

**A Short Course in
Neurophysiology for Social
Workers**

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Acknowledgements

- The Urban Child Institute, Memphis
- Dean Karen Sowers



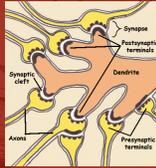
**First, Some Basic
Definitions**

- Neurons: Brain cells
- Must be connected to other brain cells to do their work



Basic Definitions

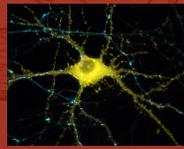
- Synapses: the connections among neurons
- “Neurons that fire together wire together”
- Formed by *experience*
- Learning is synaptogenesis
- Begins *in utero* & continues throughout life



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Basic Definitions

- Axons: projections from neurons that transmit signals to other neurons
- Dendrites: projections from neurons that receive signals from other neurons
- Both begin forming prenatally & continue throughout life (less as time passes)



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Basic Definitions

- Myelin: the fatty sheath that surrounds axons & dendrites
- Insulates the wiring
- Makes signaling faster & more efficient
- Biggest periods of development: gestation/infancy & adolescence



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Basic Definitions

- fMRI: functional Magnetic Resonance Imaging
- Non-invasive brain imaging
- Measures brain activity in real time (e.g. while performing a cognition task) as opposed to *structural MRI*
- Not perfect methodology!



A Little about Brain Development



Hierarchy of the Brain

- Develops from the bottom up, from the inside out
- Simple, autonomic functions first, followed by motor & sensory functions
- Higher-order thinking last
- Each structure relies on integrity of lower structures for healthy development



Neural Plasticity (Ability to grow new synapses)

- Ability to change with experience: both functionally & structurally
- Greatest earliest in life, declining with time
- But—*brain remains plastic throughout life*
- This is foundation of learning, recovery from injury, survival of our species & psychotherapy!

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Neurons that wire together....



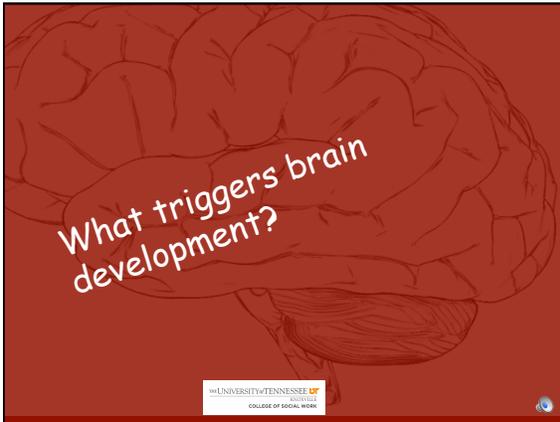
Got cheese?

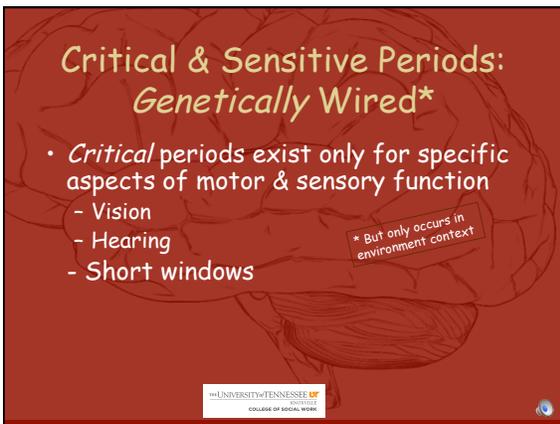
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Other examples

- Smell of my first day of school (memories)
- Playing the piano (skills)
- Fear of men in abused children (implicit memory)
- Attachment to caregiver (experience)

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2 kinds of development

- Experience-expectant
- Experience-dependent





Experience-Expectant

- Common to entire species
- More *critical periods*
- Most often related to sensory & motor functions
- Designed to set up relationship between brain & reliably occurring environment



Experience-Dependent

- Unique to cultures & individuals
- Designed to interact with flexible demands of environment
- Most plastic



Two Sensitive Periods: Infancy

- Rapid growth & organization
- Right brain most active in neonate
- Stimulated by touch & gaze
- Facial recognition, emotions & emotion regulation

Schore, 2000

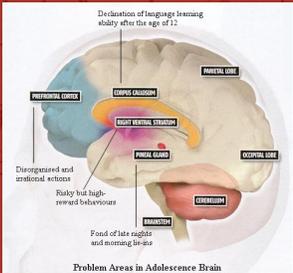




TOUCH. TALK. READ. PLAY.



Two Sensitive Periods: Adolescence



Schore, 2000



Plasticity



- *Lifelong* ability of the brain to reorganize neural pathways based on new experiences
- More plastic at some times than others (esp. during rapid growth)

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Plasticity



- More susceptible to *both* enhancement & damage

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What Is Stress?

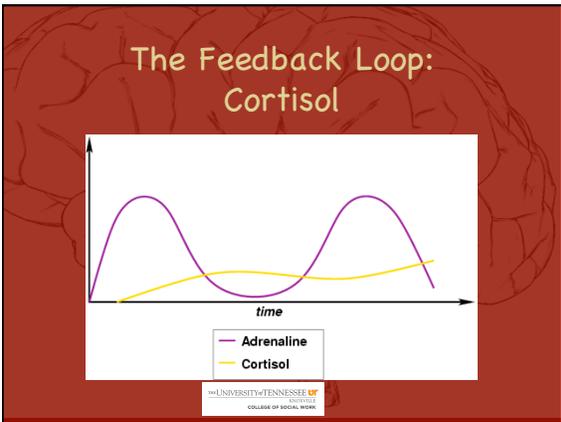
- Is *not* a feeling
- Is body's physiological process for coping with challenge or threat
- Human Stress Response = elegant physiological system that has evolved & permitted survival of our species by promoting escape from threat

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- Mobilization of Energy
- Increased Cardiovascular Tone
- Suppression of digestion
- Suppression of growth
- Suppression of reproduction
- Suppression of immune system
- Sharpening of cognition, alertness, & pleasure.

The diagram illustrates the HPA axis. The Hypothalamus (green box) releases a 'Releasing factor' to the Anterior pituitary (blue box). The Anterior pituitary then releases 'ACTH (through blood)' to the Adrenal cortex (pink box), which produces 'Cortisol'.

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Stress Is Adaptive

- Enhances survival capabilities
- But — designed to be shut down by the feedback loop
- Feedback loop disrupted by chronicity
- Body can't differentiate real from perceived threat

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Allostasis

- Process of achieving stability, or *homeostasis*, through physiological or behavioral change
- Eg: sweating when hot, shivering when cold
- The process helps return body to homeostasis, but *costs* the organism
- Cost is called *allostatic load*
 - May just be calories burned
 - May be serious organ damage



Allostatic Overload

- Repeated frequency &/or severe nature of stress w/out adequate coping resources → constant effort to adapt
- Constant flow of cortisol so body fails to respond to signal to return to normal
- Constant “fight-or-flight” condition damages body



Chronic



- High heart rate
- High blood pressure
- Dialed-down immune system
- Interference with hippocampus processing of information so ineffective higher-order thinking
- Infertility
- Obesity & Diabetes
- Digestive problems



Real stress...



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And there is modern stress...



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Stress & Survival

- Adaptive response to threat
- Feedback loop “turned it off” when threat passed
- Humans now perceive *psychological threat* in same way as physical danger
- Feedback loop becomes faulty
- Constant stress response *kills*

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Coping with Allostatic Overload

Stress Reduction Kit

**Bang
Head
Here**

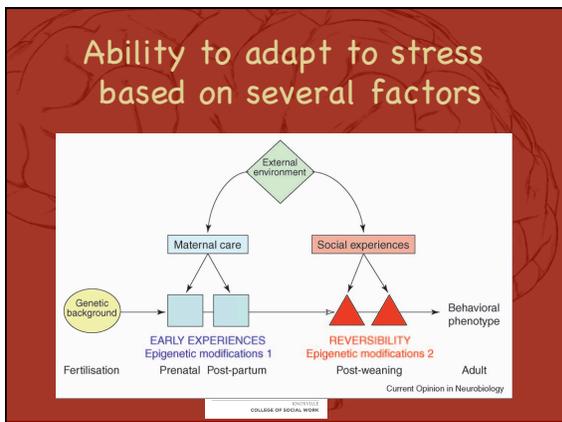
Directions:

1. Place kit next to your bed.
2. Pull kit away from you during cycle of AB.
3. Repeat step 2 in intervals, or until you are asleep.
4. If you experience, some minor irritation activity.

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Coping with Allostatic Overload

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Allostasis

- Process of achieving stability, or homeostasis, through physiological or behavioral change
- The process *costs* the organism
- Cost is called *allostatic load*



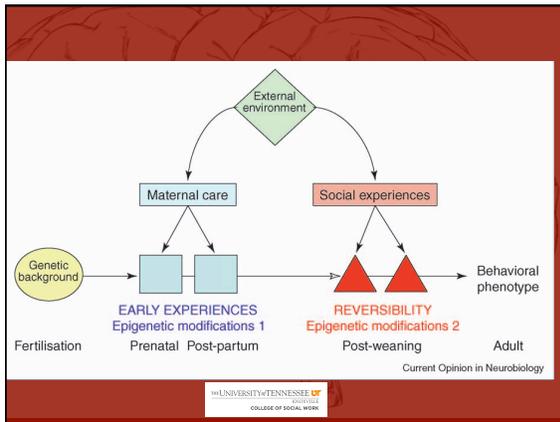
Allostatic Overload

- Repeated frequency of stress responses to multiple novel stressors
- Failure to habituate to repeated stressors of the same kind
- Failure to turn off each stress response in a timely manner due to delayed shut down
- Inadequate response that leads to compensatory hyperactivity of other mediators.



Allostatic Load





Set-points & Effects of Allostatic Overload

- Down-regulation: Some systems respond to high levels of activation by increased HPA activity
- Epigenetic tags (caused, e.g. by poor parenting) reduce activity of glucocorticoid receptors in brain
- Cannot launch effective HPA response



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Examples: Child Abuse (McGowan et al., 2009)

- Hippocampal tissue samples from Quebec Suicide Brain Bank
 - 12 suicide victims w/ history abuse
 - 12 suicide victims, no abuse
 - 12 controls (other causes death)
 - Matched for psychiatric dx, gender, age
- Analyzed methylation & expression

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McGowan et al., 2009

- Expression of glucocorticoid receptors in hippocampus significantly reduce in suicide victims w/ history abuse & controls
- No differences between nonabused suicide victims & controls





Research by Michael Meaney, PhD, & associates*

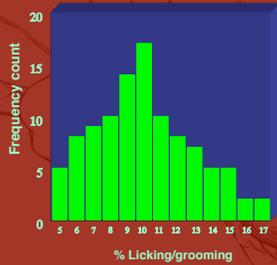
- Rodent models
- Series of studies showing maternal care in early life related to stress response through shaping of HPA Axis



*McGill University, Montreal

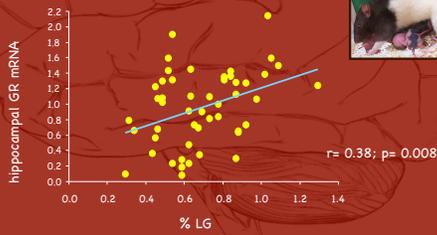


Variations in maternal care similar to humans'



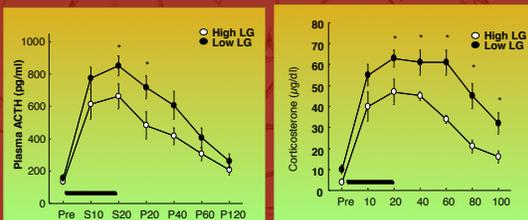
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Love (Licking and Grooming): Mom always licked you best!



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Adult offspring of High LG mothers show more modest HPA responses to stress



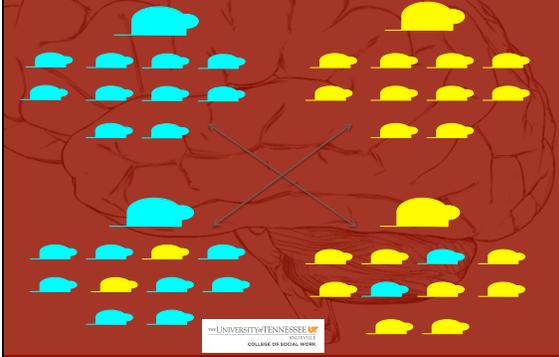
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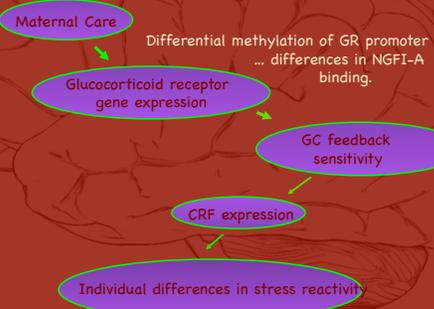
But couldn't this be genetic?

- We know good parents tend to have children who are good parents themselves
- We know abuse tends to run in families
- Maybe good mouse-mothering is genetic?



High LG ("Good" moms) Low LG ("Bad" moms)





CONCLUSIONS/ SUGGESTIONS

- Poverty is stressful
- That stress begins at (before!) conception
- Poor children's brains are permanently affected by this stress

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WHAT TO DO?

- Expensive, labor-intensive & partly successful school-based interventions?
- Restore Food Stamp cuts?
- Expand Medicaid?
- Raise the minimum wage to a *living wage*?

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