Early Adversity & Brain Development

Kathleen M. Thomas, Ph.D.
Professor, Institute of Child Development
ConnectU – April 24, 2015

Why does preterm birth happen?

- In 2012, the preterm birthrate in the United States was 11.7% of all live births (March of Dimes).
- 80% of preterm babies world-wide are born moderate (32-33 wks) or late (34-36 wks) preterm

Example 1: Preterm Birth

- 80% of preterm babies world-wide are born moderate (32-33 wks) or late (34-36 wks) preterm

The brain is dynamically changing in response to our experiences.

Example: prematurity, deprivation, maltreatment

How does early adversity impact the developing brain?

Examples: prematurity, deprivation, maltreatment

Cool Executive Function

Four-year-olds born moderate to late preterm showed poorer working memory than their full-term peers.

Spatial Working Memory Task

Hot Executive Function

Executive functions were even more impaired in the face of high motivation or reward.

Magnetic Resonance Imaging (MRI)

MRI methods can be used to measure physical brain structure, fiber pathways, and regional brain activity.
Prefrontal cortex is smaller in adolescents born moderately preterm.

- Adolescents born moderately preterm showed reduced prefrontal gray matter volume.
- Those with smaller prefrontal volume showed poorer performance on a spatial working memory task.

Example 2: Child Maltreatment

- In 2011, 763,000 children in the United States were determined to be maltreated (DHHS, 2011).

Physically abused children required less information to recognize angry faces.

Maltreated children showed preferential processing of angry faces.

Prefrontal cortex volume was smaller in adolescents who were physically abused.

Child maltreatment altered overall brain volume and corpus callosum volume.

Maltreated children show decreased brain volume overall as well as specific reductions in corpus callosum volume.
Example 3: Early Orphanage Rearing

Deprivation is associated with:

- Speech and motor delays
- Learning difficulties
- Behavioral problems
- Increased anxiety
- Increased ADHD
- Social isolation
- Being bullied

Post-institutionalized youth had smaller prefrontal cortex volume.

Activity in the parietal cortex varied by age at adoption, and was correlated with task performance.

Early deprivation is associated with altered white matter connections between the frontal & temporal lobes.

Deprivation may alter early synaptic pruning.

- Some adoptees show more diffuse fiber pathways, especially in the right prefrontal cortex, suggesting reduced pruning of connections.

Govindan et al (2010), Cerebral Cortex

Hodel et al (2014), NeuroImage

Behen et al (2009), Brain Imaging Behav
Some individuals show resilience, even in the face of adverse conditions.

Like dandelions, they can grow just about anywhere.

Ellis & Boyce (2008), Curr Dir Psych Sci

Others individuals are highly sensitive to the environment.

Like orchids, when given the perfect environment, they will thrive and surpass dandelions. But, they will wither and wilt without the necessary care and attention.

Ellis & Boyce (2008), Curr Dir Psych Sci

Some genetic variants promote resilience to early stress or adversity, whereas others make us more sensitive to environmental conditions.

<table>
<thead>
<tr>
<th>Early Adopted</th>
<th>Late Adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Val/Val</td>
<td>Val/Met</td>
</tr>
</tbody>
</table>

Genetic variation in the BDNF gene

Positive environments can result in positive effects on brain development.

Images courtesy of William Greenough

Lack of sufficient resources can disrupt maternal care.

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

Environmental enrichment counteracts effects of early adversity.
Behavioral interventions can change the brain in children.

Temple et al (2003), PNAS

Klingberg et al (2000), Neuron

Behavioral interventions in children with dyslexia have resulted in more typical activation and stronger white matter connections in brain systems involved in reading and phonological awareness.

Take-Home Messages

• Our biology and our environment cannot be viewed independently. Brain development is tuned by experience in the world.

• Such plasticity mechanisms allow us to take advantage of learning opportunities, but also leave us vulnerable to adverse experiences.

• Our genetics may lead to individual differences in the degree to which we respond to environmental stimulation.

• Interventions provide means by which we can harness or potentially even enhance plasticity.