

Continued Brain Development in Adolescence & Young Adulthood

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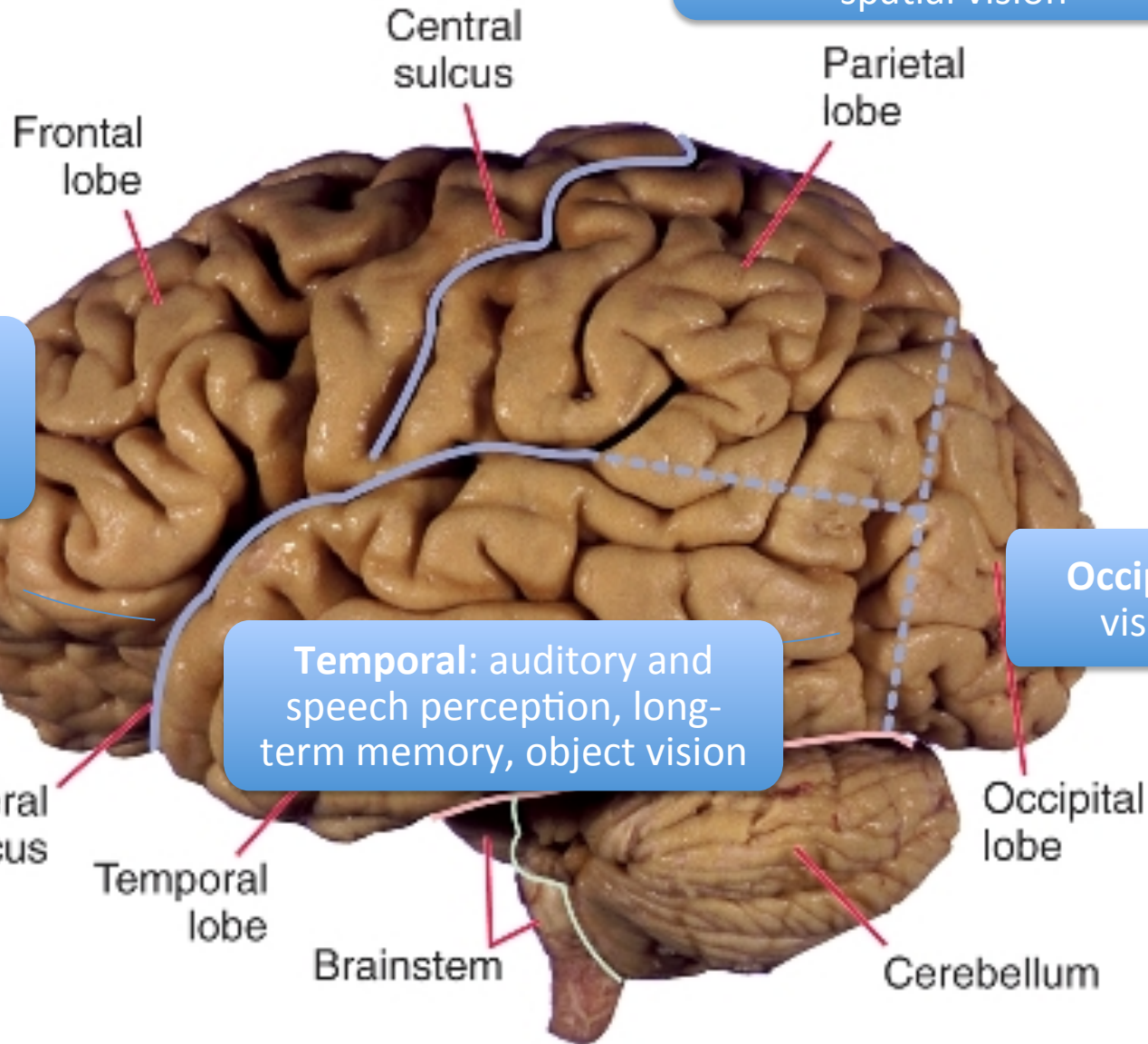


How does experience influence brain development and function?



The brain is amazingly complex.

Parietal: somatosensory perception, body sense, spatial vision



Frontal: motor control, working memory, executive functions

Temporal: auditory and speech perception, long-term memory, object vision

Occipital: vision

Lateral sulcus

Temporal lobe

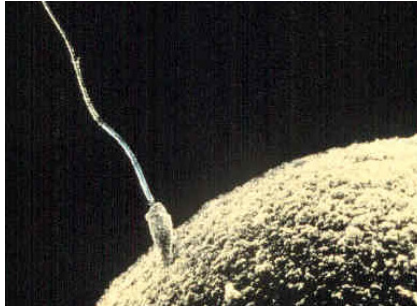
Brainstem

Cerebellum

Occipital lobe

Major changes in brain development occur prenatally.

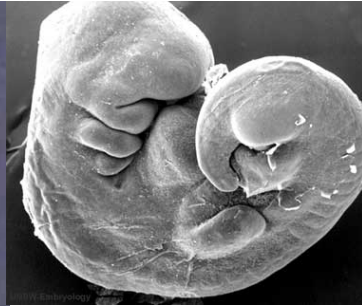
Fertilization



1 week



4 weeks



10 weeks



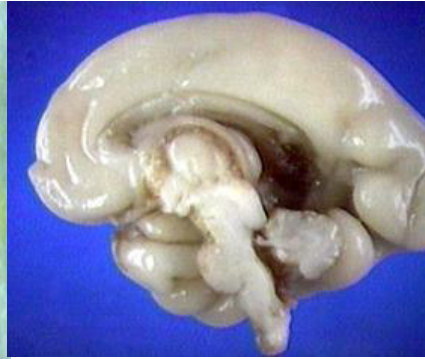
15 weeks



22 weeks



23 weeks



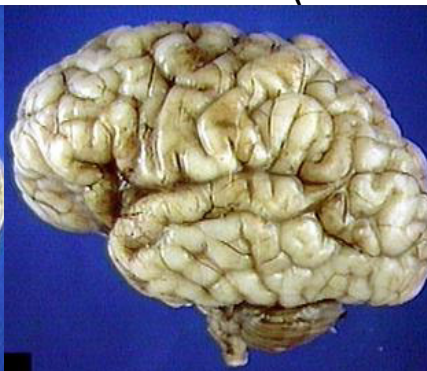
25 weeks



27 weeks



Full-term infant (40 weeks)



Adult

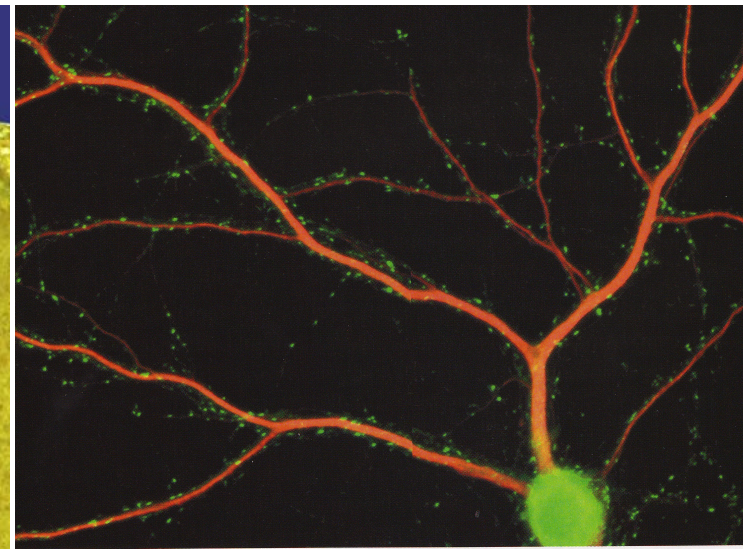
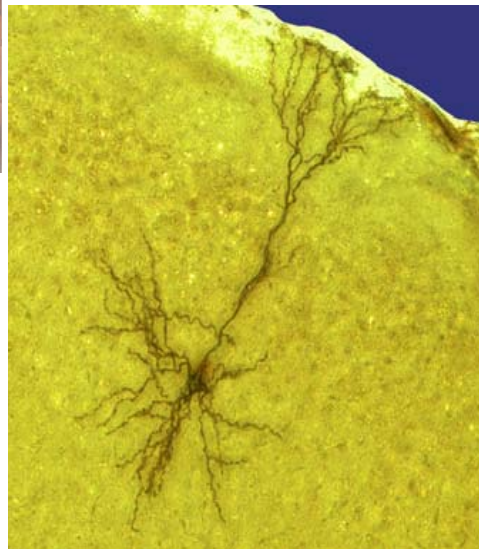
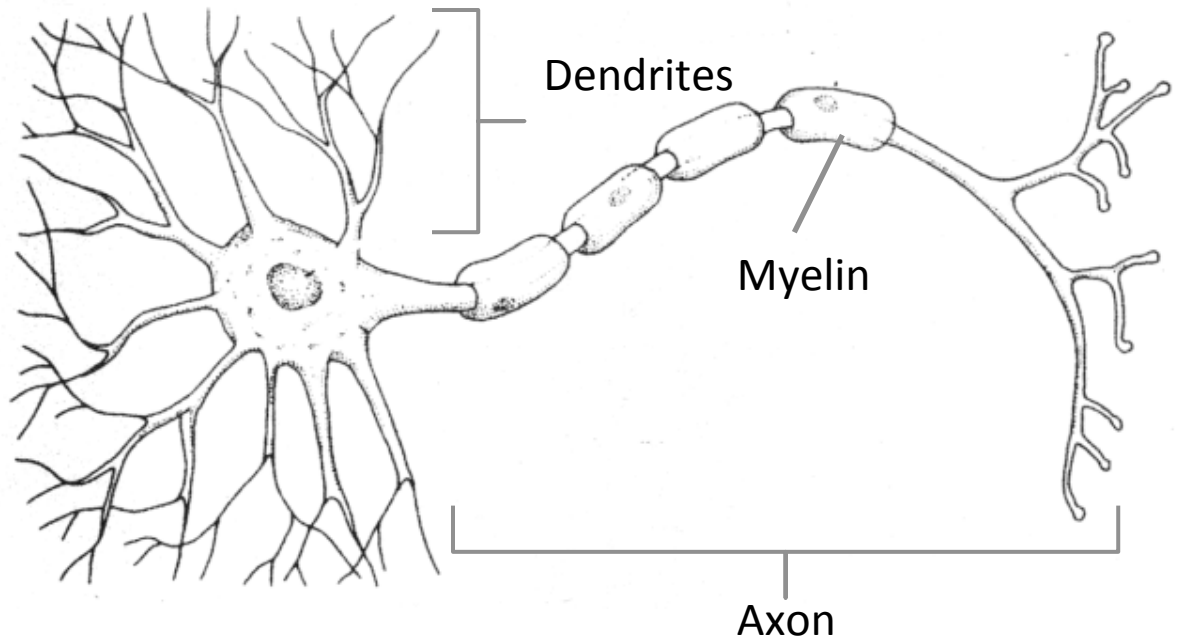


Basic building blocks of the brain

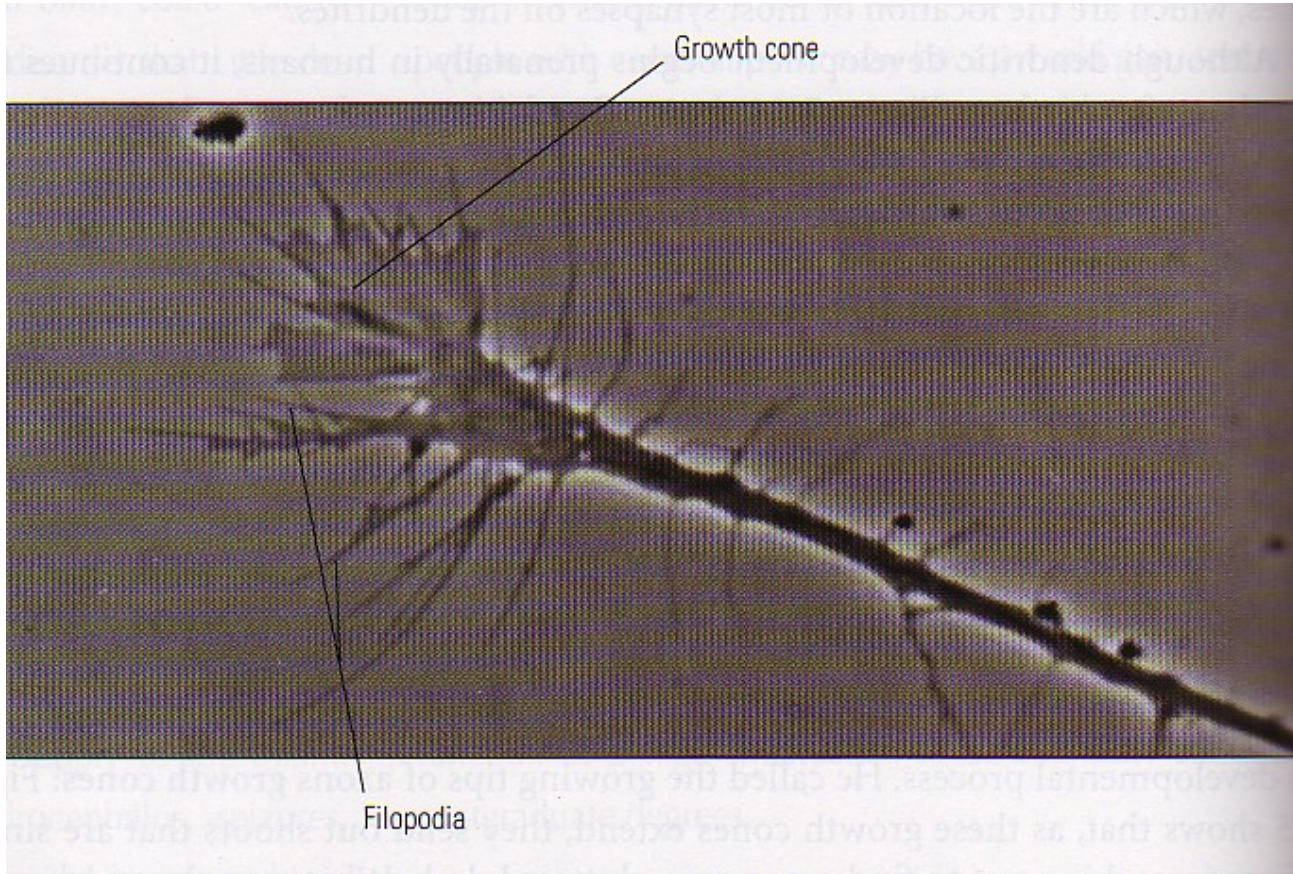
Neurons & Glia



Restak, 2001. *The Secret Life of the Brain*.



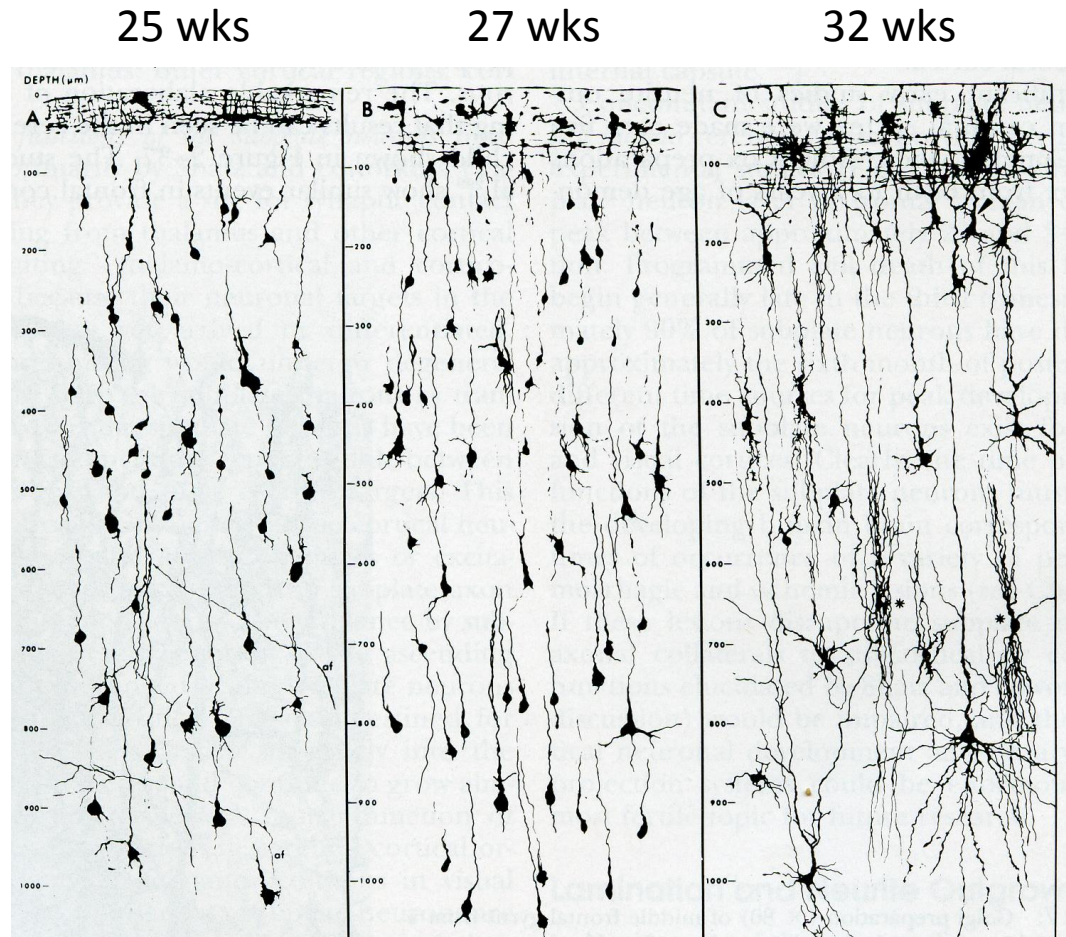
Axons carry electrical and chemical signals from the active neuron to other neurons in the network.



Bloom, F., Nelson, C., and Lazerson, A., 2001. *Brain, Mind, and Behavior* (3rd Ed).

Growing axons must sample their local environments to determine which direction to grow.

Dendrites “listen” to the activity of other neurons in the network.



Volpe (1995), *Neurology of the Newborn* (3rd ed., p. 72, figs. 2-38), Philadelphia: W.B. Saunders Company.

This example shows an early burst of dendritic development during the third trimester of pregnancy.

Some glial cells can generate myelin, an insulating layer that speeds up the signal transmission along an axon.

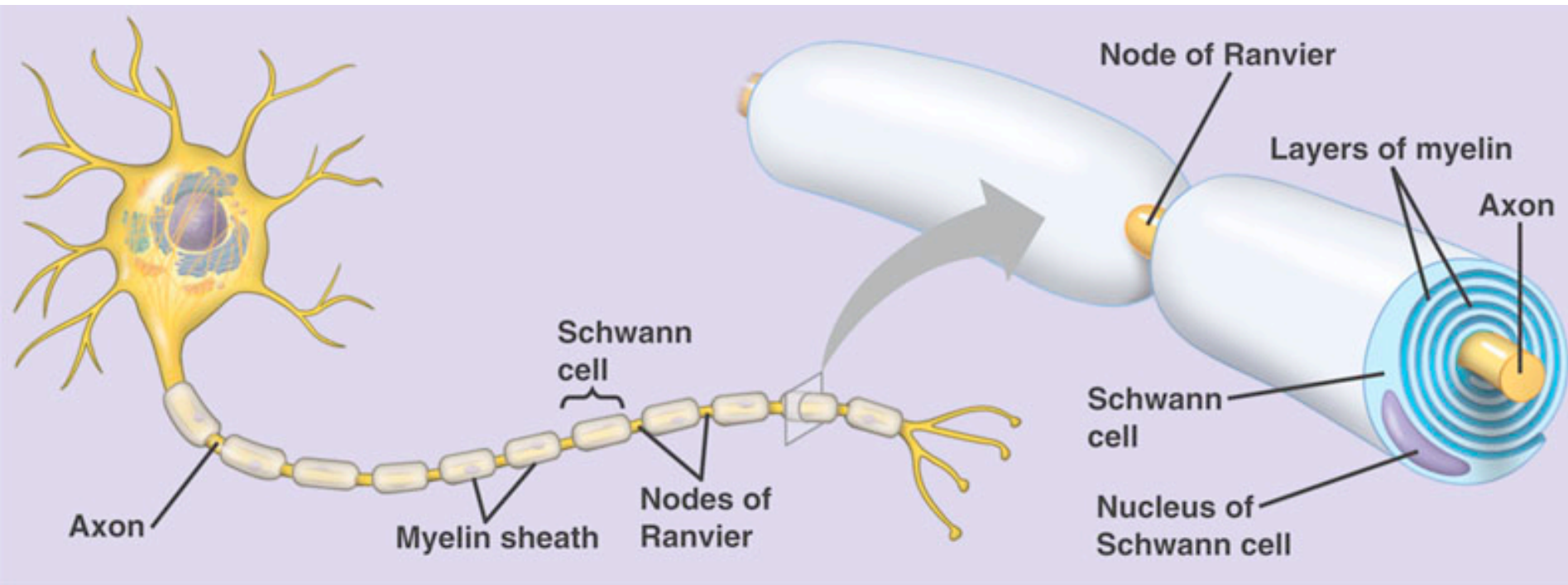


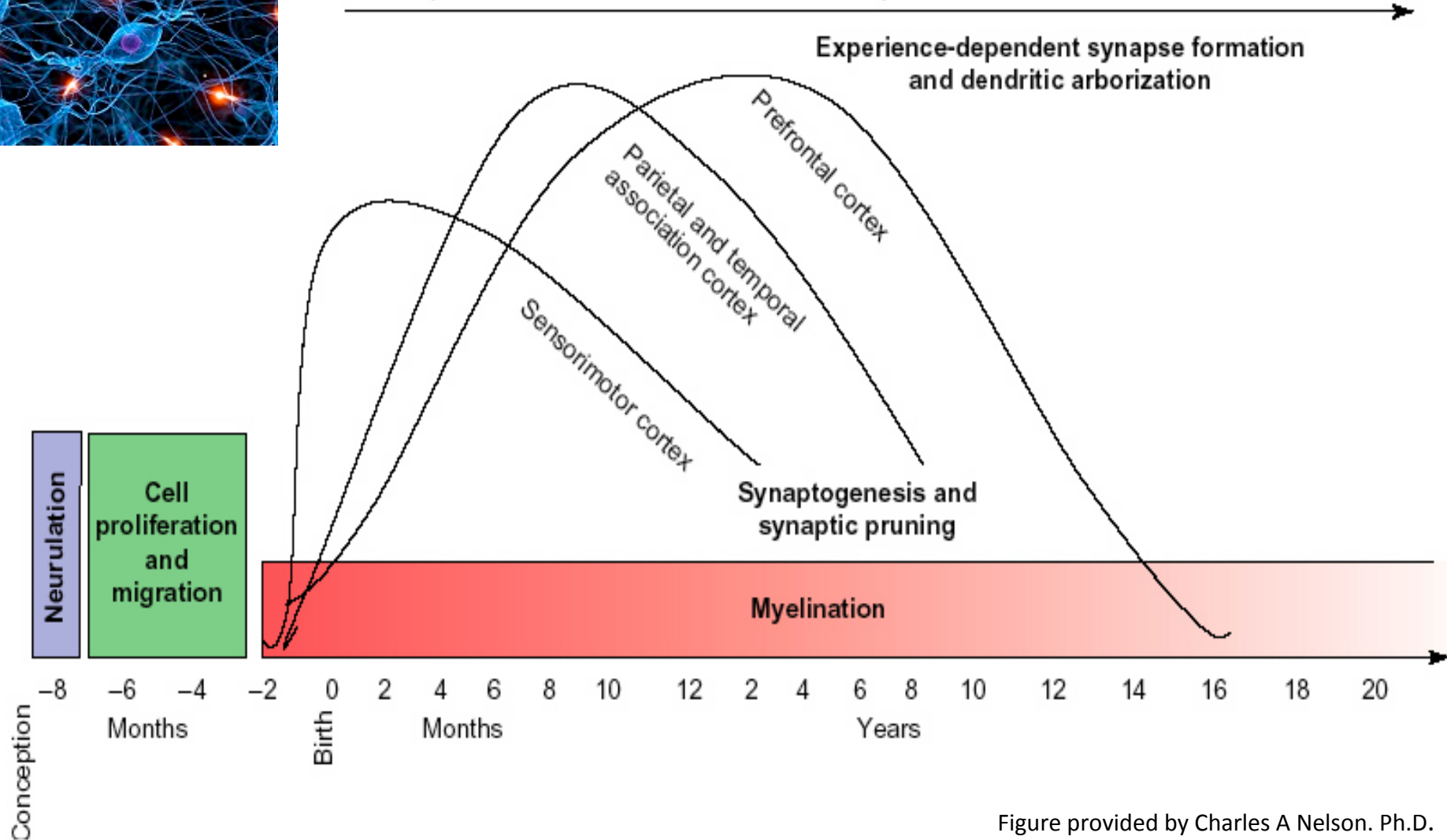
Image downloaded from <http://kvhs.nbed.nb.ca>

Myelin development is guided by activity of the neurons and is therefore dynamic.

Wiring the brain is a developmental process.



Developmental course of human brain development

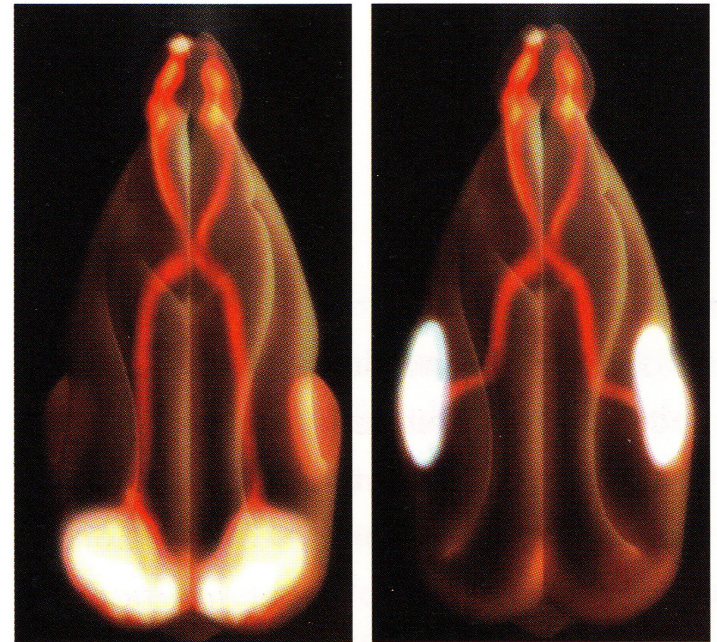
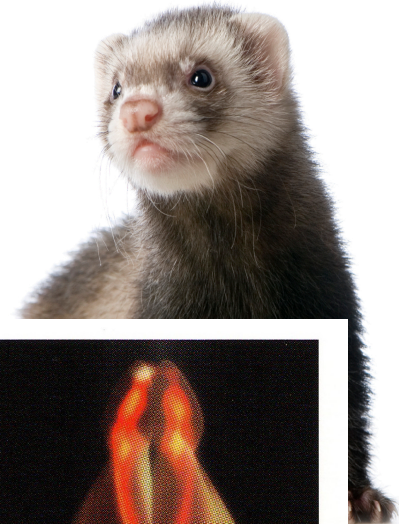


The brain is not pre-wired for function. Input from the environment is essential for many aspects of typical brain development.

Development of the brain's visual system requires light input into the eye.



Light is translated into a neuronal signal by the retina, and this neuronal firing initiates the functional development of visual regions of the brain.



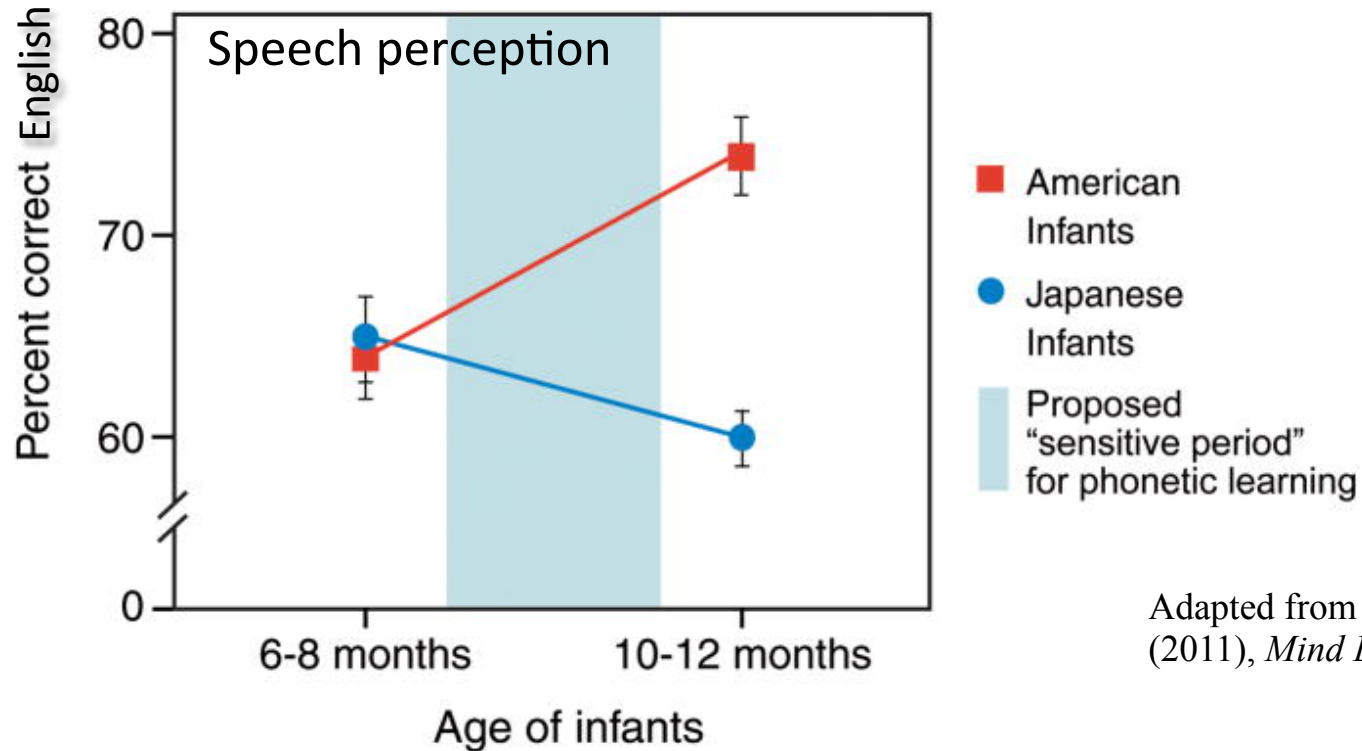
Auditory cortex can become visual cortex if it receives visual input.

Infants are world language learners.



Six-month-olds can discriminate speech sounds that their parents cannot.

With development, we sacrifice some of our flexibility for efficiency and expertise.



Adapted from Kuhl, P. (2011), *Mind Brain Educ*

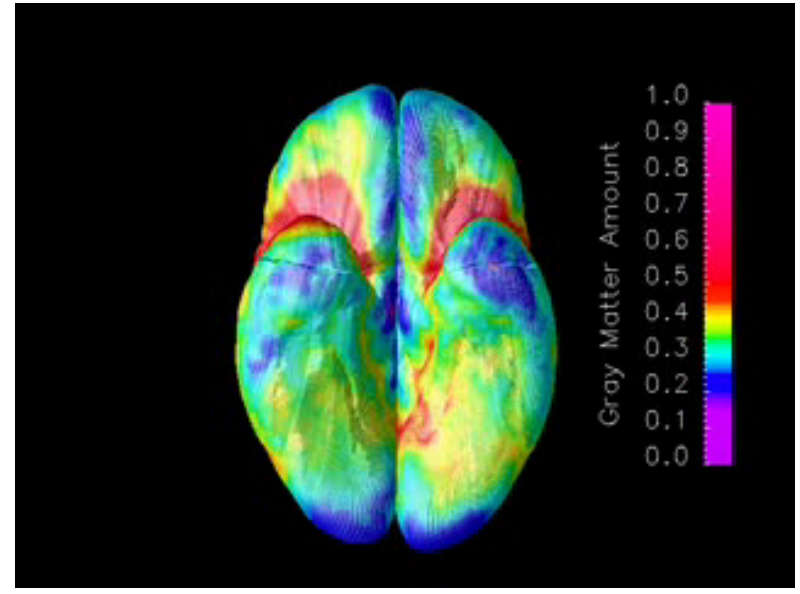
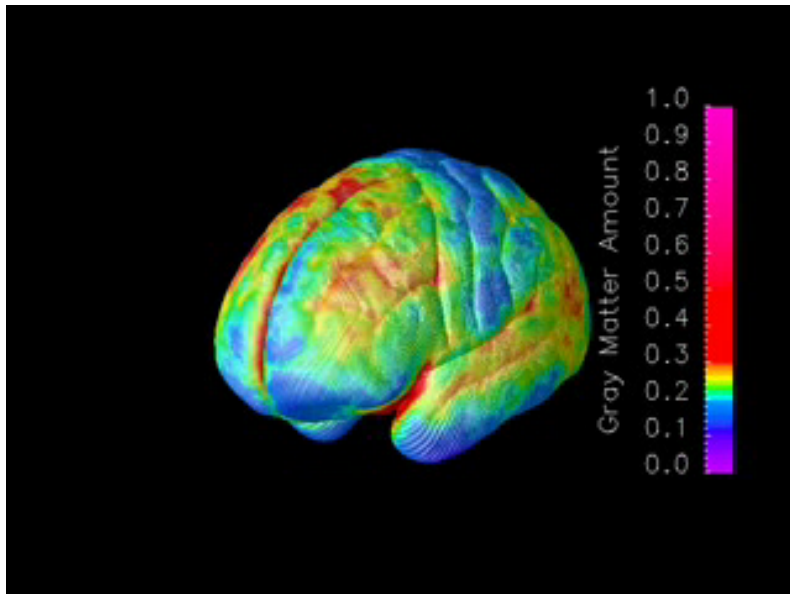
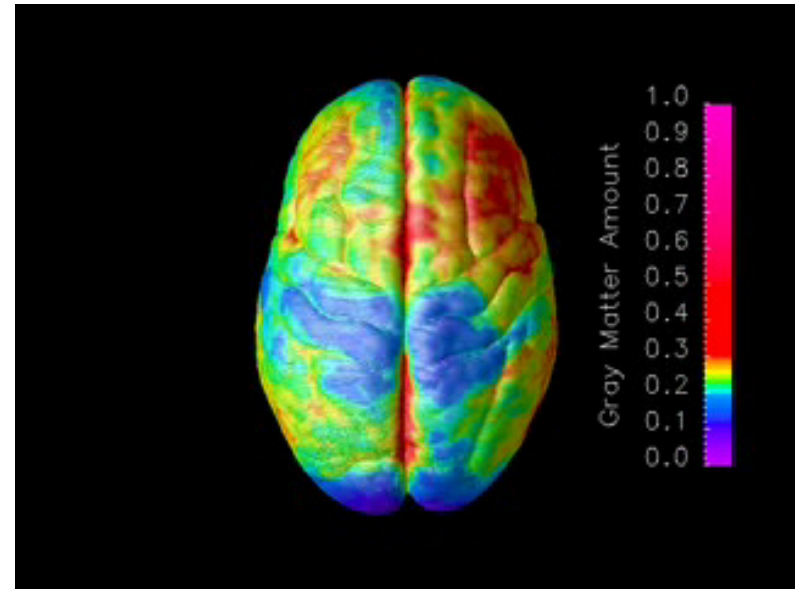
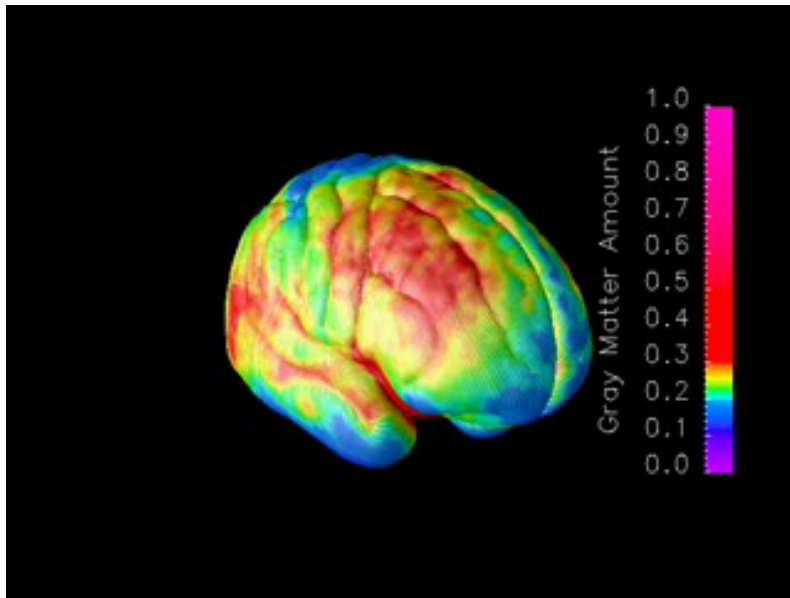
Plasticity →

The brain adapts based on input.

Pruning →

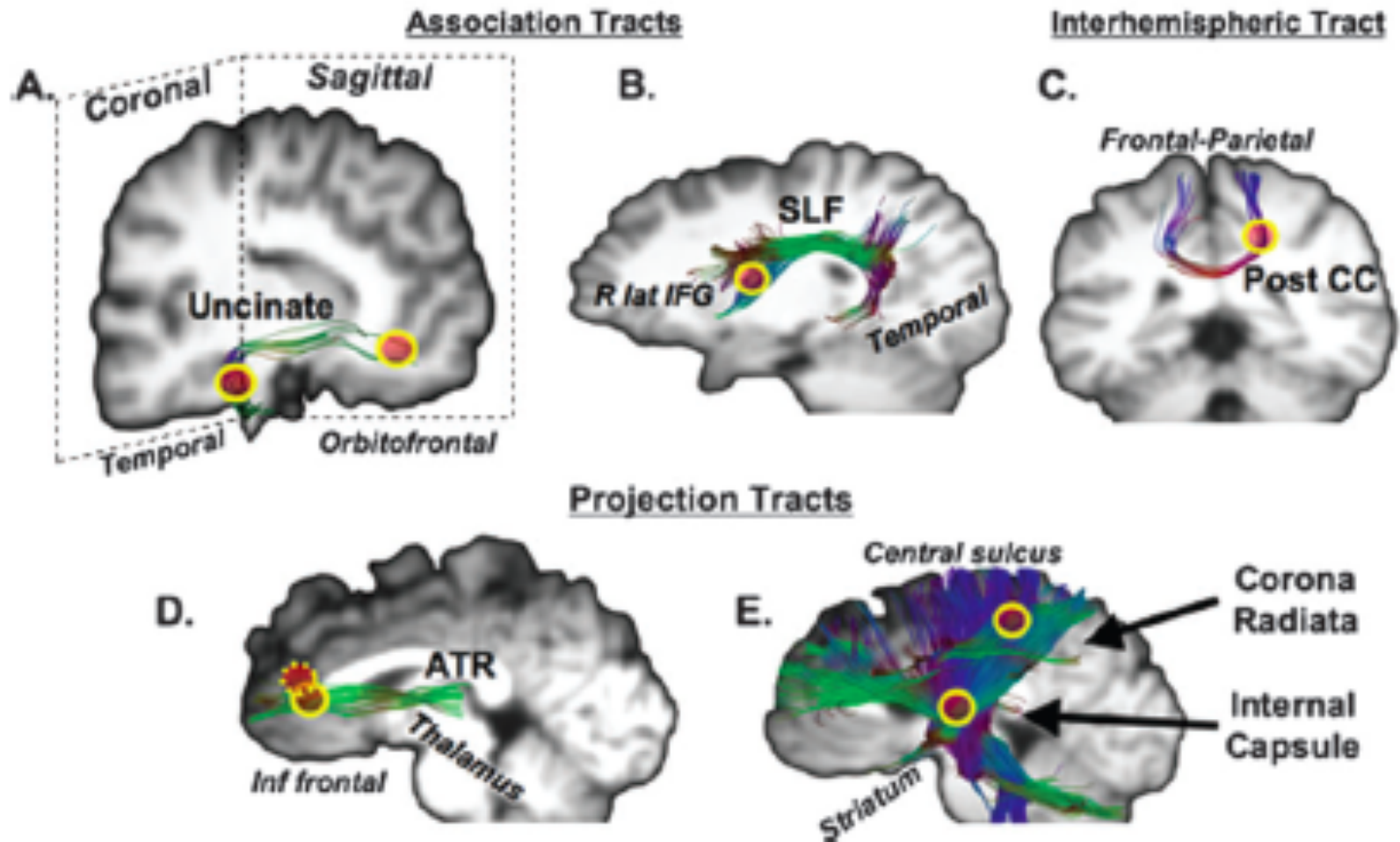
Unused connections are discarded.

Pruning and refinement continue into adulthood.

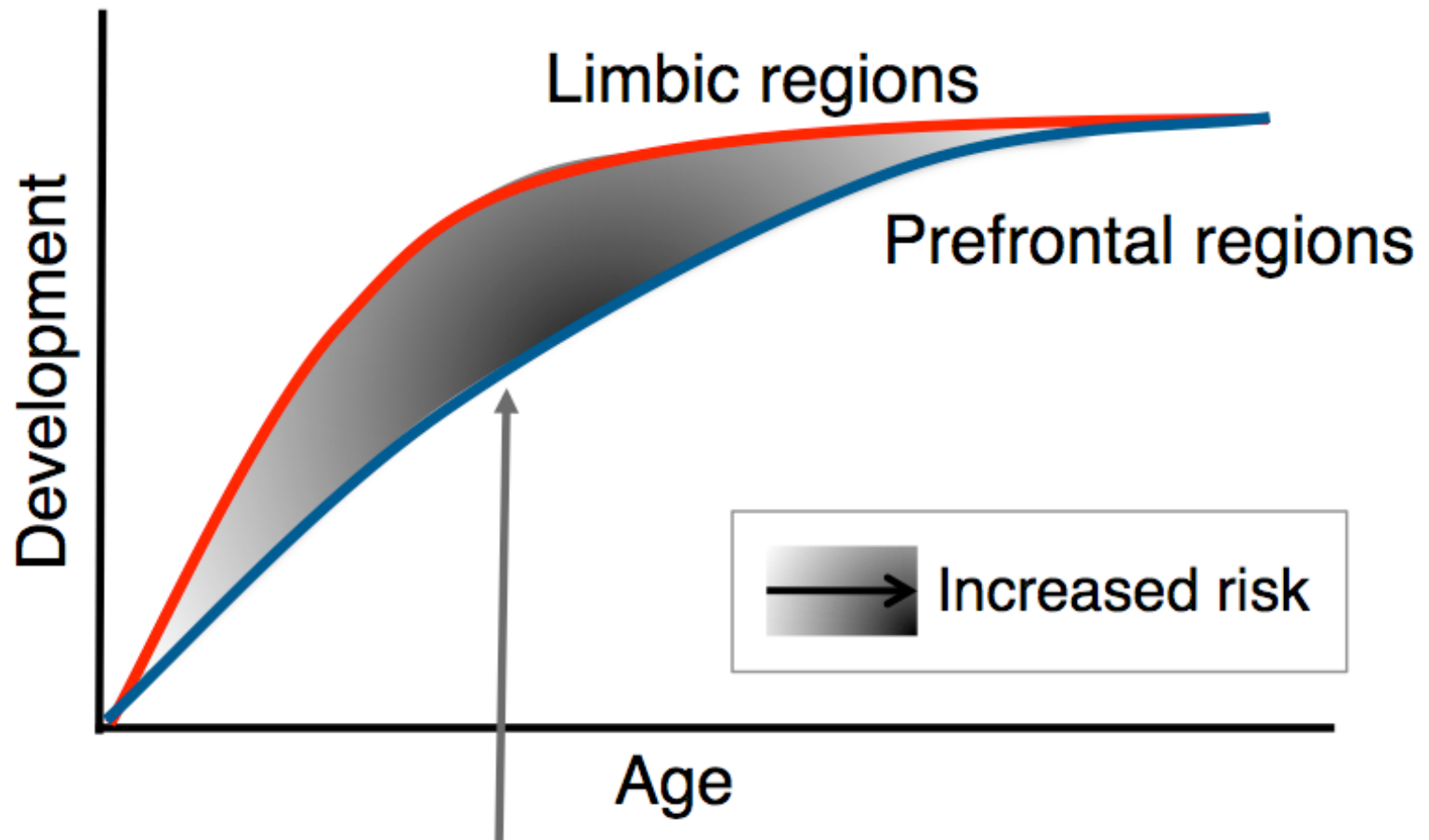


Myelin production increases during adolescence and strengthens connections between regions.

Immature During Adolescence

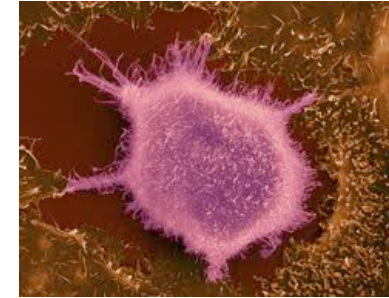


The maturity of individual regions may not be as important as the relative maturity between regions



Plasticity can also leave us vulnerable to negative environments & experiences.

Prenatal Drug Exposure

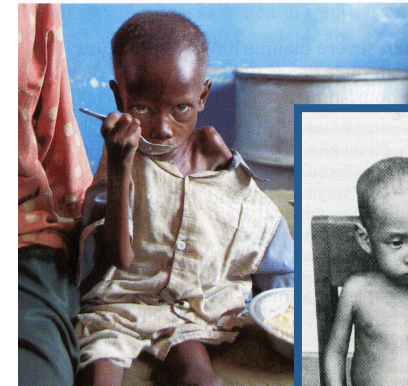
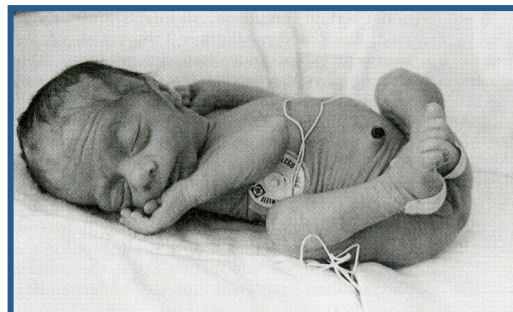


Maternal Infection

Deprivation & Maltreatment



Premature Birth



Malnutrition

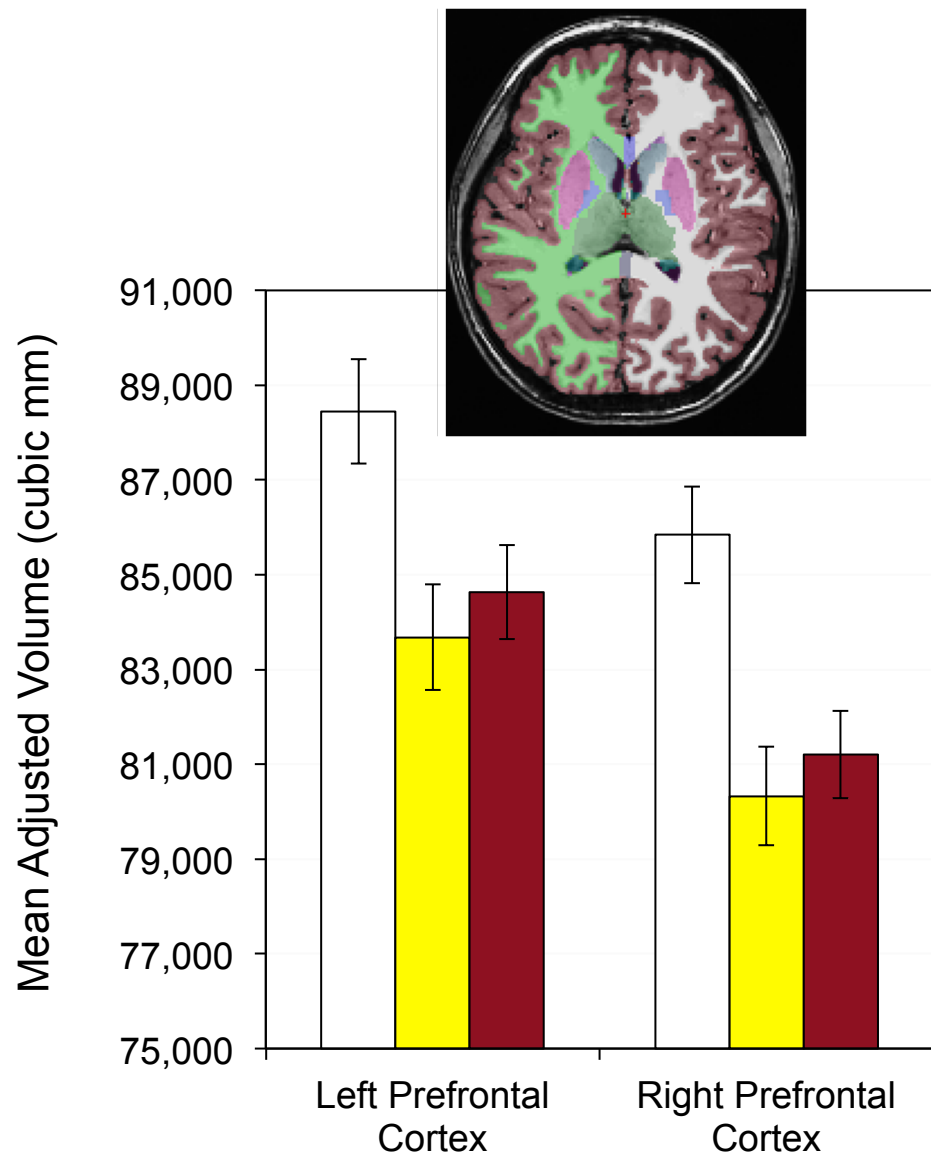


Environmental Toxins

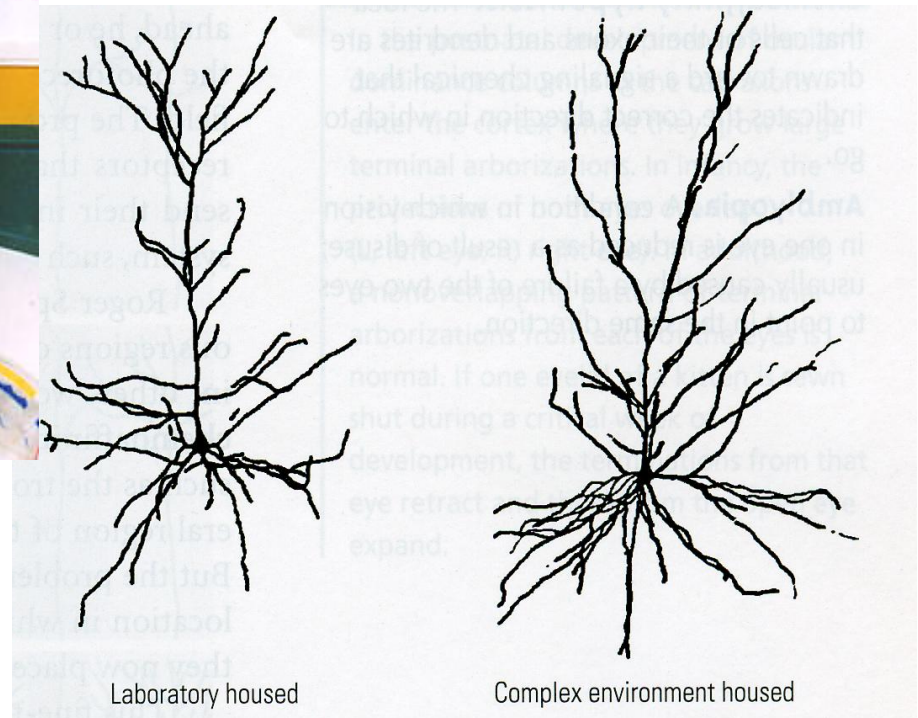


Hypoxia (lack of oxygen)

Early experience can have long-term effects.



Positive environments also impact brain development.

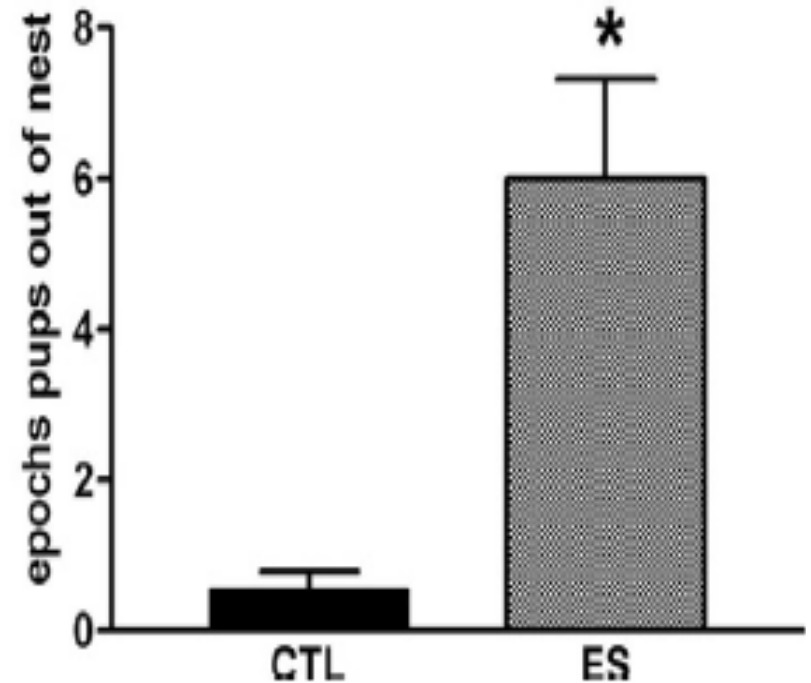


Driven in part by activity dependent release of dendritic growth factors.

Lack of sufficient resources can disrupt maternal care.



<http://www.pbs.org/wgbh/nova/nature/genes-behavior.html>



Lack of nesting materials (early stress, ES) leads to disrupted maternal care.

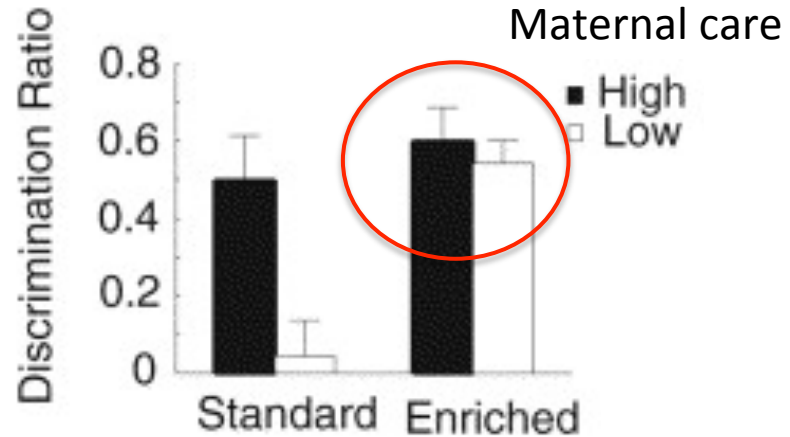
Baram et al (2008), *Neuroscience*

Environmental enrichment can prevent stress-related cognitive deficits in adulthood.

Object Discrimination



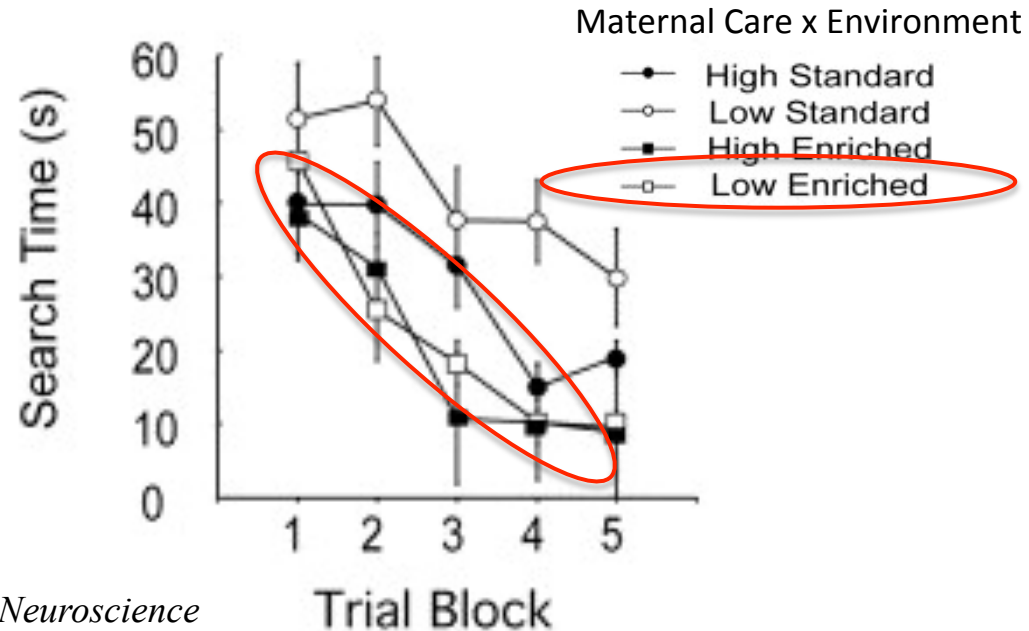
<http://www.noldus.com/animal-behavior-research/research-learning-and-memory-rodents>



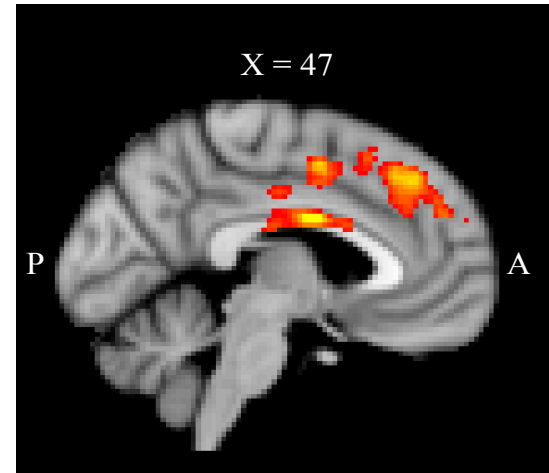
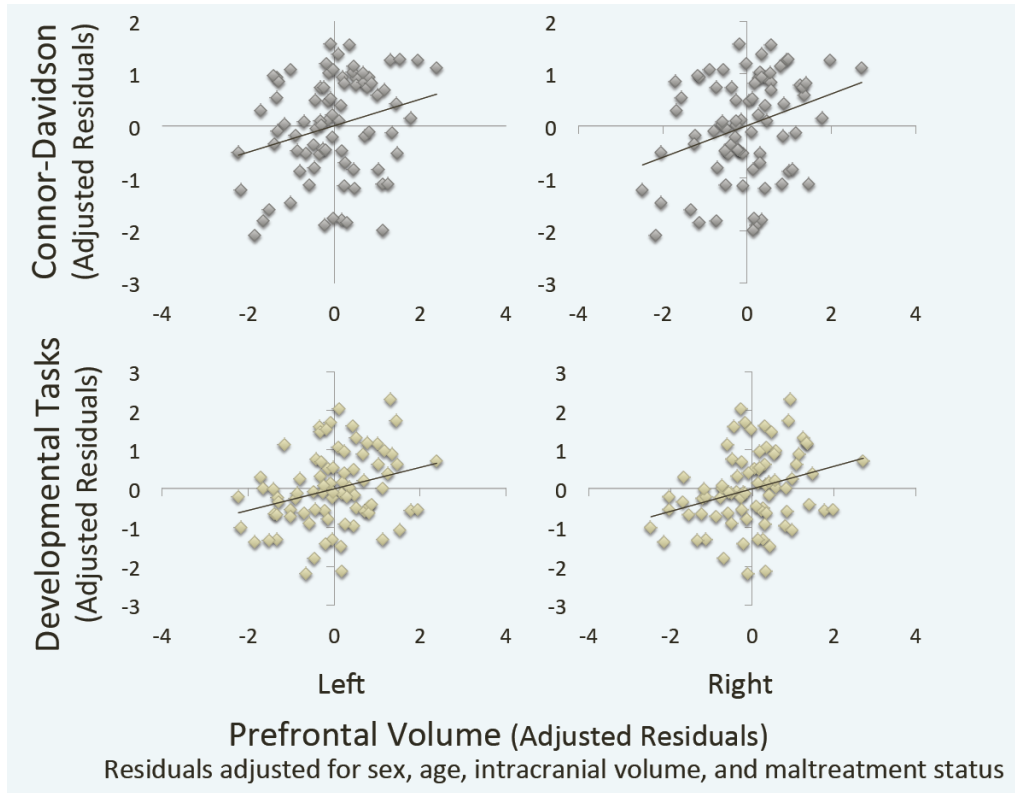
Morris Water Maze



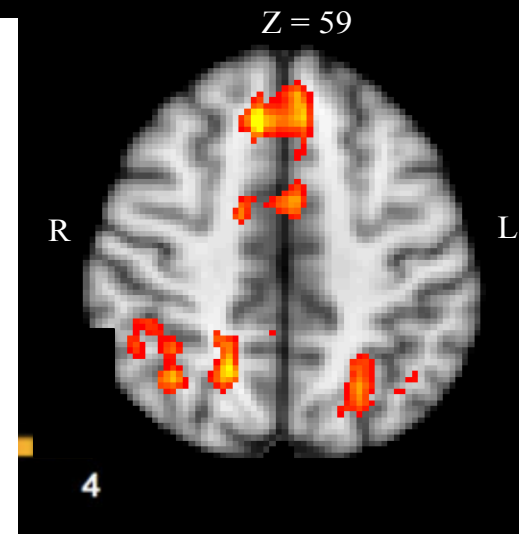
http://www.neuralwiki.org/index.php?title=NMDA_mediated_learning_and_memory



Individual differences in resilience are related to differences in brain structure and function.



$Z > 2.575$,
cluster
corrected



Higher resilience was associated with larger prefrontal volume and stronger amygdala connectivity during an emotion task.

Take-Home Messages

- Biology is not deterministic. Brain development is entirely dependent on input from the environment.
- Biological processes of synaptic pruning and refinement throughout the lifespan are critical mechanisms by which our experiences get into the brain.
- Such plasticity mechanisms allow us to take advantage of learning opportunities, but also leave us vulnerable to adverse experiences.
- An underdeveloped prefrontal cortex doesn't explain all of adolescent behavior; interactions between systems that develop at different rates are important
- Early experiences can have long-term effects in the brain, but ongoing experiences also change the brain.