

Effects of Poverty on Brain Development

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December, 2016

Key Points

- Children raised in poverty are exposed to millions of fewer spoken words at home
- Income level negatively impacts cognitive functions
- There are links between family income and memory and attention
- Poverty is associated with chronic stress which can have a toxic effect on brain architecture
- ELL's often have a triple jeopardy – language barrier to learning, history of poverty, learning disabilities
- Computer games designed to target the skills that are impacted can turn around some effects of poverty

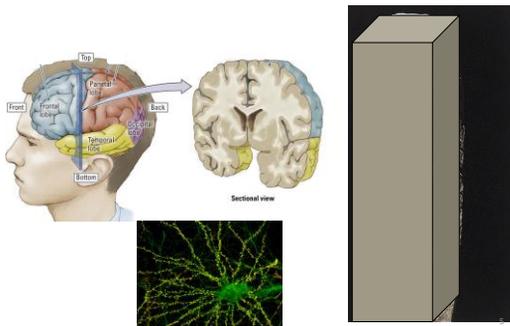
The Brain is an Experience Dependent Organ

- What does that mean?
- In early development there is proliferation of connections
- As we age there is pruning – the brain gets better at fewer things (more rigid)
- Fiber tracts also build myelin to improve processing speed and efficiency as we learn and practice our new knowledge

How Experience Changes the Brain (Gopnik, 2015)

- Early in development proliferation prevails – young children make many more new connections than adults
- Later in development pruning is more important – adults shift from a young brain that is good at learning to an older brain that is more effective and efficient but more rigid.
- **We get better and better at fewer and fewer things**

Synaptic pruning fine-tunes synaptic connections – cortex thins



But the cortex is only part of the story – fiber tracts become more myelinated through learning (Fields, 2015 *Nature Reviews Neuroscience*)

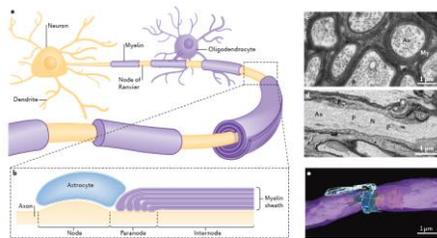
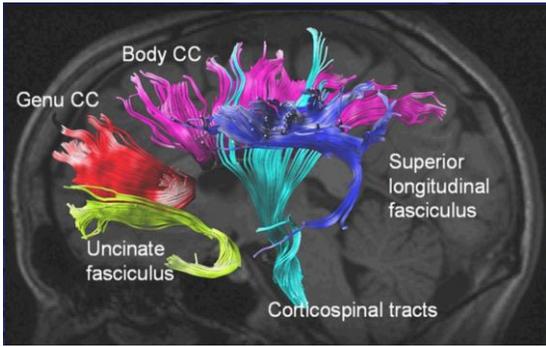


Figure 2 | Myelin and the nodes of Ranvier. a) Dendrodendrites form synapses on axons to enable high-speed impulse transmission via inhibitory conductance. b) Action potentials are generated at nodes of Ranvier situated periodically along the axon between internodal segments of axons insulated by compact myelin. Perinodal astrocytes are in contact with the axon at nodal regions. c) Transmission electron micrograph of mouse optic nerve axons in cross section, showing the multiple layers of compact myelin (My) and myelinating axon (Ax). d) Longitudinal section through an axon through the node of Ranvier, illustrating the axon perinodal astrocyte, node (N) paranode (P) and internode axon regions as shown in part b. e) Three-dimensional reconstruction of the node of Ranvier from serial block-face electron microscopy (compact myelin is shown in purple and perinodal astrocytes are shown in blue, with the axon being depicted in yellow).

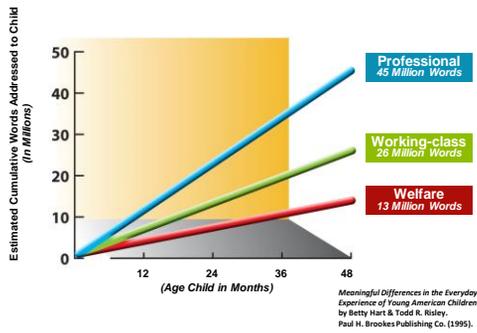


Lebel, et al. 2008

Language Experiences



Language Experiences by Group



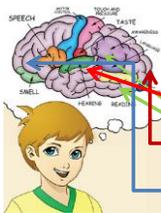
Family income, parental education and brain structure in children and adolescents Noble, et. al.

Nature Neuroscience 30 March 2015

- Among children from lower income families,
 - small differences in income were associated with relatively large differences in surface brain area
- Among children from higher income families, similar income increments were associated with smaller differences in surface area.



Brain structure and poverty (Noble et al, 2015)



- Brain Structure and income level relationships were most prominent in regions supporting
 - **language**
 - **reading,**
 - **executive functions**
 - **spatial skills**

Noble et al 2015 Conclusion

- This research implies that **income relates most strongly to brain structure among the most disadvantaged children.**



Excessive Stress Disrupts the Architecture of the Developing Brain

WORKING PAPER 3



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Effects on Brain Development

- The neural circuits for dealing with stress are particularly malleable (or “plastic”) during the fetal and early childhood periods
 - the regions of the brain involved in fear, anxiety, and impulsive responses may overproduce neural connections
 - those regions dedicated to reasoning, planning, and behavioral control may produce fewer neural connections



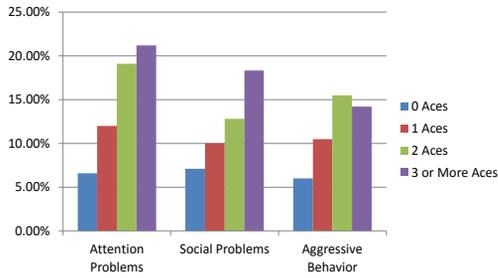
Damage to health and well-being



This wear and tear increases the risk of stress-related physical and mental illness later in life

- Extreme exposure to toxic stress changes the stress response system
 - Responds at lower thresholds to events that might not be stressful to others,
 - Activates more frequently and for longer periods than is necessary, like revving a car engine for hours every day.

Table 5. Teacher Ratings of Behavior – Percentages (Jimenez et al, 2016)



A summary view of effects of Poverty, Stress and ACES (Sheridan and McLaughlin, 2016)

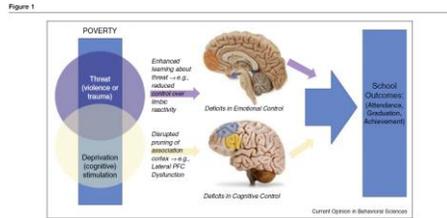


Figure 1
 Within adversity exposure, we hypothesize that dimensions of experience can be measured which will differentially impact neurodevelopment leading reductions in academic success. First panel: While exposure to cognitive enrichment (deprivation dimension) is likely to be reduced as a function of poverty, it may not be, thus the deprivation circle is shown as not completely overlapping with poverty. Similarly, exposure to violence or trauma is likely to be, but is not always, increased for children living in poverty. These two circles are shown as overlapping because children are sometimes exposed to both deprivation and threat. Second panel: Next we show a cartoon of the hypothesized cognitive, emotional, and neurobiological pathways through which these kinds of exposures may impact school outcomes. Third panel: In the final part of the figure we show that school outcomes are an equal outcome for both dimensions of exposure. Thus, examining the neurobiology is central to distinguishing the impacts of various dimensions of exposure.
 Current Opinion in Behavioral Sciences 2016, 10:100-113 www.sciencedirect.com
