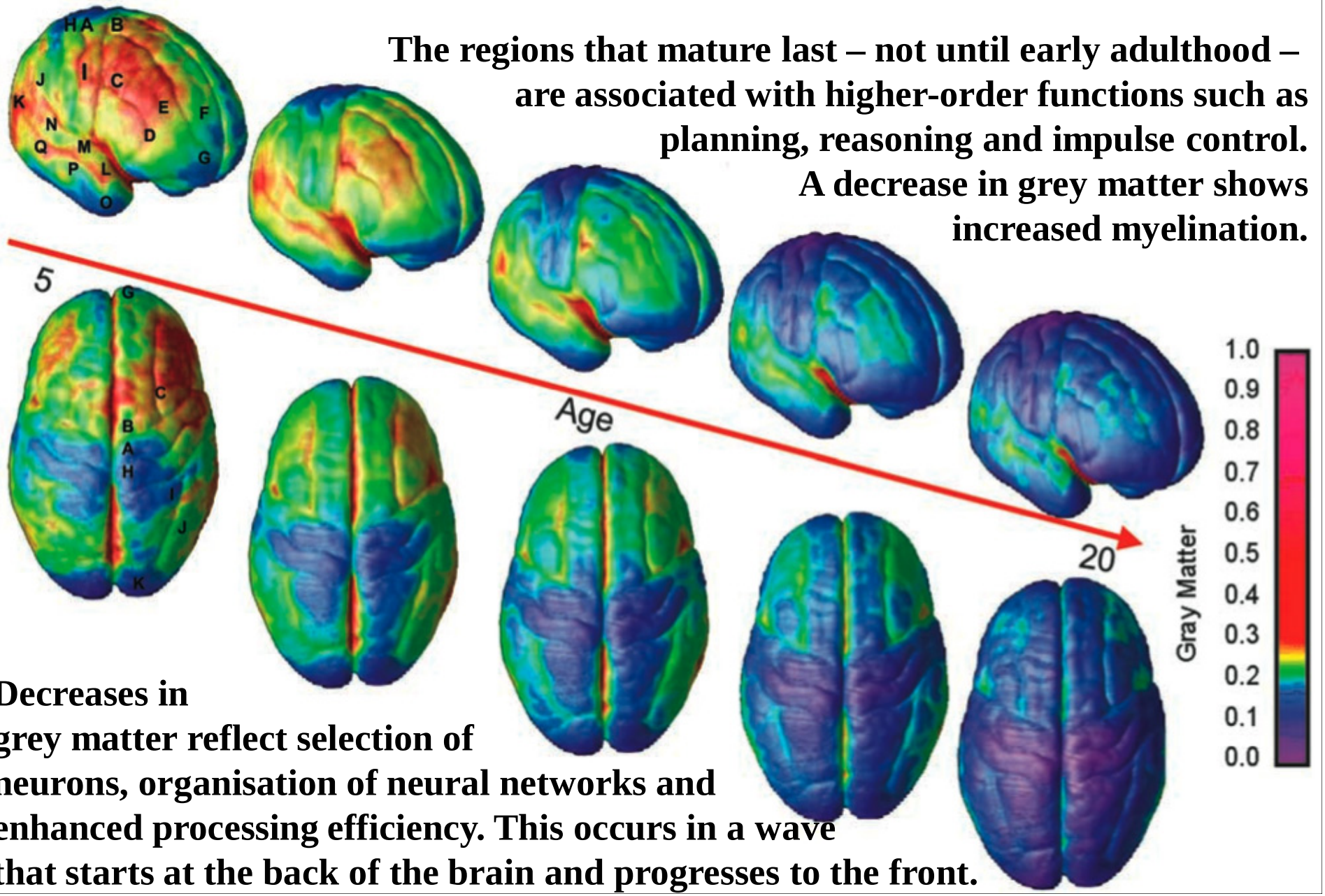
For the first 8 months after birth the rate of creating new synapses far outstrips that of pruning. By age 1, and through early childhood, the rate of reabsorbing redundant connections gains on the rate of creating new synapses. By adolescence, in most cortical areas, this process again reaches equilibrium.

Fewer but faster connections.

A second wave of synaptic proliferation and pruning within the cerebral cortex occurs in late childhood; and the final, critical part of this, affecting the higher mental functions, occurs in the late teens.

This overproduction, or *exuberance*, occurs in the parietal lobes – logic and spatial reasoning, connects senses with motor abilities and creates the experience of a sense of our body in space; and the temporal regions – linked to auditory processing, language and memory functions.

The maturation of grey matter in the cortex.



The regions that mature last – not until early adulthood – are associated with higher-order functions such as planning, reasoning and impulse control. A decrease in grey matter shows increased myelination.

Decreases in grey matter reflect selection of neurons, organisation of neural networks and enhanced processing efficiency. This occurs in a wave that starts at the back of the brain and progresses to the front.

The prefrontal cortex (the area of ‘sober second thought’, or the ‘chief executive’) is the last part of the brain to mature. Adults depend on this area of the brain to process emotional information, resist impulses and exert voluntary control. Unexpected stress may exhaust the prefrontal cortex resources of the adolescent, undermining executive functioning. Teenagers still rely heavily on the amygdala to process emotions, and frequently read the cues wrongly so the emotion gets wrongly labelled.

By eliminating seldom-used pathways the brain leaves room for sturdier, more efficient, neural networks.

And:

Like all Darwinian selection, this process of synaptic pruning is an extremely efficient method for adapting the baby's neural circuits to the exact demands imposed by his or her social , relationship-based, environment.

Windows of opportunity.

Birth to 6 months old.

Brain growth is unmatched during the first six months of life. The most critical windows during this stage are vision, vocabulary, and emotional development.

Because the windows for vision and emotions shut so early, it is important to pay attention to them during this stage.

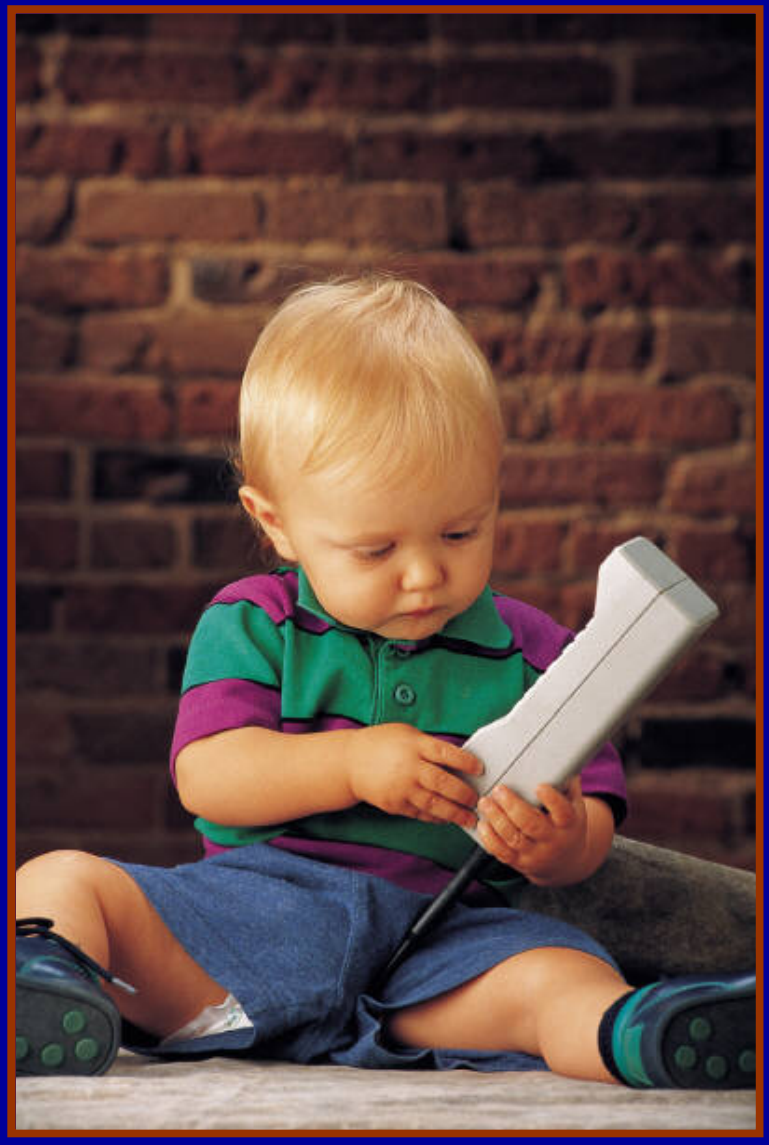
6 to 12 months old.

With connections primarily established for sight, the critical windows during this stage are speech and emotional development. The foundations for governing emotions are established. Language capacity grows tremendously during this period, and this is a good time to introduce the natural sounds of other languages.

12 to 18 months old.

Most of the critical windows of human brain development are open during this stage. At no other time is the brain so receptive and responsive.

Many of the neurological connections that govern a lifetime of skill and potential are beginning to take shape.



18 to 24 months old.

Children in this stage are gaining more control of their bodies, and their motor skills are developing.

They are becoming more aware of other people's feelings and beginning to learn to share.

Language and vocabulary remain important.

Attention should be given to maths and logic as well – but in the form of play, not a curriculum!

2 to 3 years old.

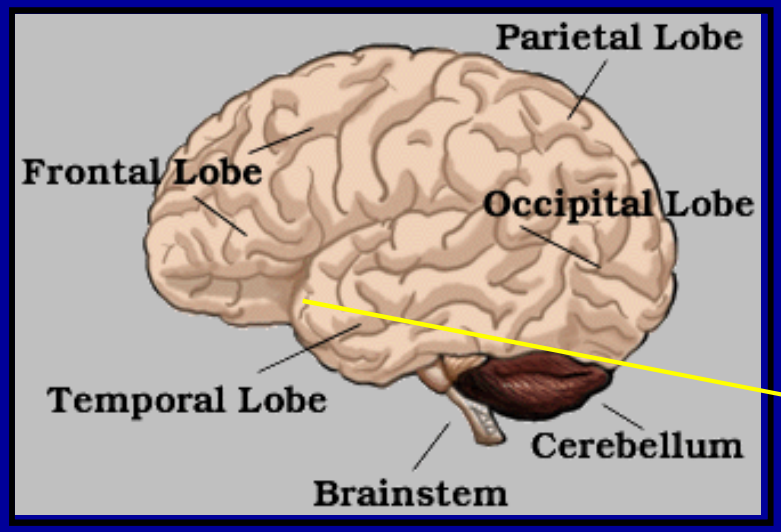
By the age of three, much of a child's brain growth and density is complete. The brain patterns that will guide a child's development are already well established. The critical windows for some skills such as speech begin to close, so vocabulary building is important.

Brain patterns for music begin to develop at the end of this stage.

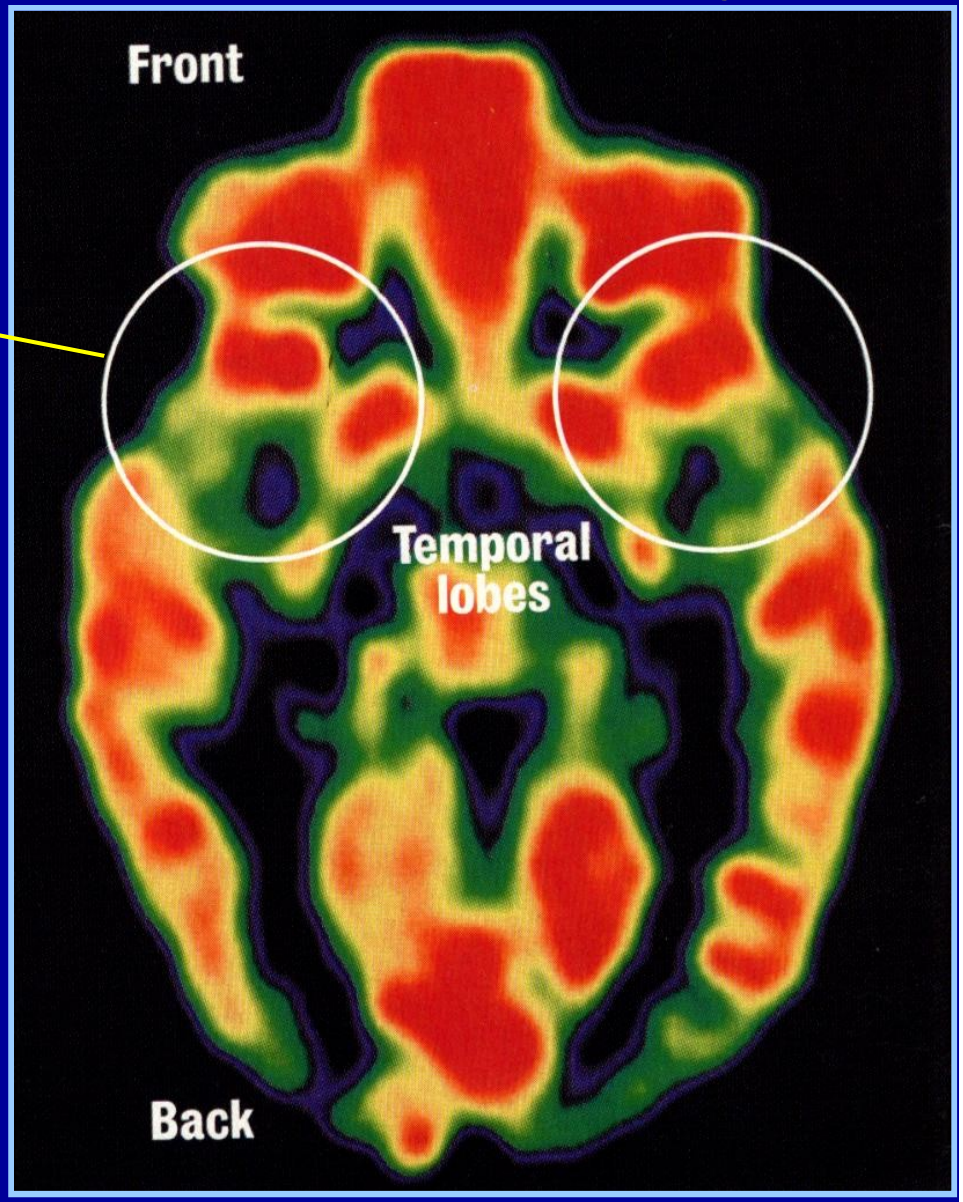
The baby's environment is defined by relationships.

Negle p-based organising experiences at key times during development.

Windows of vulnerability.



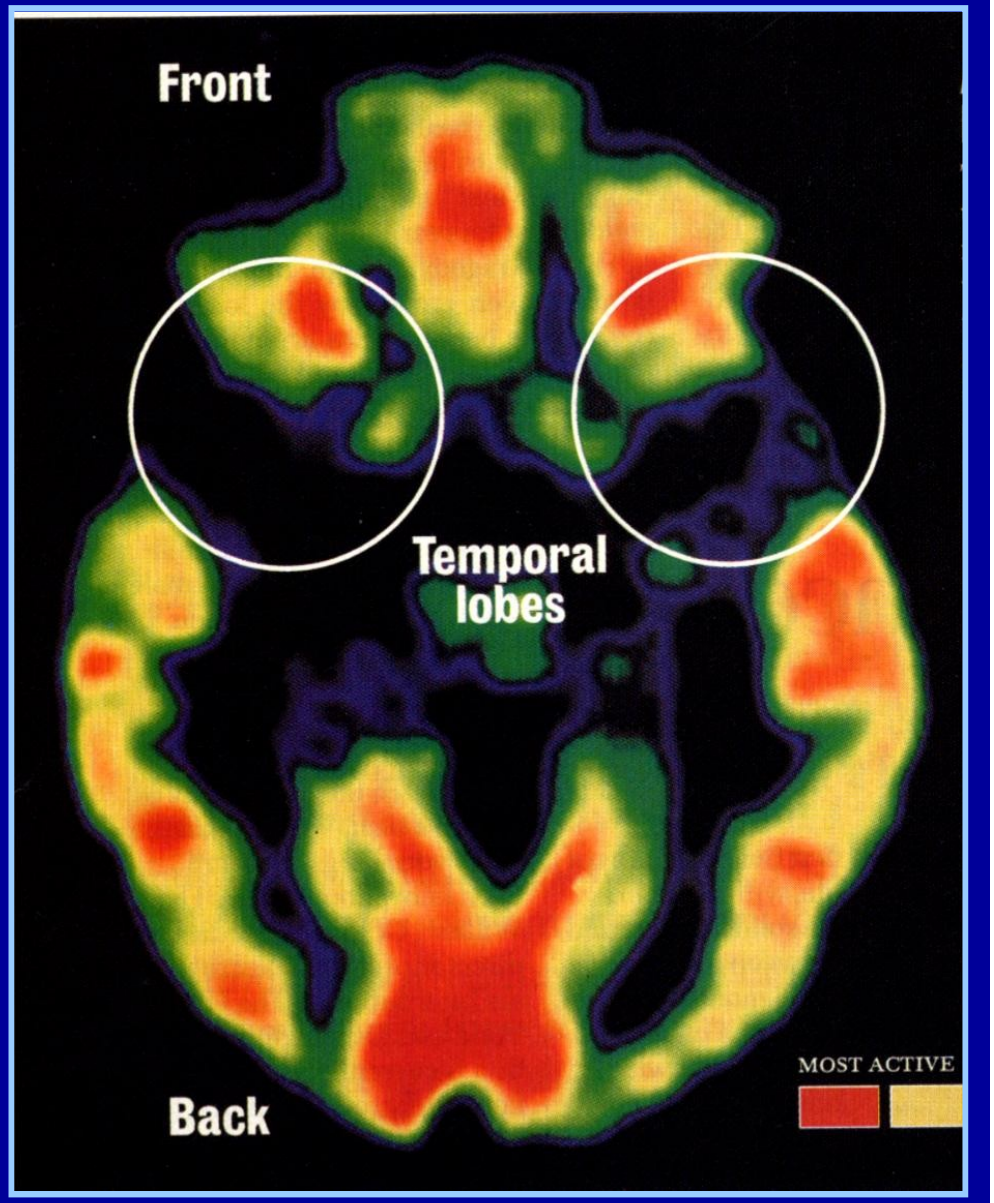
P.E.T. scan of a normal two year old.



The temporal lobes receive and integrate inputs from the senses, and combine them with deep primitive drives from the limbic system and brain stem. They also deal with hearing, learning, memory skills, emotions and identifying trustworthy and familiar people.

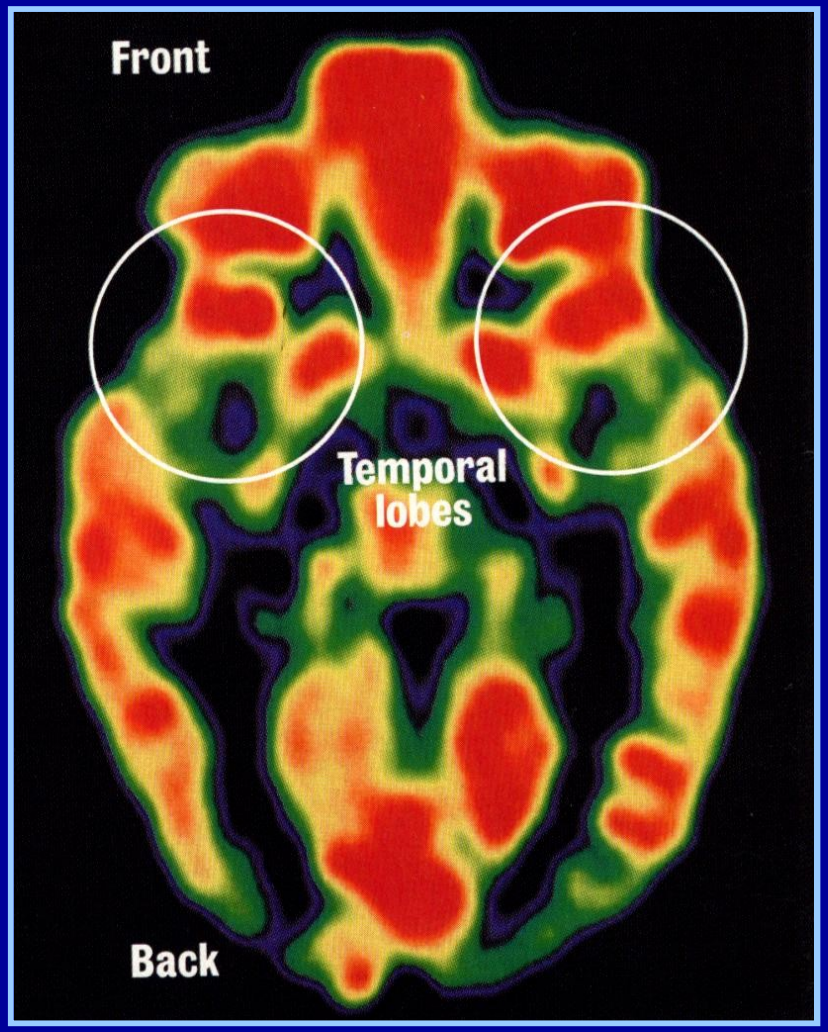
PET scan of the brain of a Romanian orphan institutionalised shortly after birth shows the effects of extreme deprivation in infancy.

Global neglect has been followed by atrophy of ‘unnecessary’ areas.

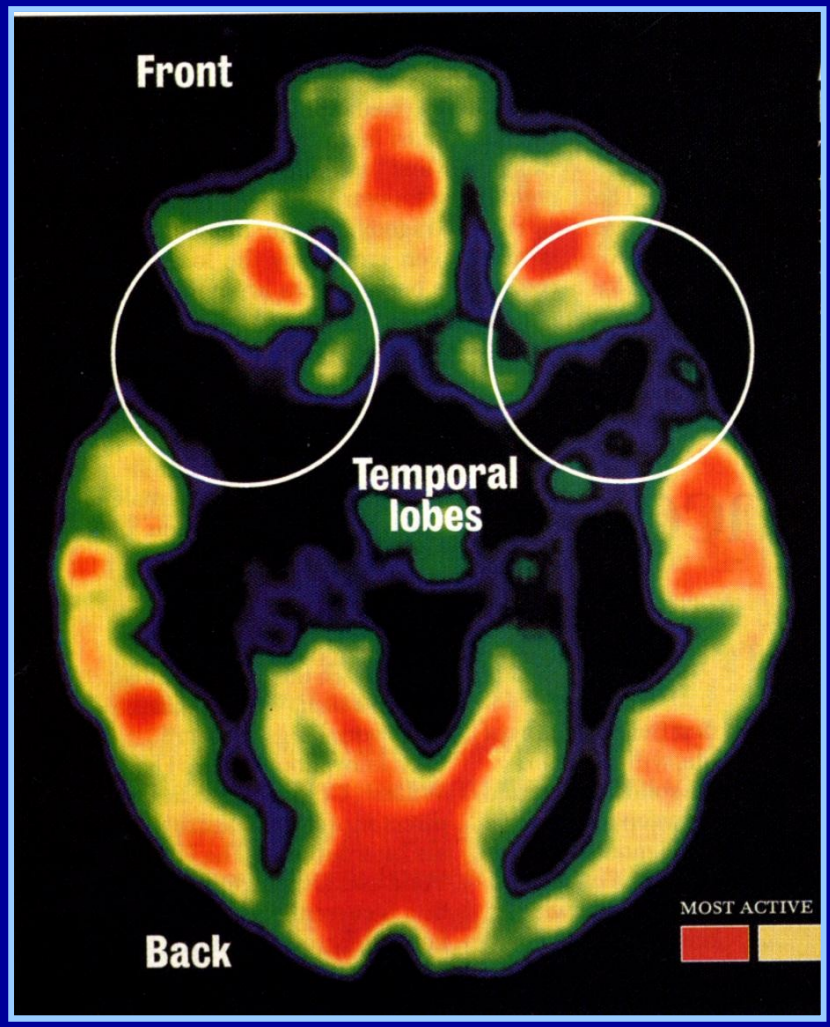


For a direct comparison.

Normal 2-year old.



2-year orphan.

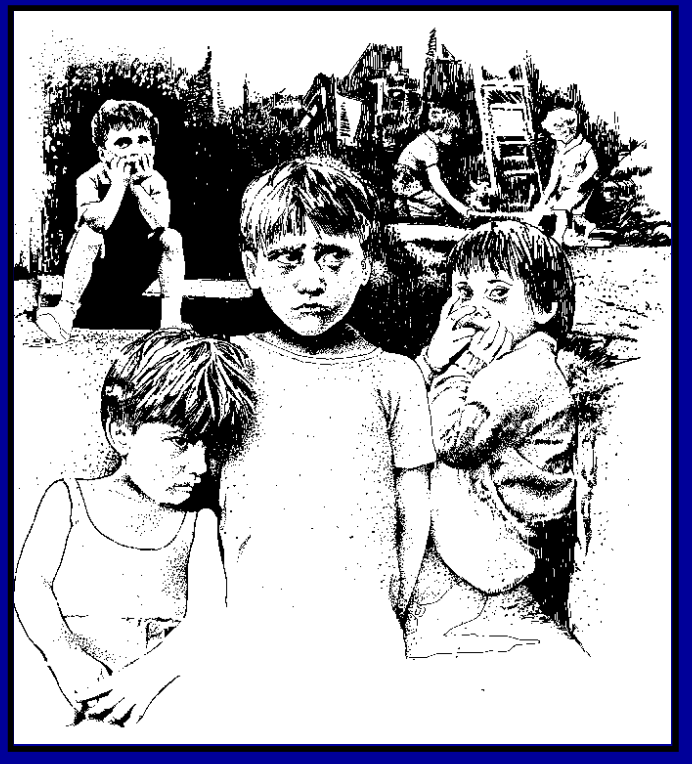


The neurobiological impact of abuse.

"Because childhood abuse occurs during the critical formative time when the brain is being physically sculpted by experience, the impact of severe stress can leave an indelible imprint on its structure and function. Such abuse, it seems, induces a cascade of molecular and neurobiological effects that irreversibly alter neural development." (p.56)

Martin H. Teicher. *Scars that won't heal: the neurobiology of child abuse.* Scientific American, March 2002. pp.54-61.

- The organising brain *requires* patterns of sensory and emotional experience to create the patterns of neural activity that will guide the neurobiological processes involved in development.
- In the face of interpersonal trauma, all the systems of the social brain become shaped for offensive and defensive purposes.
- A child growing up surrounded by trauma and unpredictability will only be able to develop neural systems and functional capabilities that reflect this disorganisation.

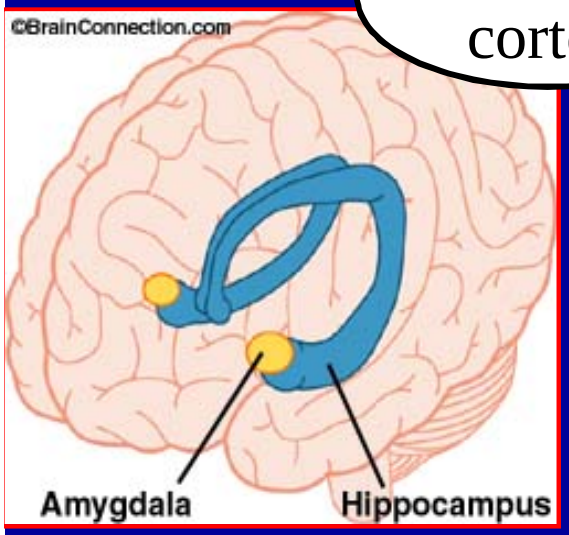


Linking thalamus, amygdala and cortex.

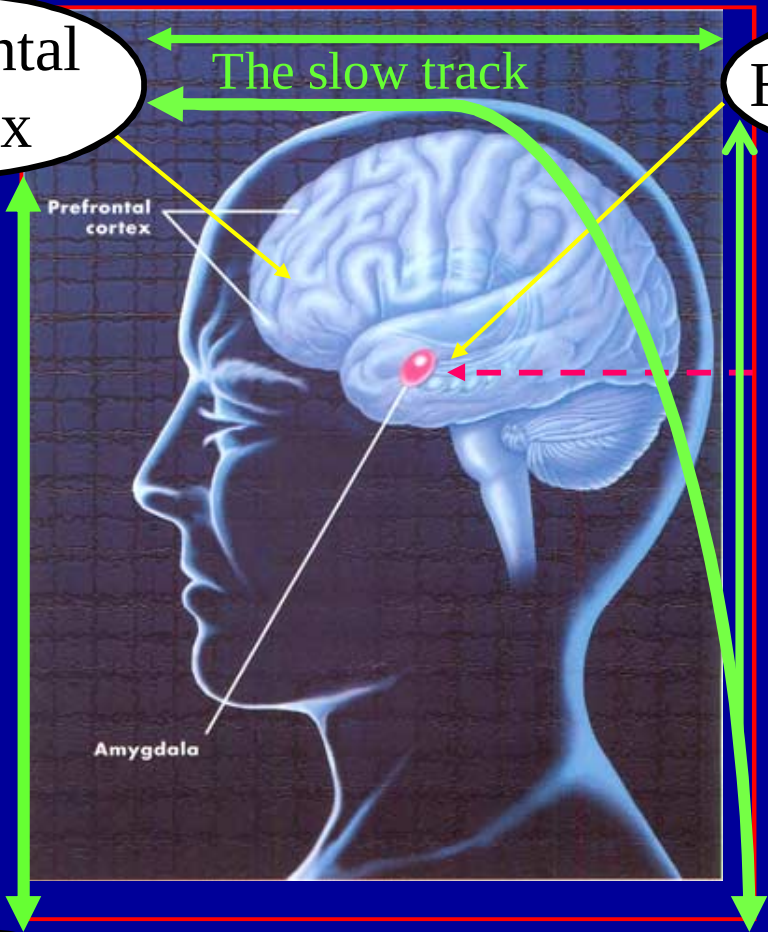
Prefrontal cortex

The slow track

Hippocampus



Sensory gateway to cognitive process organised through cortex & hippocampus.



Busy translating the sight of danger into preparing to fight, flee or freeze.

Here we have regulation of emotions by cognitive processes.

Thalamus

The fast, primitive, track

Amygdala

Sensory input

Activation of emotions before cognitive processes occur.

Controls the emotional responses.

"Abuse and neglect in the first years of life have a particularly pervasive impact. Pre-natal development and the first two years are the time when the genetic, organic, and neurochemical foundations for impulse control are being created. It is also the time when the capacities for rational thinking and sensitivity to other people are being rooted - or not - in the child's
(p. 45)

Karr- Morse, R. & Wiley, M. (1997)
Ghosts From the Nursery.
New York: Atlantic Monthly Press.

Pathway to the stress response.

Sensitive caregiver response.

Affect regulation occurs.

Return to calm state.

Signal of danger; e.g. maltreatment, absence of caregiving.

No response.

Fight or flight, *hyperarousal.*

or

Inappropriate response.

The infant is making a bid for interactive regulation.

Freeze & fade.
'Terror without solution'
Dissociation, or
hypoarousal.

STRESS!

Super nanny!

Insensitive caregiver.

Sensitive caregiver.

Heightened arousal.

Dysregulated stress response.

States

Traits

Homeostatic recovery.

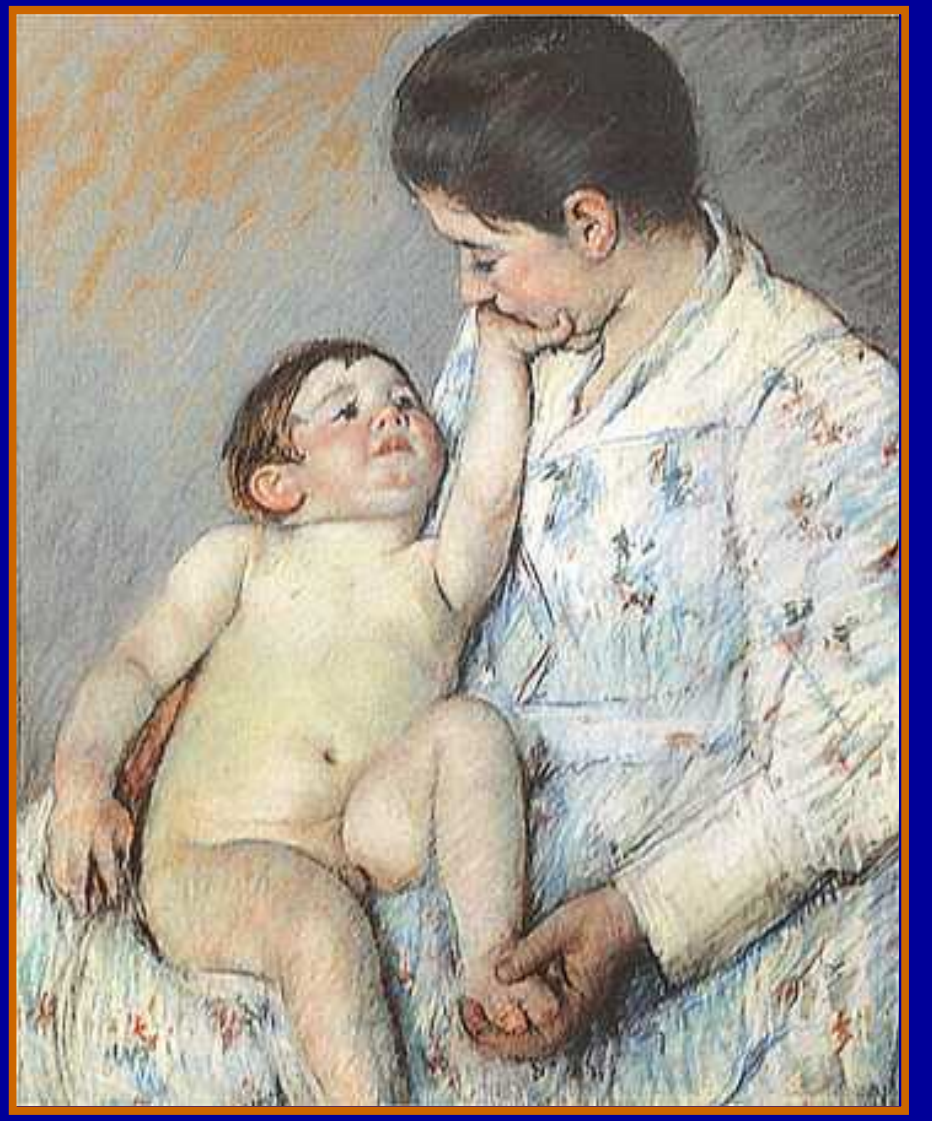
Infant learns to tolerate internal challenges.

Calm & connect versus flight, fight or freeze.

Under or over activity becomes a hard-wired feature of stress response system.

Implications for babies.

Optimal growth and development occurs within nurturing relationships; and these directly affect the formation of neural networks and the capacity for affect-regulation. The birth and care of a baby offers a chance for change.



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Good websites:

www.childtrauma.org

www.zerotothree.org

www.brainconnection.com

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