Brain Development & Plasticity

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Early knowledge of the brain came from studies of individuals with brain injuries or neurological disease.

- **Rasmussen’s Encephalitis**
  - symptoms: frequent and severe seizures, loss of motor skills and speech, hemiparesis (paralysis on one side of the body), and eventually, dementia
  - treatment: hemispherectomy

How can a child function without half of her brain? What are the limitations to the brain’s ability to adapt?

The brain is amazingly complex.

The brain is formed from the neural tube. The neural tube is completely formed before some women even know they are pregnant. Errors in neural tube formation, including Spina Bifida, have been linked to folic acid intake.

Major changes in brain development occur prenatally.

What aspects of brain development account for the changes in human behavior?
50-70% of neural tube defects can be prevented when women supplement their diet with folic acid, a water-soluble B vitamin.

Women capable of becoming pregnant should consume 400 μg of folic acid per day. (CDC)

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

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

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

Wiring the brain is a developmental process.

* Lack of myelin can result in poorer motor control and slower thinking.
Connections between neurons (synapses) are refined after birth.

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.

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Infants are world language learners.

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

Our DNA cannot code for the wide range of individual differences.

Our brains must be able to adapt to changes in our environment, either positive or negative.

Is plasticity limited to early brain development?
From Gogtay & Thompson (2009), Brain & Cognition

Brain structure continues to change throughout childhood and adolescence.

Plasticity allows our brains to be shaped by our unique experiences. Initially by pruning, later by tuning of synapses.

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 may leave us vulnerable to adverse experiences.

Plasticity can leave us vulnerable to negative environments & experiences.

Environmental Toxins
Prenatal Drug Exposure
Deprivation & Maltreatment
Maternal Infection
Premature Birth
Hypoxia (lack of oxygen)
Malnutrition