Brain Development & Traumatic Experience

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The brain is amazingly complex.

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.

How can experience influence brain development?
Basic building blocks of the brain

Neurons & Glia

The formation of the neural tube begins the process of brain development.

* Errors in neural tube formation, including Spina Bifida, have been linked to folic acid intake.

Neurons often travel long distances to get to their final position in the brain.
Growing axons sample their environments to determine which direction to grow.

Dendrites develop prenatally but continue to be refined throughout the lifespan.

Dendritic development can be disrupted by oxygen deprivation, toxins, & malnutrition, as well as genetic disorders like autism and fragile X.

Connections between neurons (synapses) develop at different rates in different parts of the brain.

Adapted from Hetherington (1994), “Synaptogenesis in Human Cerebral Cortex”, in Dawson & Fischer (Eds.), Human Behavior and the Developing Brain (p. 142), New York: Guilford Press.

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

*Lack of myelin can result in poorer motor control and slower thinking.

Major changes in brain development occur prenatally, making this a period of particular risk.

Source: http://medstat.med.utah.edu

<table>
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<tr>
<th>15 1/2 wks</th>
<th>22 weeks</th>
<th>23 weeks</th>
<th>25 weeks</th>
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<td>27 weeks</td>
<td>Full term infant</td>
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Wiring the brain is a developmental process.

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.

The infant brain performs better than the adult brain on some tasks.

Johnson & Morton, 1991

Sometimes we have to sacrifice flexibility for efficiency

Six-month-old infants can distinguish speech sounds within many world languages; however, infants become specialized by 11 months, and no longer discriminate between sounds that are not relevant in their native language.

Some environments are unexpected.

Approximately 11% of births in the U.S. are premature (less than 37 weeks gestation).

For these infants, the extra-uterine environment is unexpected.

Errors of Commission

- Prenatal Drug Exposure
- Environmental Toxins
- Maternal Infection
**Errors of Omission**

Sensory & Social Deprivation

Malnutrition

Hypoxia (lack of oxygen)

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**Child maltreatment alters brain structure.**

Maltreated children show decreased brain volume overall as well as specific reductions in corpus callosum volume.

Pollak & Sinha, 2002, Dev. Psychology

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**Physically abused children require less information to recognize angry faces.**

Pedat & Gima, 2002, Dev. Psychology
Maltreated children show preferential processing of angry faces.

Pollak et al. (2001), Psychophysiology

Orphanage rearing is typically associated with significant cognitive and social deprivation.

Hodel et al. (2011, abstract), Society for Research in Child Development

Early orphanage rearing is associated with smaller prefrontal cortex.

Hodel et al. (2011, abstract), Society for Research in Child Development
Early deprivation is associated with decreased connectivity between the frontal & temporal lobes.

Sensory and social deprivation may impact early synaptic pruning.

Cognitive brain activity varies as a function of duration of deprivation.
Positive environments show positive effects on brain development.

Research by William Greenough, PhD, University of Illinois, Urbana-Champaign

Lack of sufficient resources can disrupt maternal care.

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


Environmental enrichment can prevent stress-related outcomes in adulthood.

Morris Water Maze

Object Discrimination


Maternal Care x Environment

High Standard

High Enriched

Low Standard

Low Enriched

Behavioral interventions can change the brain in children.

Reading intervention in children with dyslexia resulted in more typical activation of brain systems involved in reading and phonological awareness.

Temple et al. (2003), PNAS