Neurodevelopmental Deviance Related to Abuse & Trauma

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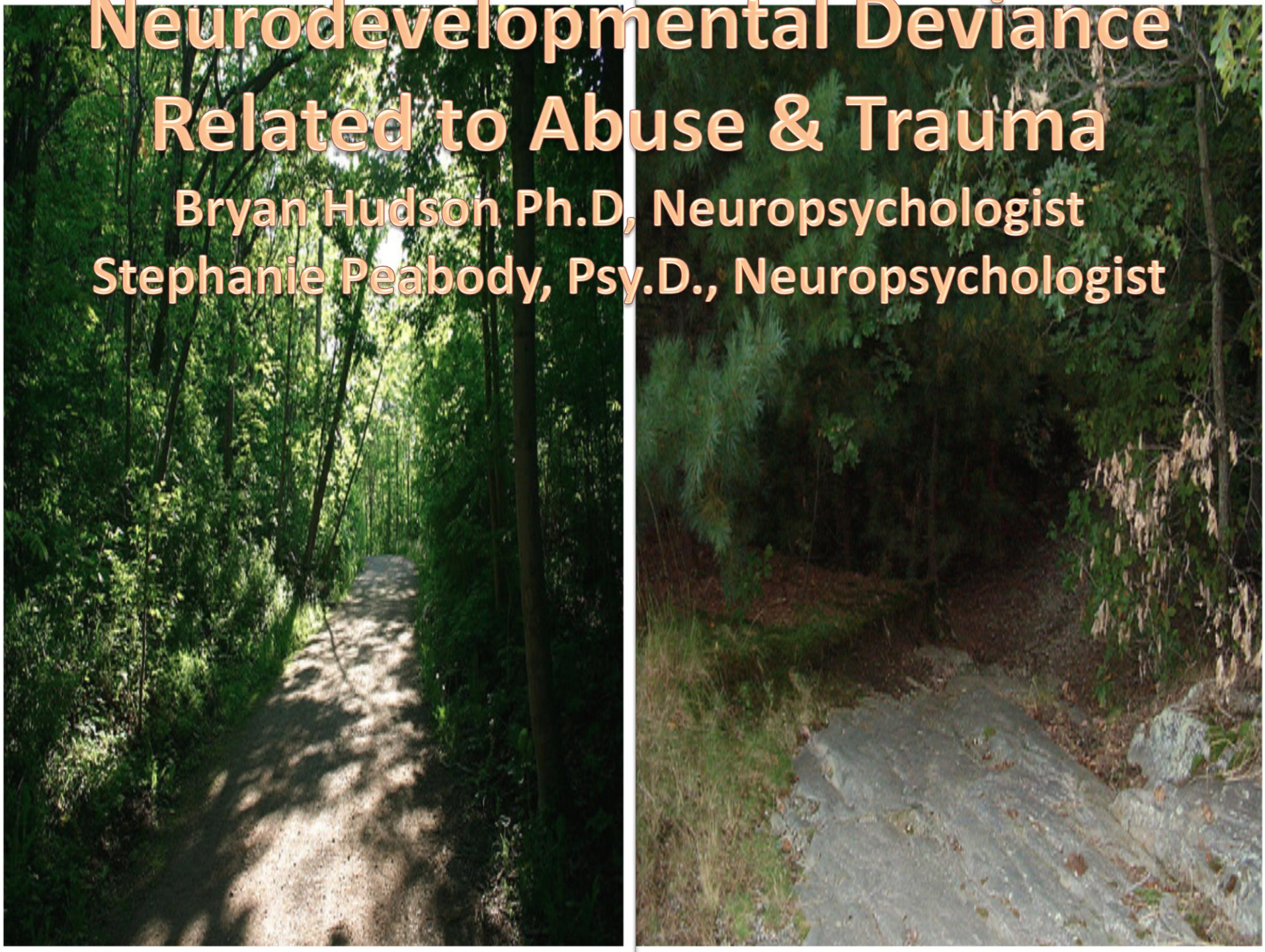
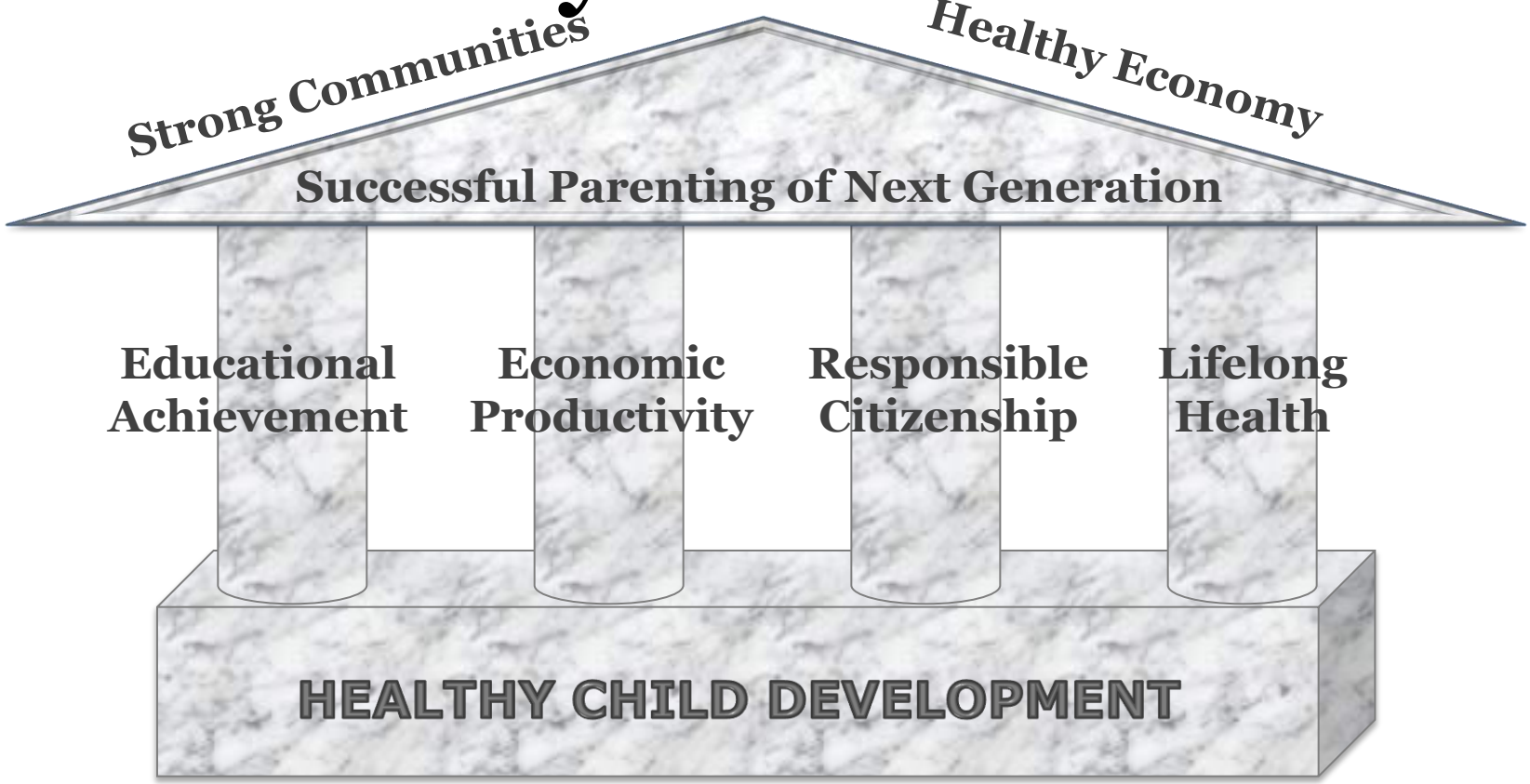


http://www.surveymonkey.com/s/DSXZ5V3

How are the Children in Indiana?-The Brain

1. Slides 1 -10 Questions
Slides 1 -10 Questions
2. Slides 11-20 Questions
Slides 11-20 Questions
3. Slides 21-30 Questions
Slides 21-30 Questions
4. Slides 31-40 Questions
Slides 31-40 Questions
5. Slides 41-50 Questions

The Foundation of a Successful Society is Built in Early Childhood



Definitions

- **Neurodevelopment:**

The processes that generate, shape, and reshape the nervous system, from the earliest stages of embryogenesis to the final years of life.

Definitions Cont…

- Abuse = Any form of maltreatment
  - Acts of Omission
    - Witnessing family violence
    - Neglect
  - Acts of Commission
    - Physical Attacks
    - Sexual Attacks & Exploitation
    - Emotional
- Trauma = The intrapersonal/emotional consequence of abuse

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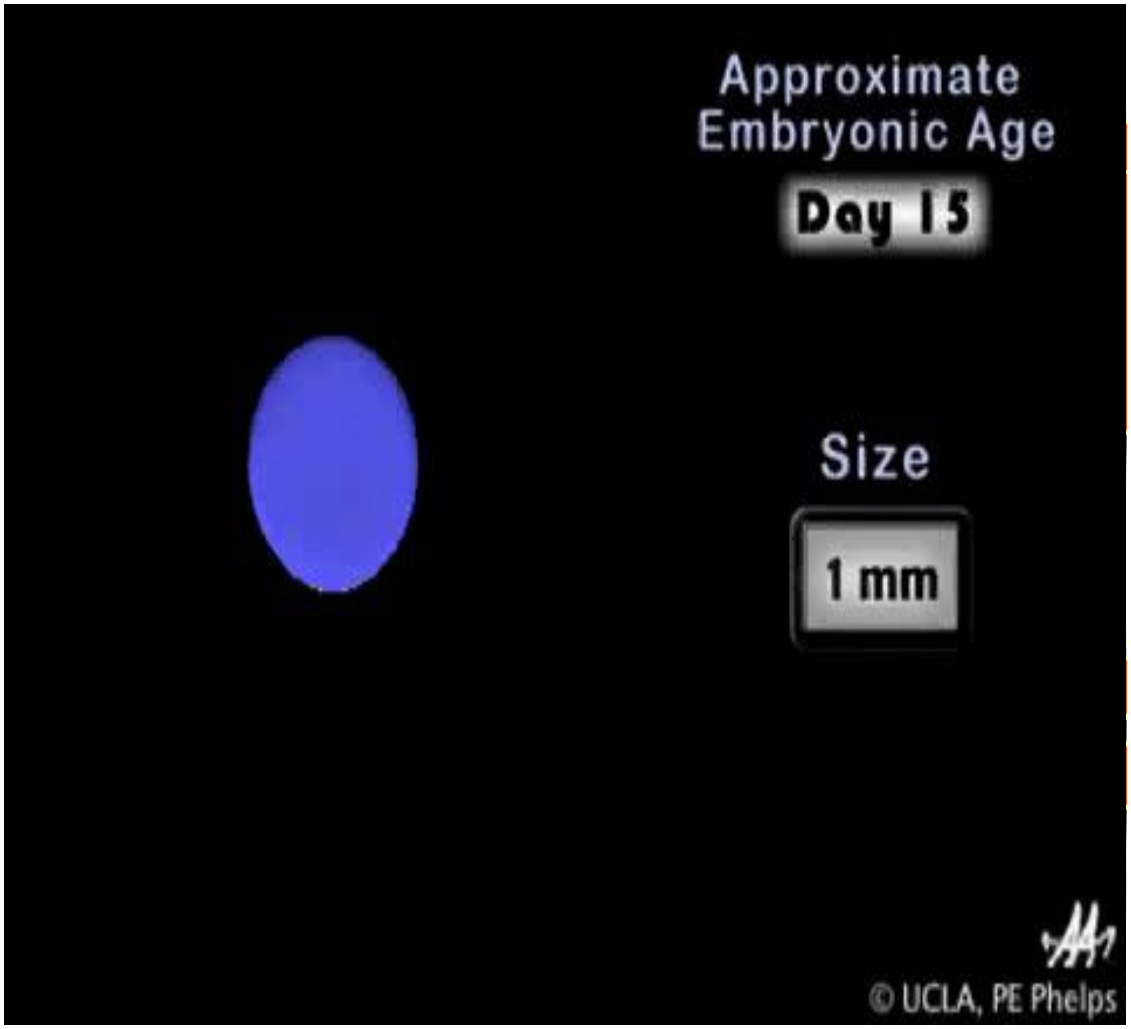
Image: dream designs / FreeDigitalPhotos.net

The Earliest Stages of CNS &PNS Development

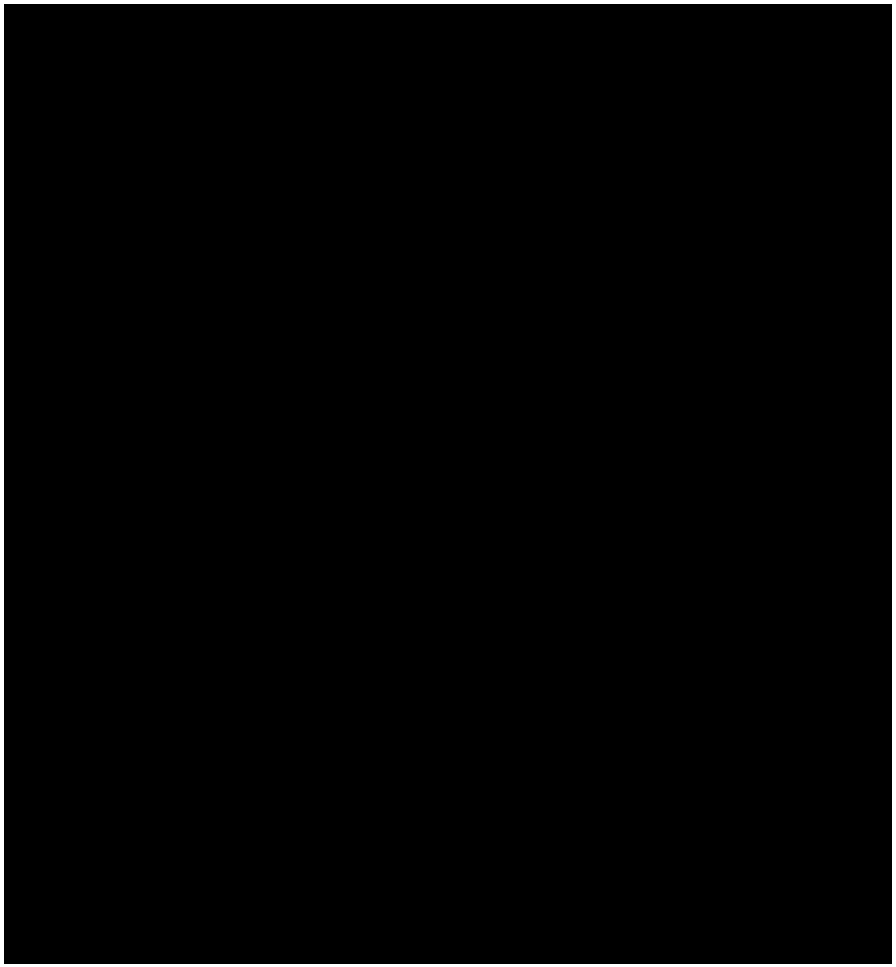
- **Neurulation**

The outermost layer of the fertilized egg folds and fuses to form the neural tube surrounding a fluid-filled cavity



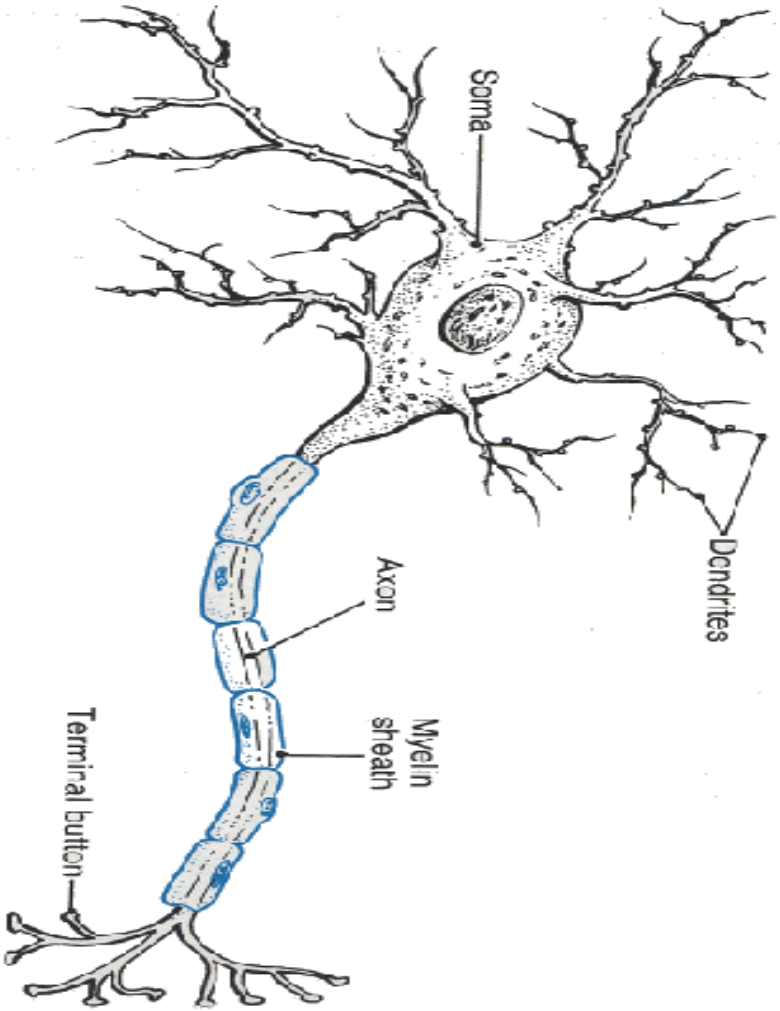
Neurogenesis

- The process involving the active production of new neurons, astrocytes, glia, and other neural lineages from undifferentiated neural progenitors or stem cells.
- Neurons migrate from lower brain regions (ventricular zones) to pre-determined destinations



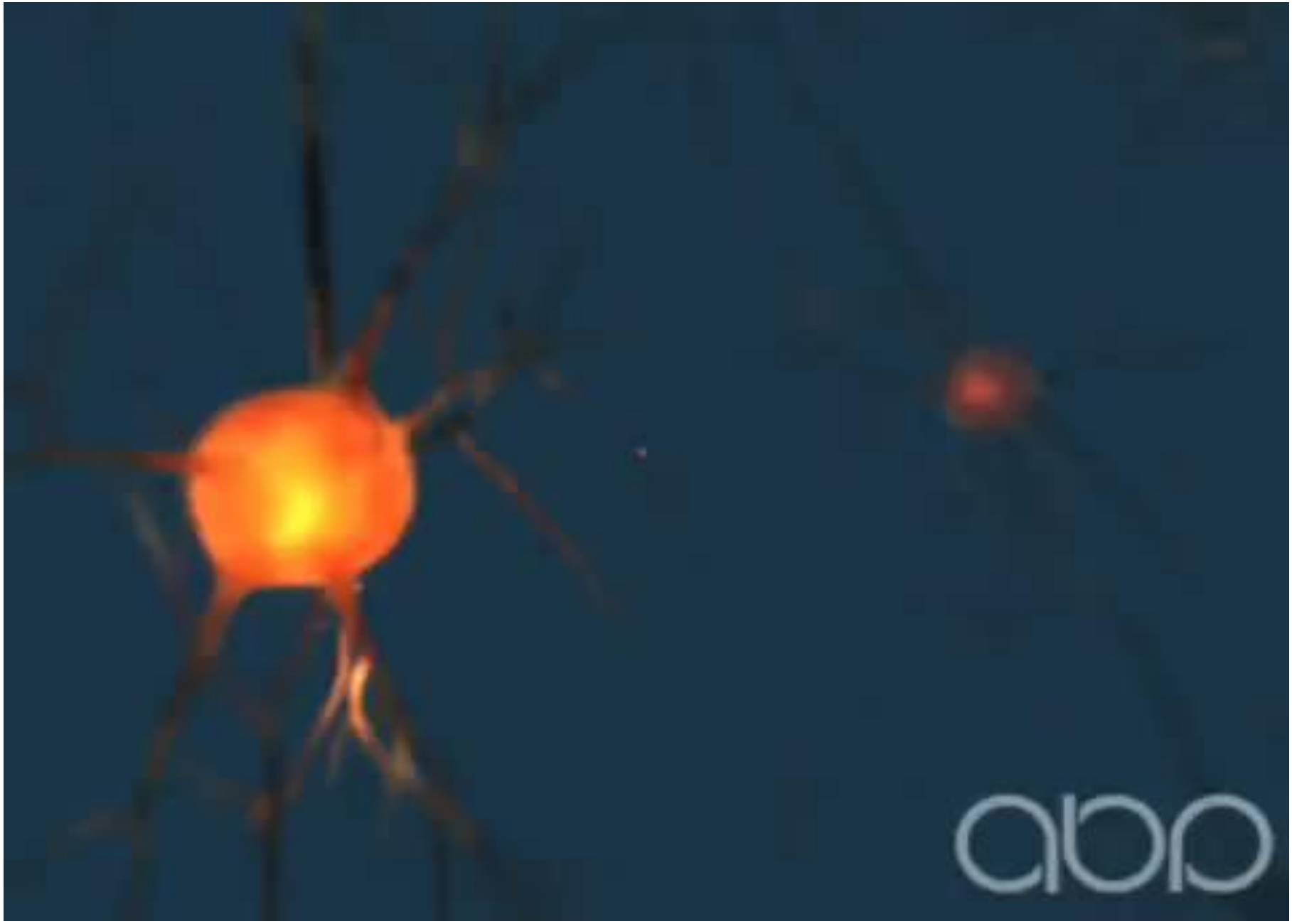
Synaptogenesis

- Axons
  - Axons form cortical-cortical, cortical-subcortical, and inter-hemispheric connections.
- Dendrites & Arborization
  - As the migrating neuronal cells reach their designated positions, dendrites being to sprout and spines grow from the dendrites.
  - This process begins prenatally, and increases in intensity from birth to 18-24 months.



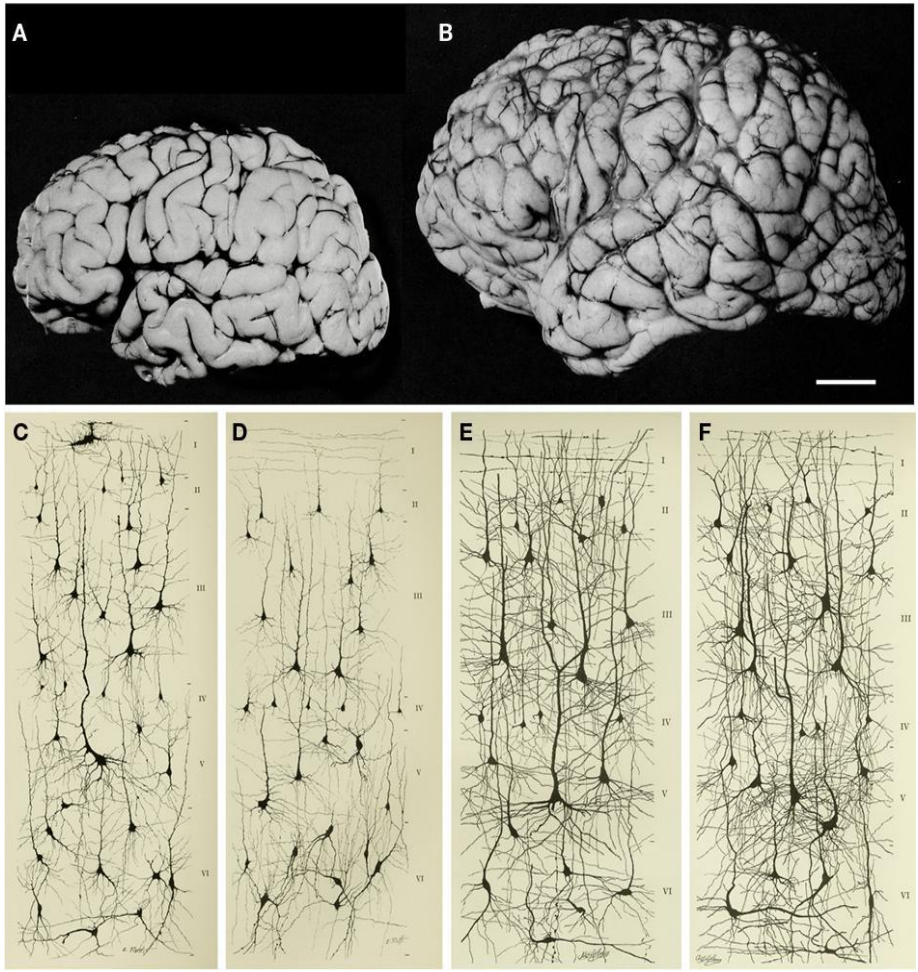
Myelination

- Axonal Transmission is Facilitated via Myelination
- Brain Size and Function are Substantially Increased

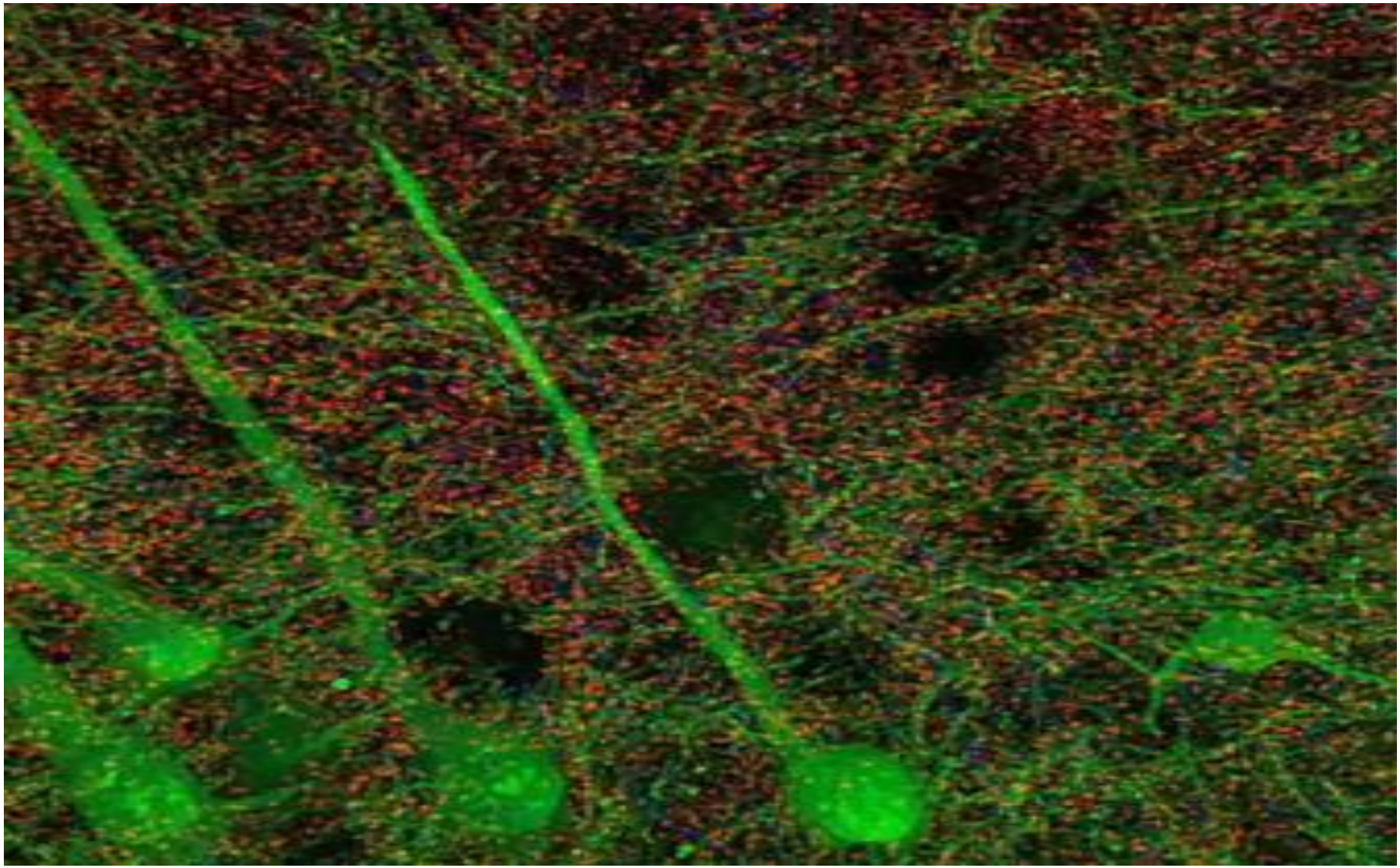

abp

Early Childhood = Growth & Refinement

- Neurons and synapses are overproduced during early development
- Early synapses are, in part, random
- Pruning purposefully sculpts the brain eliminating 40% of the cortical neurons during childhood.

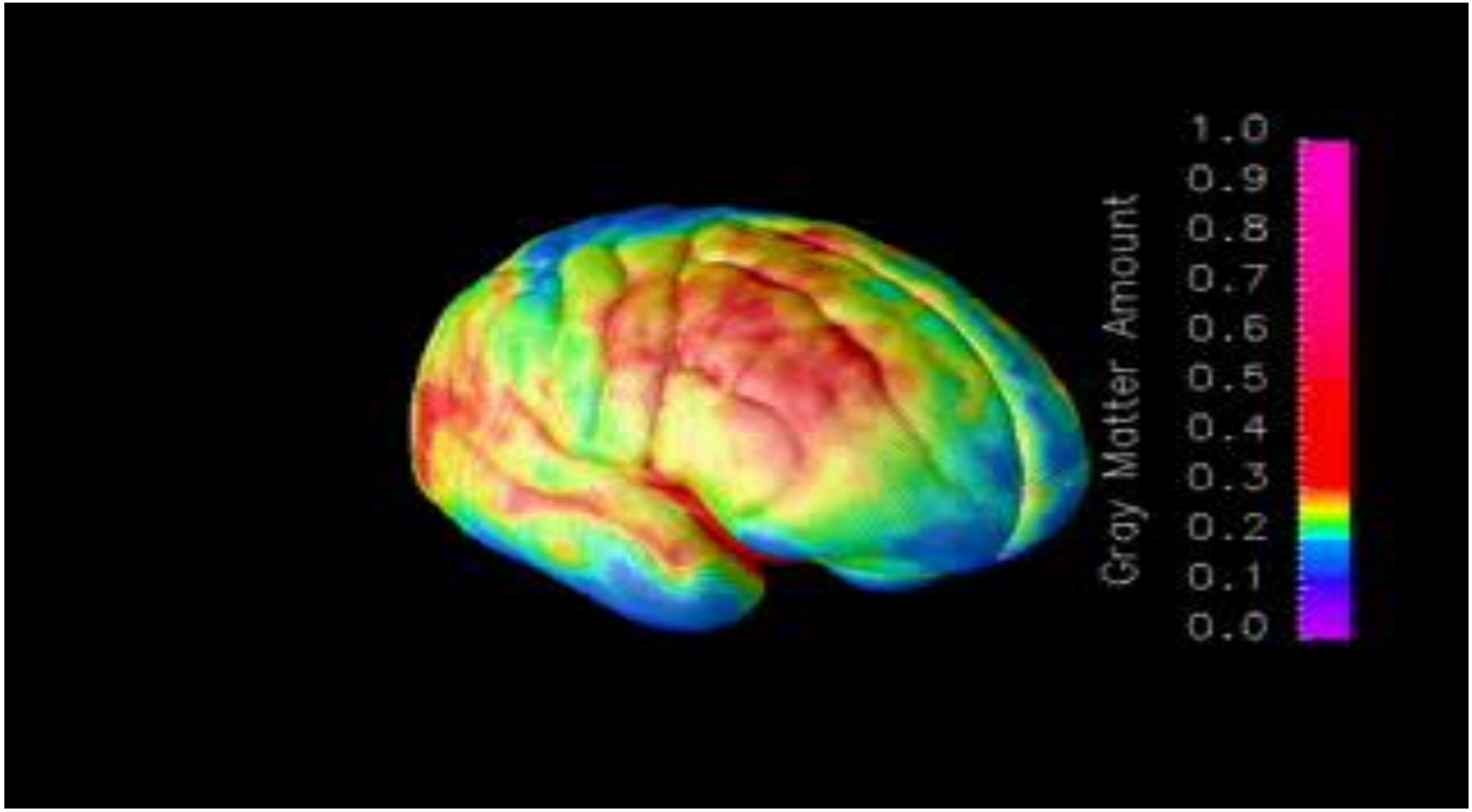


A Universe of Synapses



Use It Or Lose It

15-Years of Brain Development in 5-Seconds



The Positive and Negative of Plasticity

- **Positive: Young brains are more open to learning and enriching influences.**

- **Negative: Young children's brains are more vulnerable to developmental problems should their environment prove especially impoverished or un-nurturing.**

Normal Brain Functioning Simplified

- The brain's operation is best viewed as a unitary phenomenon.
- While different regions may produce different functions, the regions network in concert.
- Development and functioning start with the most basic of needs
- Initially bottom up processing and ultimately top down processing

The Priorities of the Structure and Function of the Brain

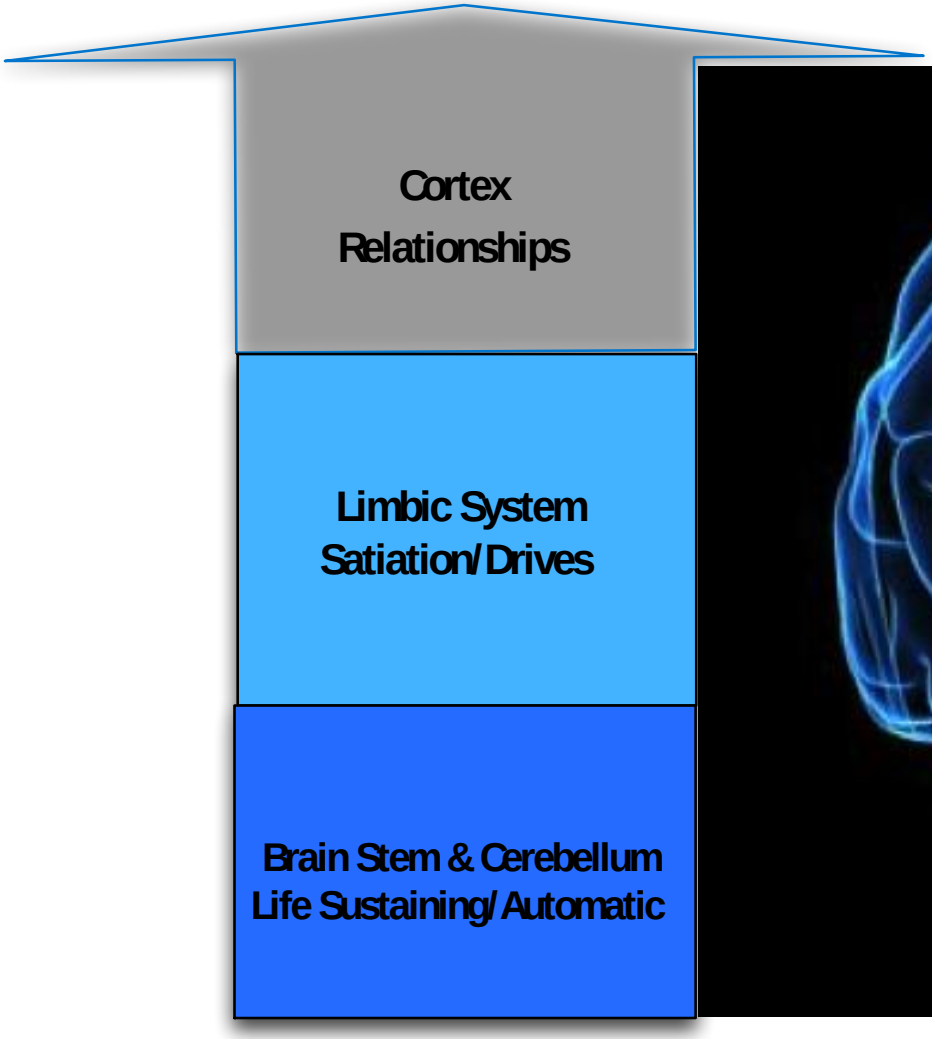
Priorities: 1st = Survival

Priorities: 2nd = Emotional Homeostatis

Priorities: 3rd = Satisfaction, Satiation

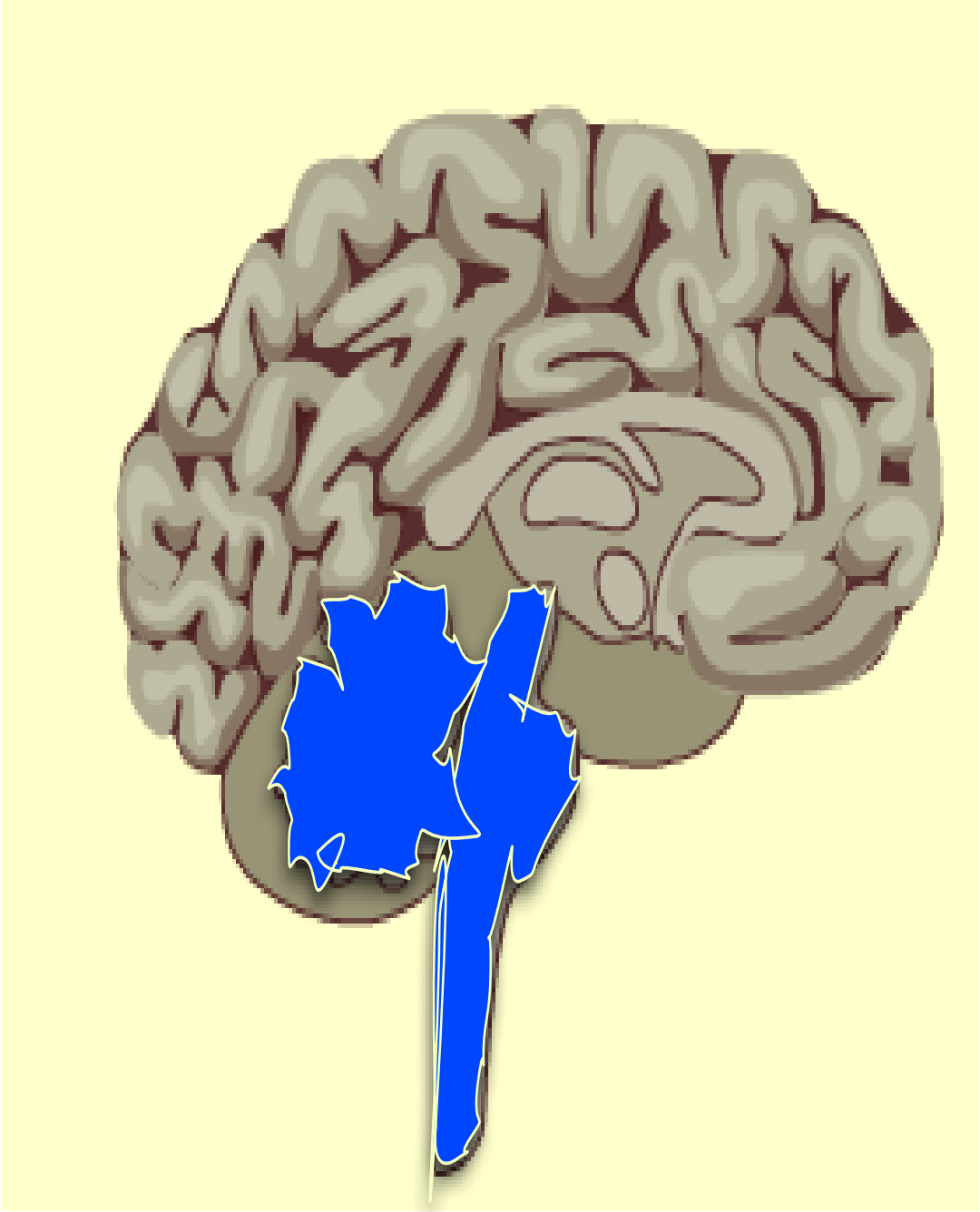
Priorities: 4th = Relationships and Personal Aspirations

Hierarchical Structure and Function



Level One

Brain Stem & Cerebellum
Life Sustaining/ Automatic



Brain Stem and Midbrain: Priority 1

SUBTHALAMIC NUCLEUS

John W. Sundsten, Ph.D.

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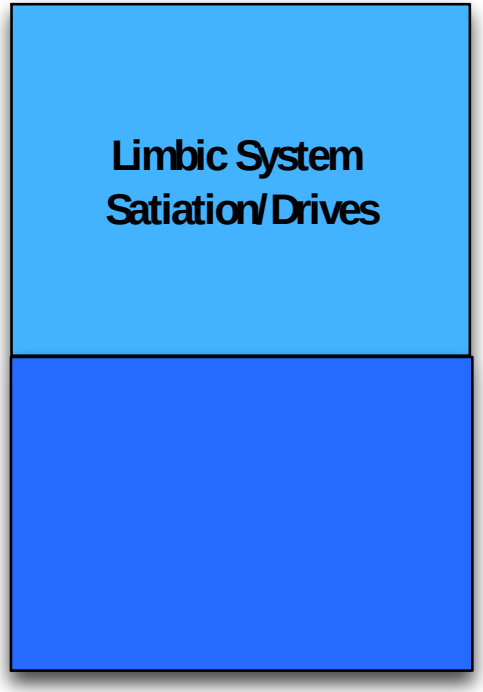
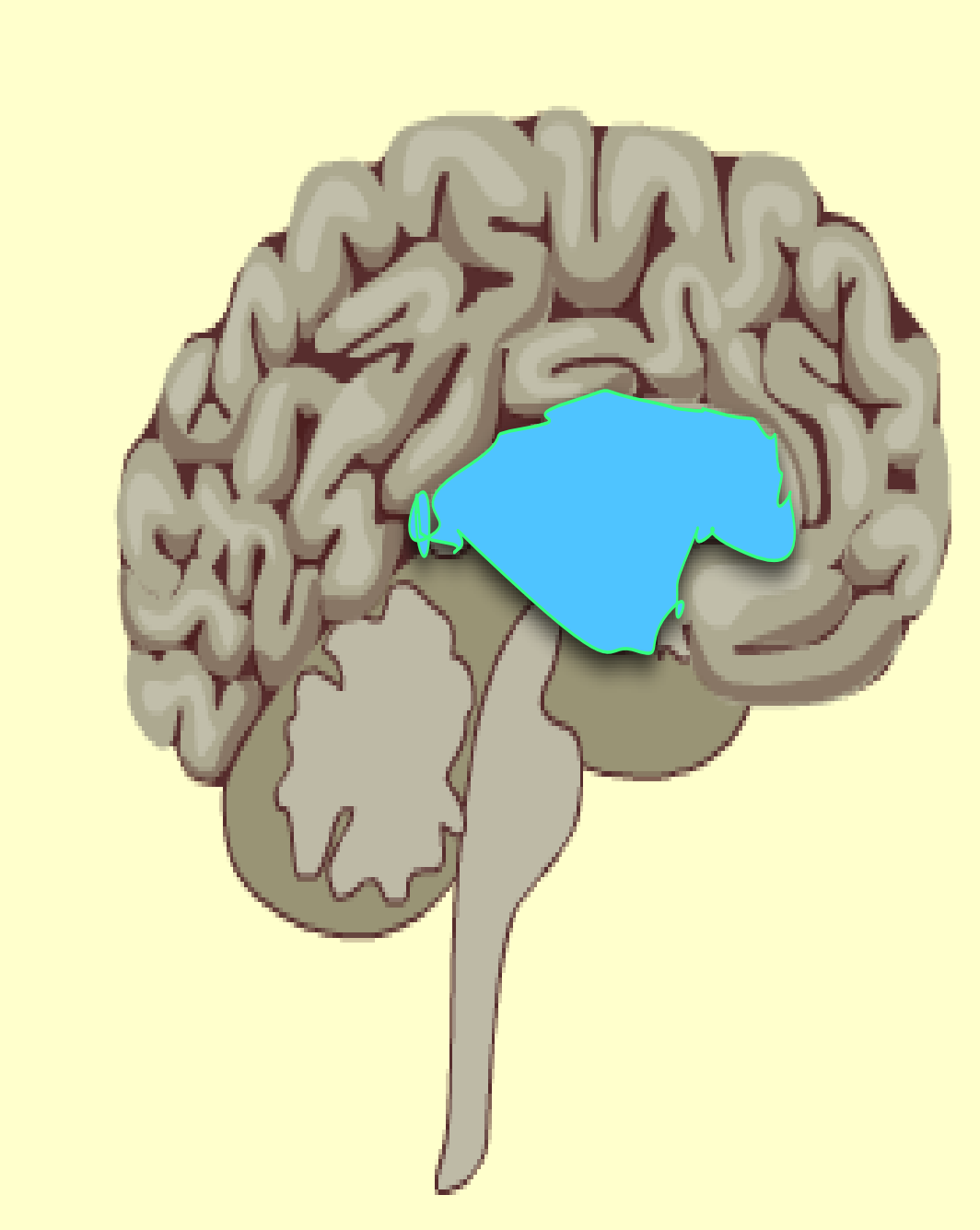
Brain Stem & Cerebellum
Life Sustaining/ Automatic

Level Two





Limbic System (Priorities 2-3)

Limbic System
Satiation/Drives

LIMBIC SYSTEM ZOOM

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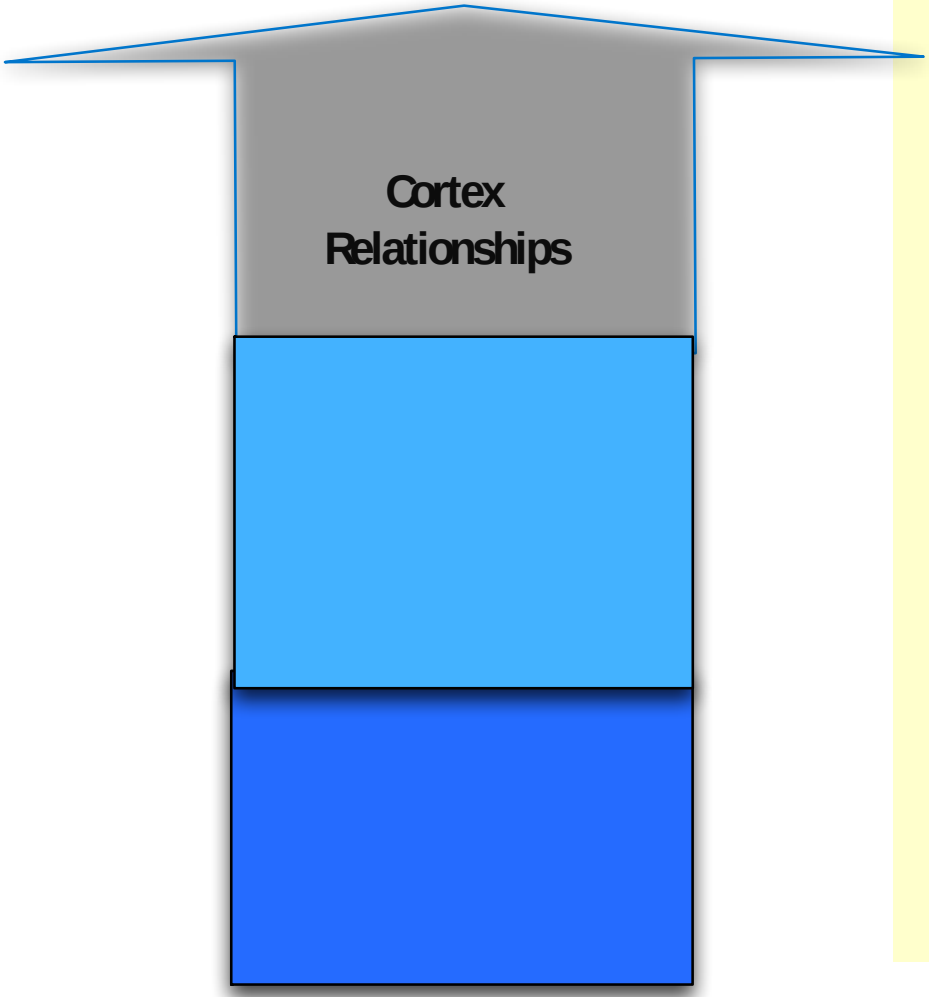
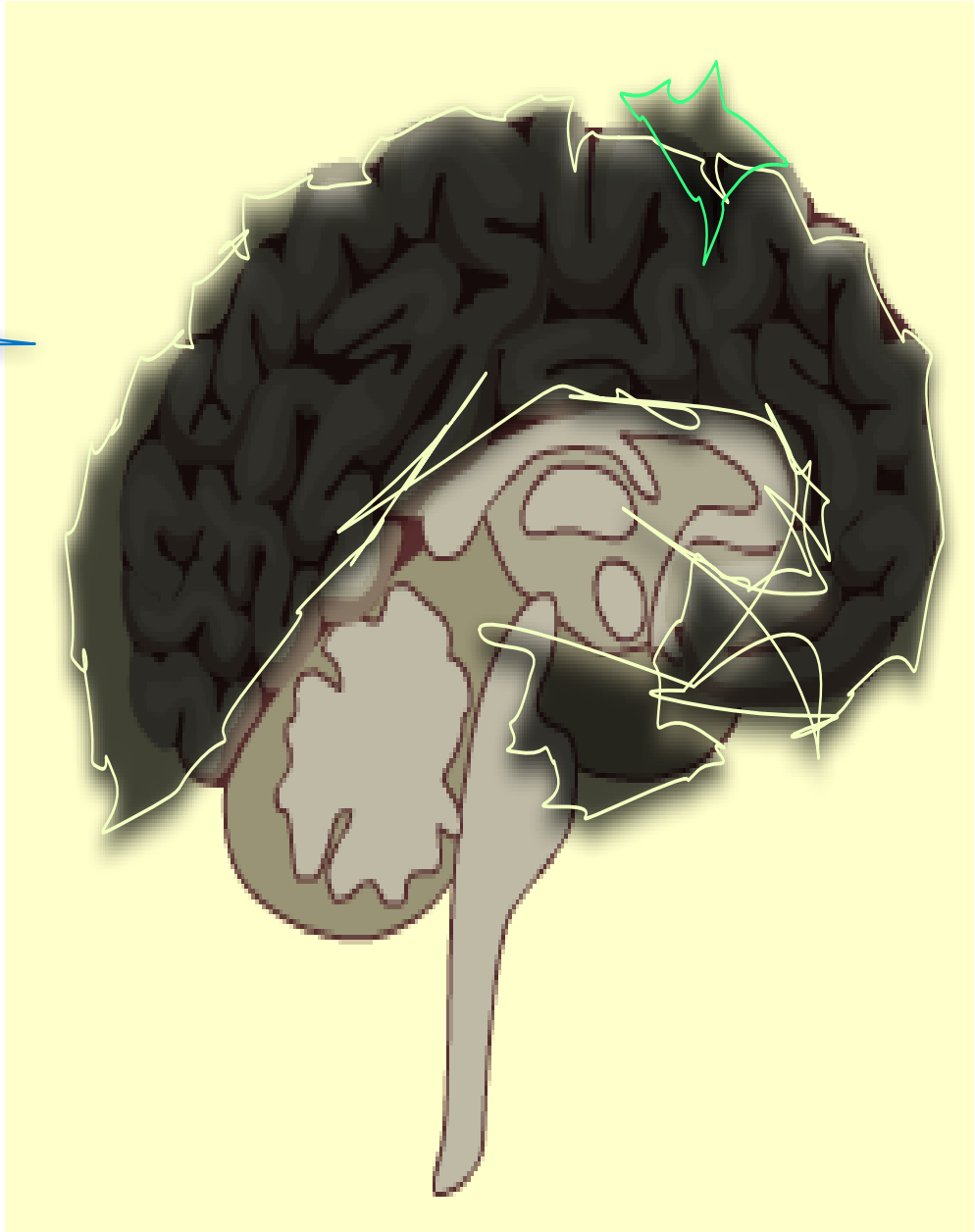
Level Three





Cortex

Cortex
Relationships

BRAIN LOBES
270 X-AXIS ROTATION

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University of Washington

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General Effects of Abuse on Prenatal Neurodevelopment

- **Environmental Agents: Drugs, ETOH, etc.**
  - **Reduced size of the cerebellum**
  - **Reduced brain size**
  - **Reduced size of basal ganglia**
  - **Impaired development or complete absence of the corpus callosum**
  - **Neural tube defects**

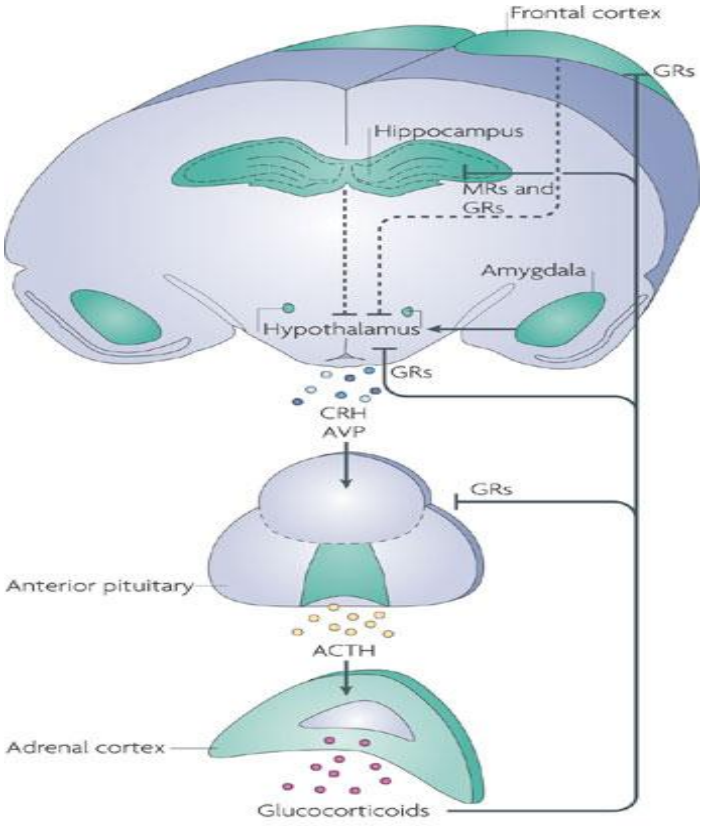
- **Nutrition Deficits: Timing & Duration**
  - **Abnormalities in neurotransmitter metabolism**
  - **Decreased myelin formation**
  - **Alterations in brain energy metabolism**
  - **Neural tube defects (iron)**

Hypothalamo-Pituitary-Adrenal/Axis (HPA)

Maternal Distress: Early Life Programming

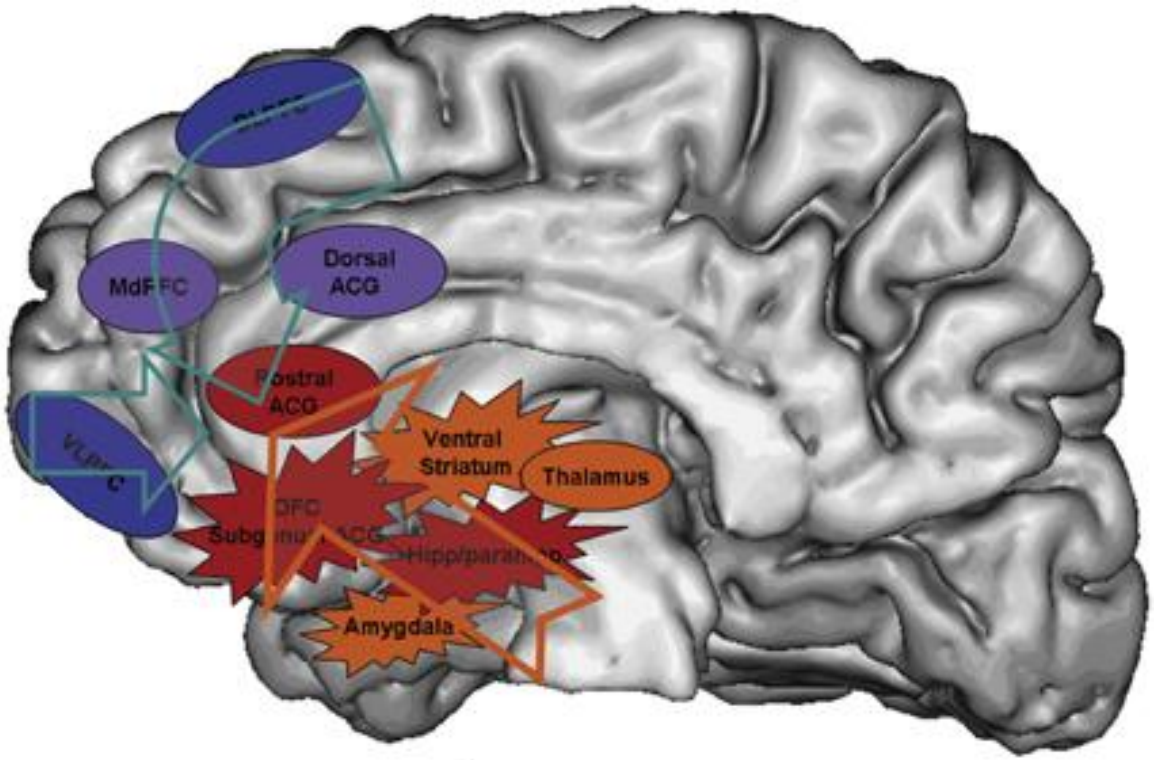
- **Prenatal stress (PS) and maternal exposure to exogenous glucocorticoids can lead to permanent modification of hypothalamo-pituitary-adrenal (HPA) function, homeostatic gauge, and stress-related behavior, cognition, and memory.**

- **Animal models and limited human studies indicate that maternal distress likely causes deviance in the trajectory of brain development.**



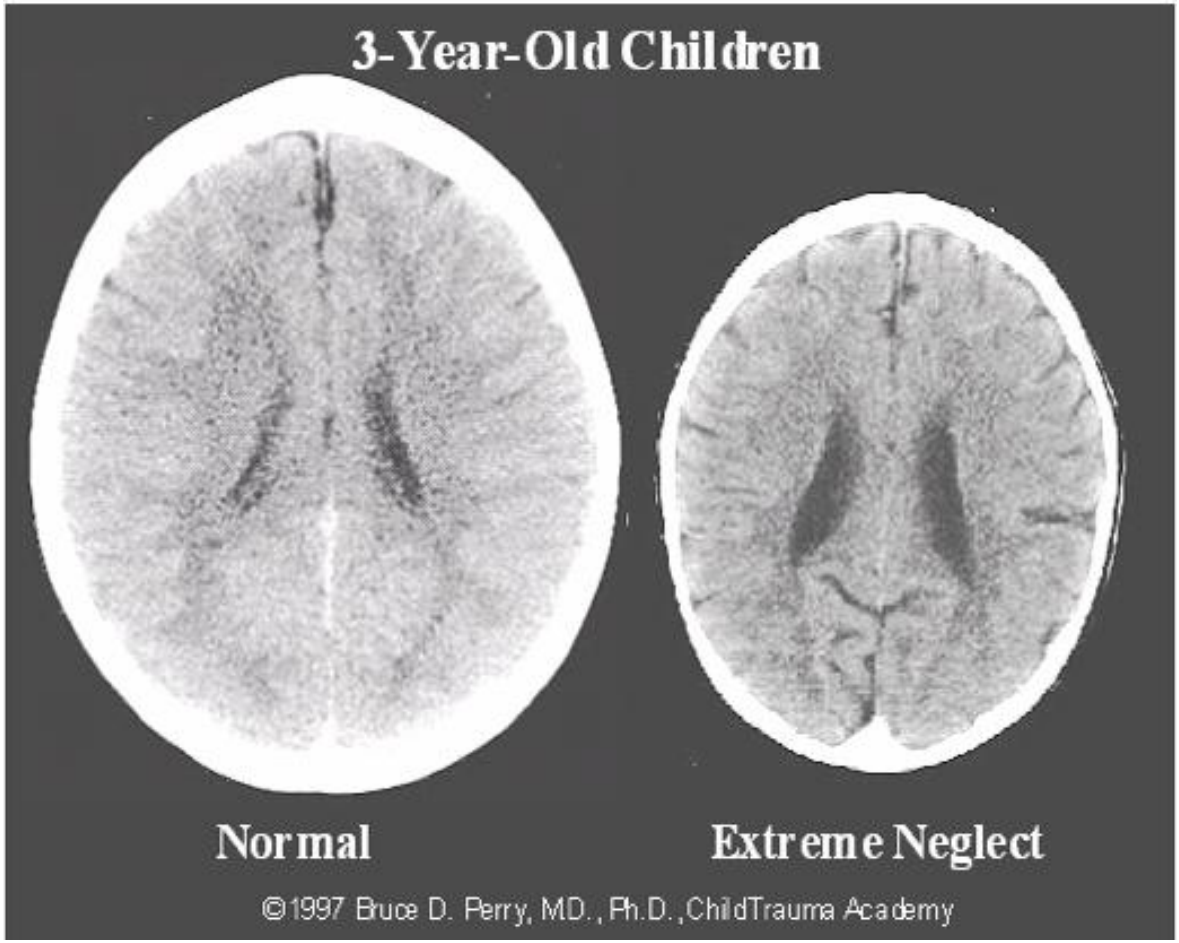
Nature Reviews | Neuroscience

The Influence of Distress on the Infant Brain



Orienting/Emotion Identification
Automatic Emotion Regulation
Voluntary Emotion Regulation
Regions Implicated in Both Automatic and Voluntary Emotion Regulation

End Result


3-Year-Old Children
Normal
Extreme Neglect
©1997 Bruce D. Perry, MD., Ph.D., ChildTrauma Academy

General Effects of Abuse on Postnatal Neurodevelopment

- **Environmental Agents: Physical, Sexual, Emotional/Abuse & Neglect, Nutrition & Enrichment Deficits:**
  - ***Deficient development and differentiation of the left or dominant hemisphere***
  - ***Limbic irritability***
  - ***Deficient left-right hemisphere integration – Corpus Callosum***
  - ***Abnormal activity in the cerebellar (vermis)***
  - ***Decreased cortical volume - complexity/density***
    - ***Diminished Gray and White Matter***

Sensitive Periods: Time & Duration Dependent

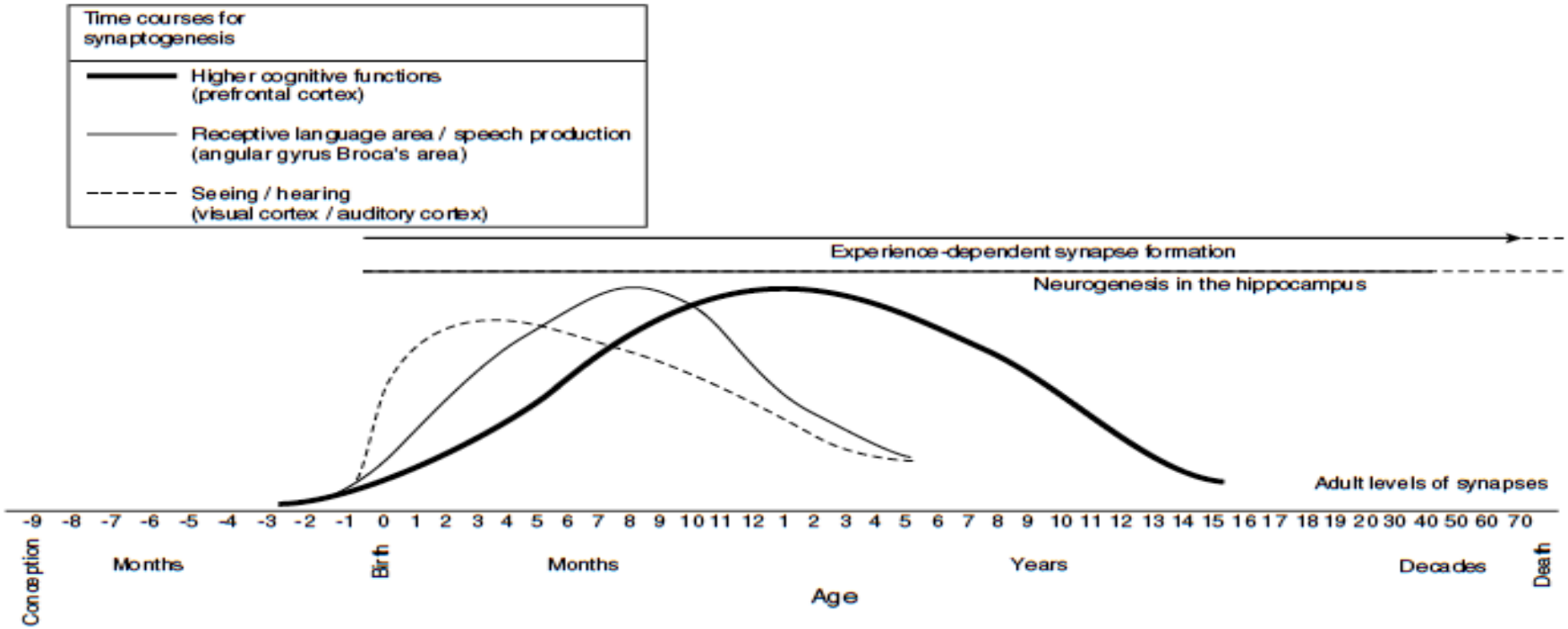
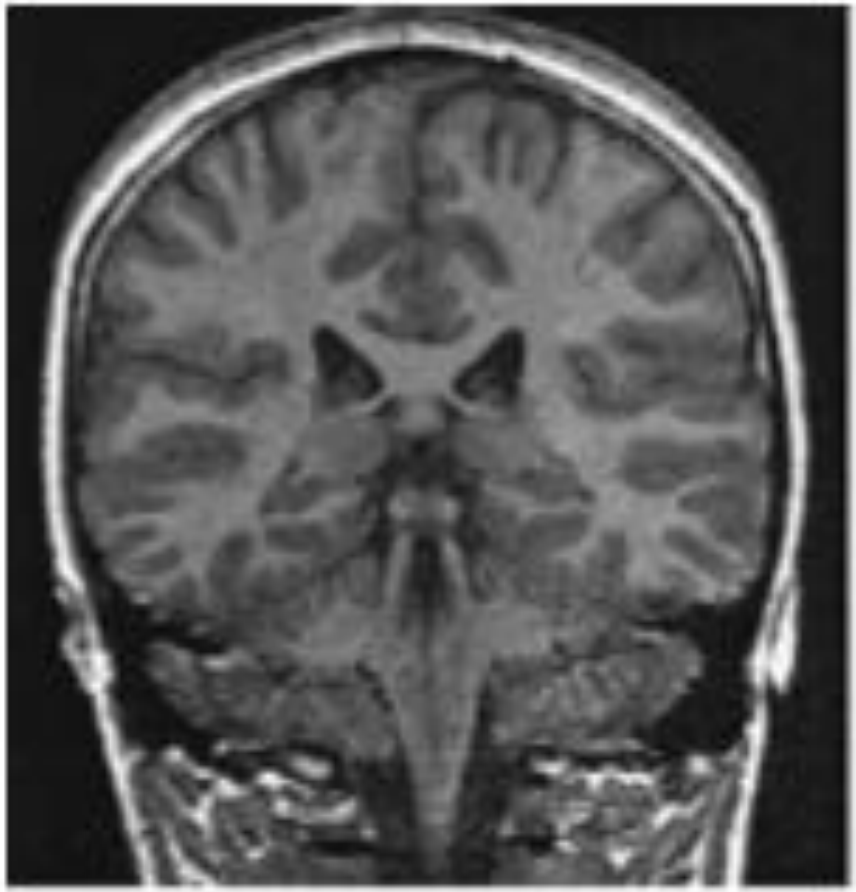
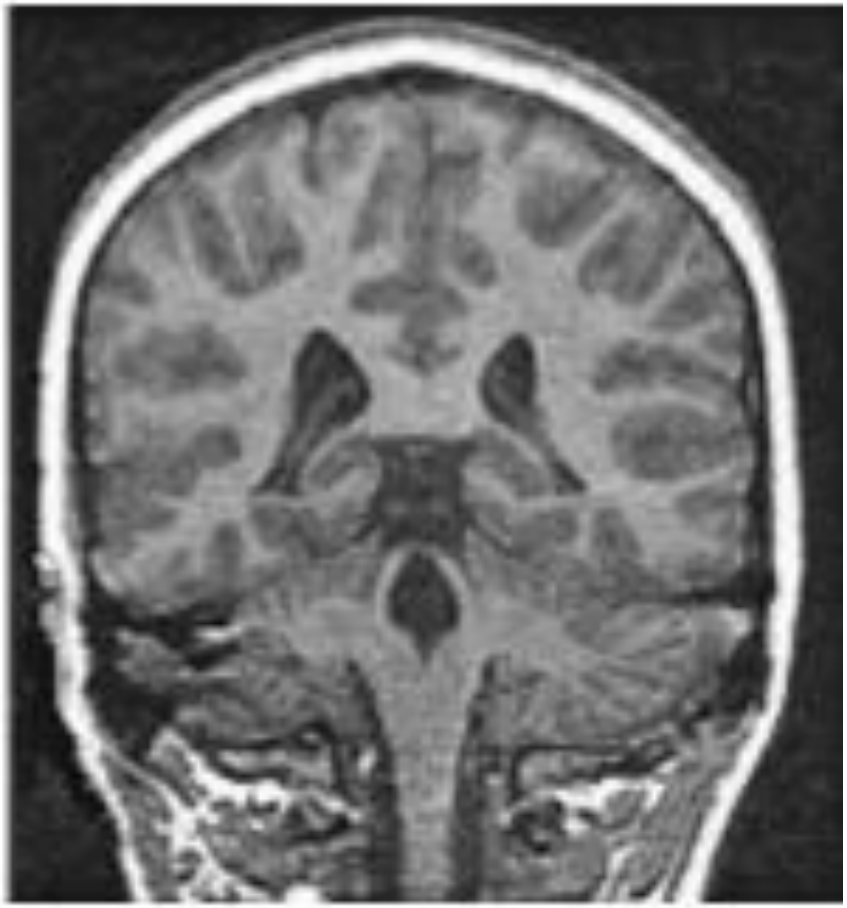


FIGURE 8-1 Human brain development. SOURCE: Charles A. Nelson, University of Minnesota. Reprinted with permission.

Normal Vs. Abnormal





THE AMERICAN JOURNAL OF PSYCHIATRY

psychiatryonline

From: MRI and PET Study of Deficits in Hippocampal Structure and Function in Women With Childhood Sexual Abuse and Posttraumatic Stress Disorder

Am J Psychiatry. 2003;160(5):924-932. doi:10.1176/appi.ajp.160.5.924

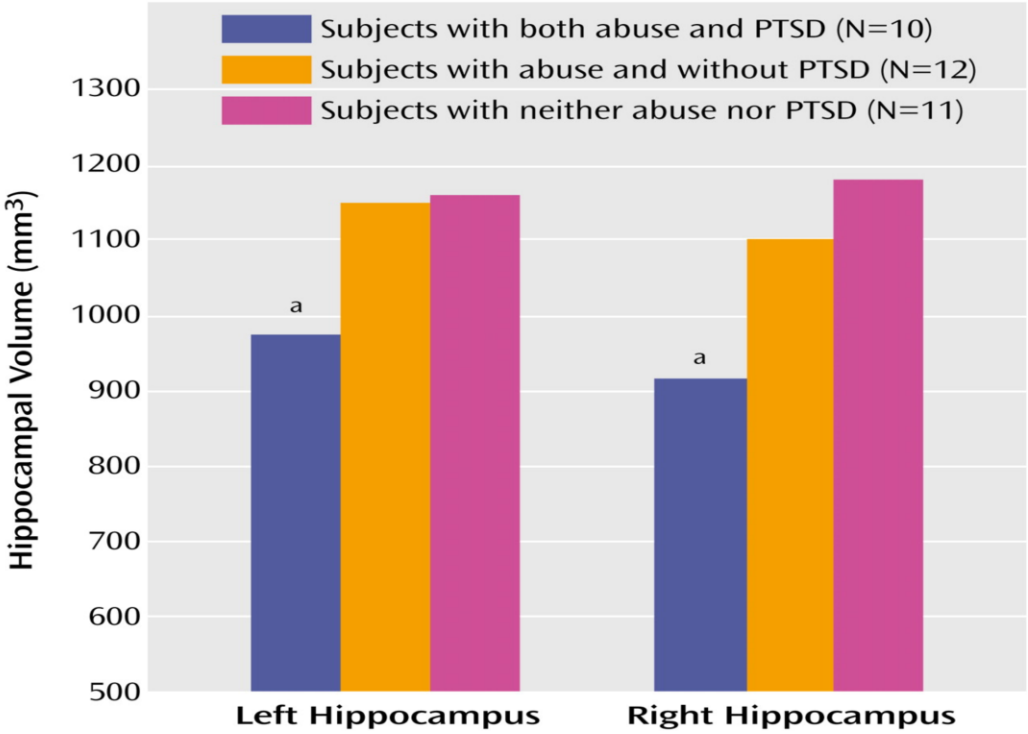


Figure Legend:

Left and Right Hippocampal Volumes as Measured With MRI in Women With and Without Childhood Sexual Abuse and PTSD

Women with abuse and PTSD differed significantly from women with abuse and without PTSD and women without abuse or PTSD.

Date of download:
9/24/2012

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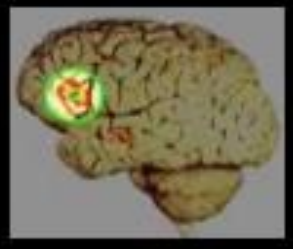
Neurodevelopment & Adolescent Abuse

Emotional Recognition

- Teens (11-17) - Response to photo
  - MRI
  - Prefrontal less activated than adults
  - Lower brain more activated than adults

Teen

Adult



Summary

- **Early Development: Primitive Areas *Priority 1* & Associated Functions**
- **Later Development: Mid Regions and *Priorities 2,3, 4* & Associated Functions**
- **While Effects are Enduring, They are Surmountable**

Three Core Concepts of Development

1 Brain Architecture Is Established Early in Life and Supports Lifelong Learning, Behavior, and Health

2 Stable, Caring Relationships and "Serve and Return" Interaction Shape Brain Architecture

3 Toxic Stress in the Early Years of Life Can Derail Healthy Development

Three Core Concepts in Early Development

1 Experiences Build Brain Architecture

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Brain Architecture Supports Lifelong Learning, Behavior, and Health

- Early experiences shape brain architecture.
- Simple skills come first; more complex skills build on top of them.
- A strong foundation in the early years improves the odds for positive outcomes and a weak foundation increases the odds of problems later in life.

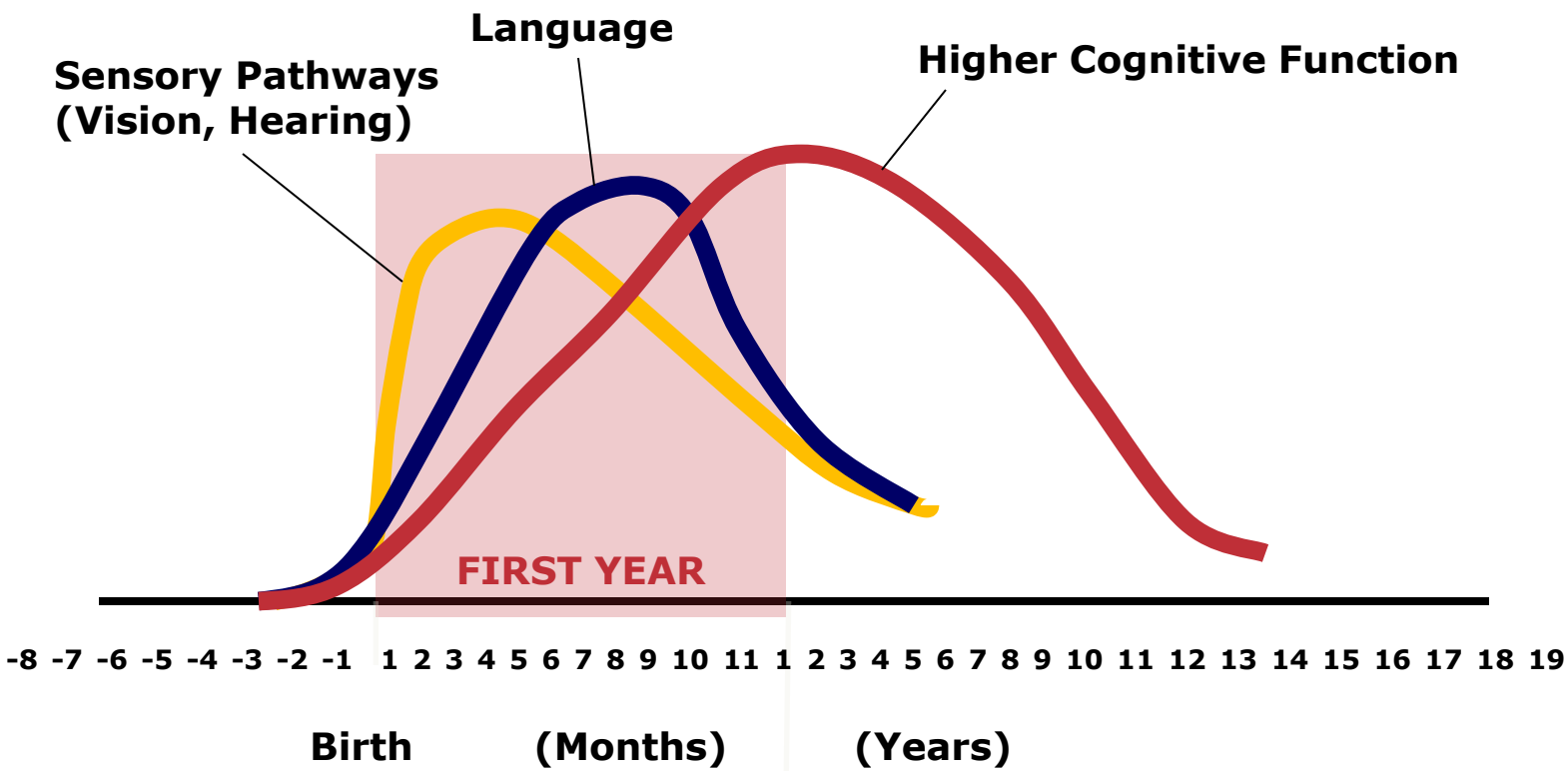
Experiences Shape Brain Architecture

700 neural connections per second in the early years

Birth

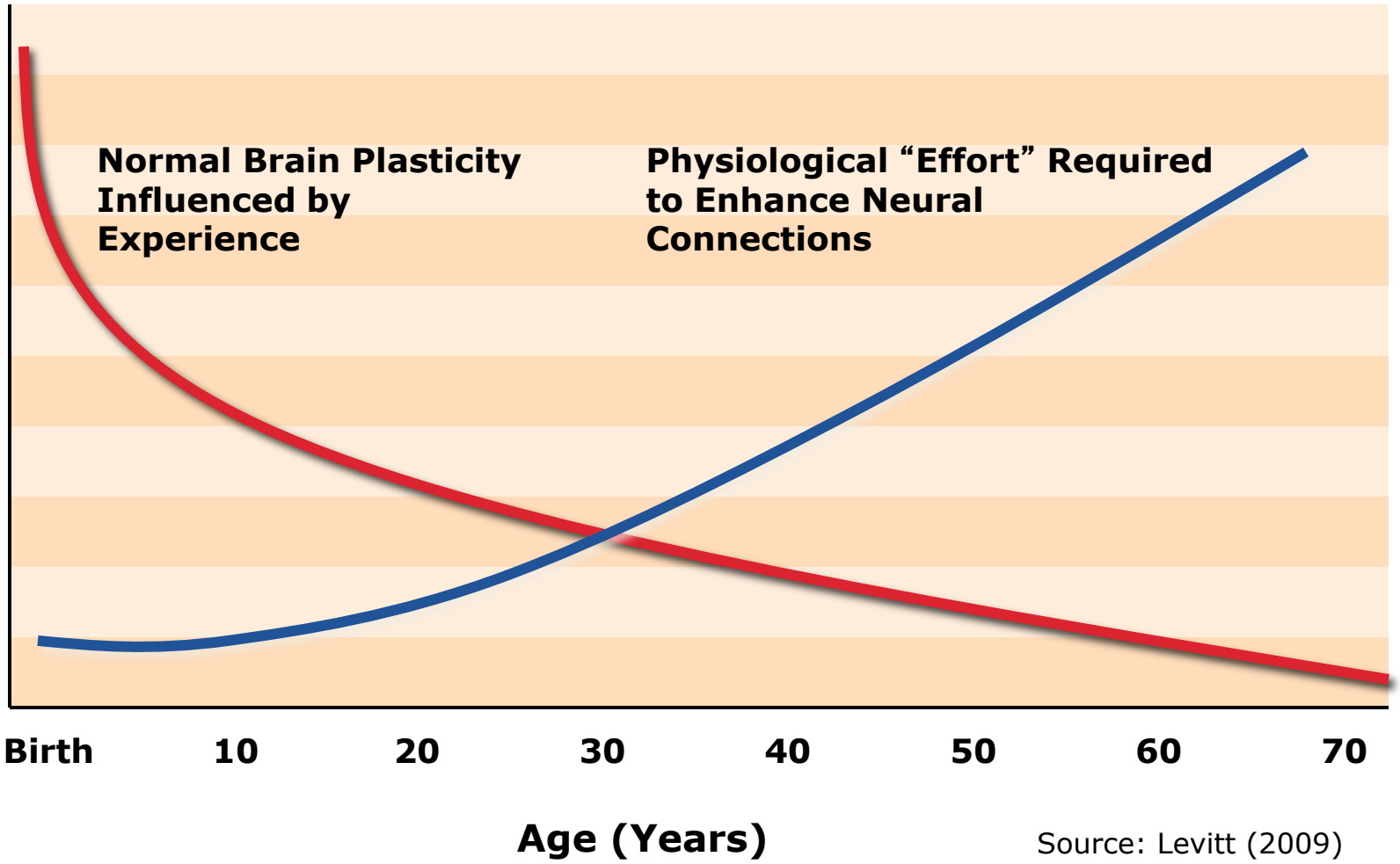
Image source: Conel, JL.

Neural Circuits are Wired in a Bottom-Up Sequence



Source: C.A. Nelson (2000)

The ability to REWIRE brains decreases over time



Source: Levitt (2009)

Three Core Concepts in Early Development

2 Serve & Return Interaction Shapes Brain Circuitry

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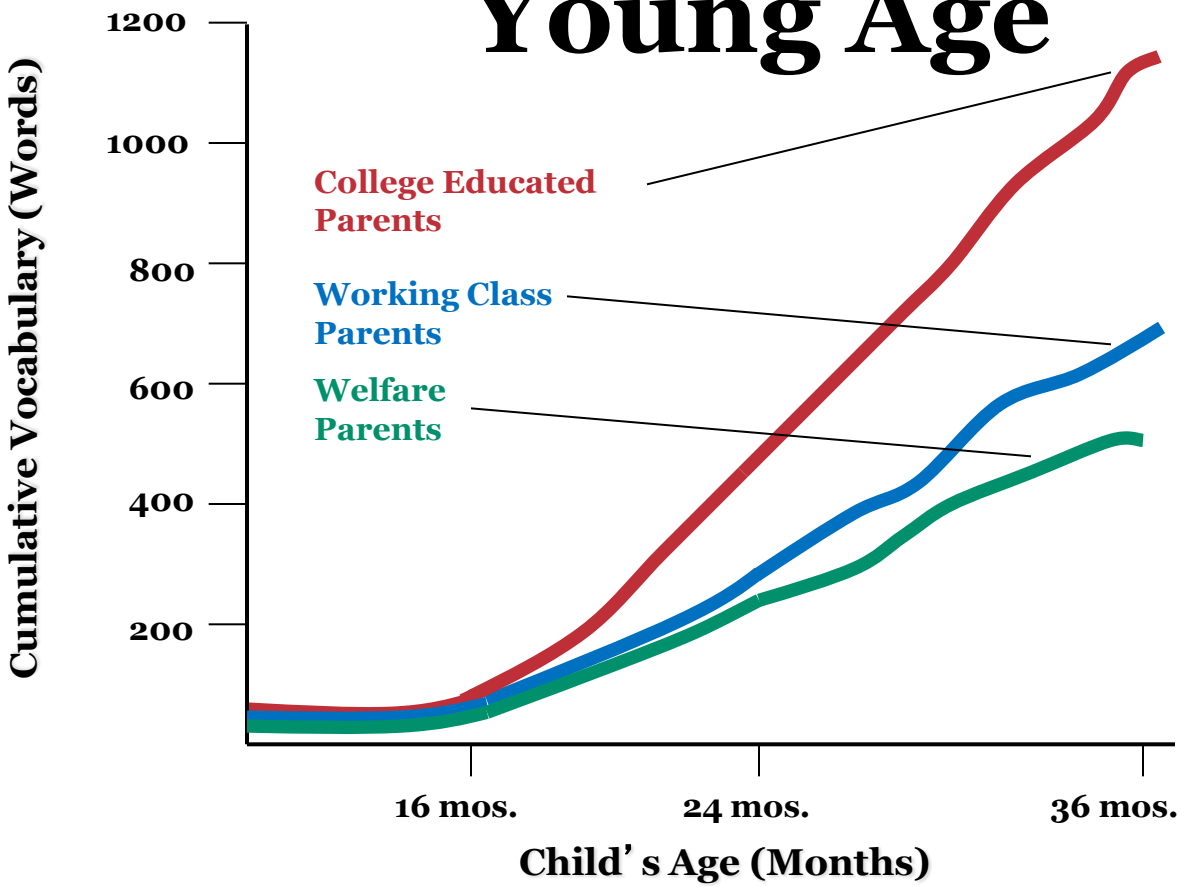
- Ongoing, reliable interaction with trusted adults is essential for the development of healthy brain circuits.

- Systems that support the quality of relationships in early care settings, communities, and homes help build brain architecture.

Barriers to Educational Achievement Emerge at a Very Young Age

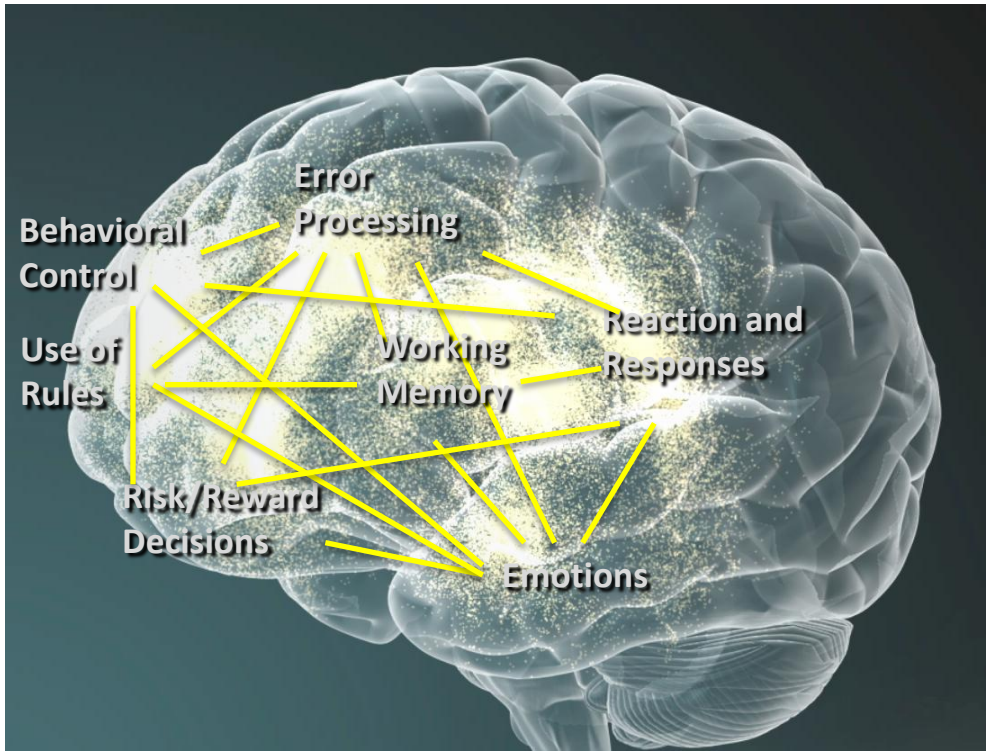


Data Source: Hart & Risley (1995)

Graph Courtesy: Center on the Developing Child at Harvard University

Executive Functioning and Self-Regulation

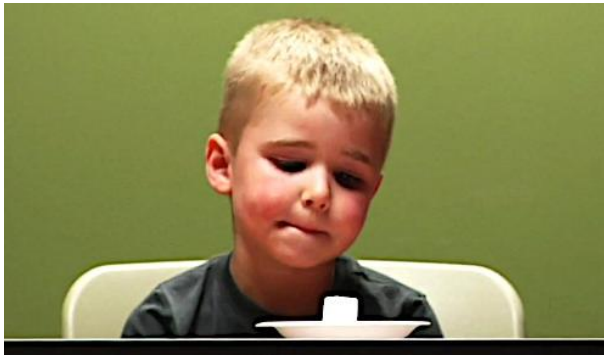
The Brain's "Air Traffic Control System"



A group of skills that include planning, monitoring, problem solving, self control, working memory, and the ability to focus attention, resist distractions, follow directions, solve problems, and adjust to changes in rules or priorities.

What are Executive Function Skills?

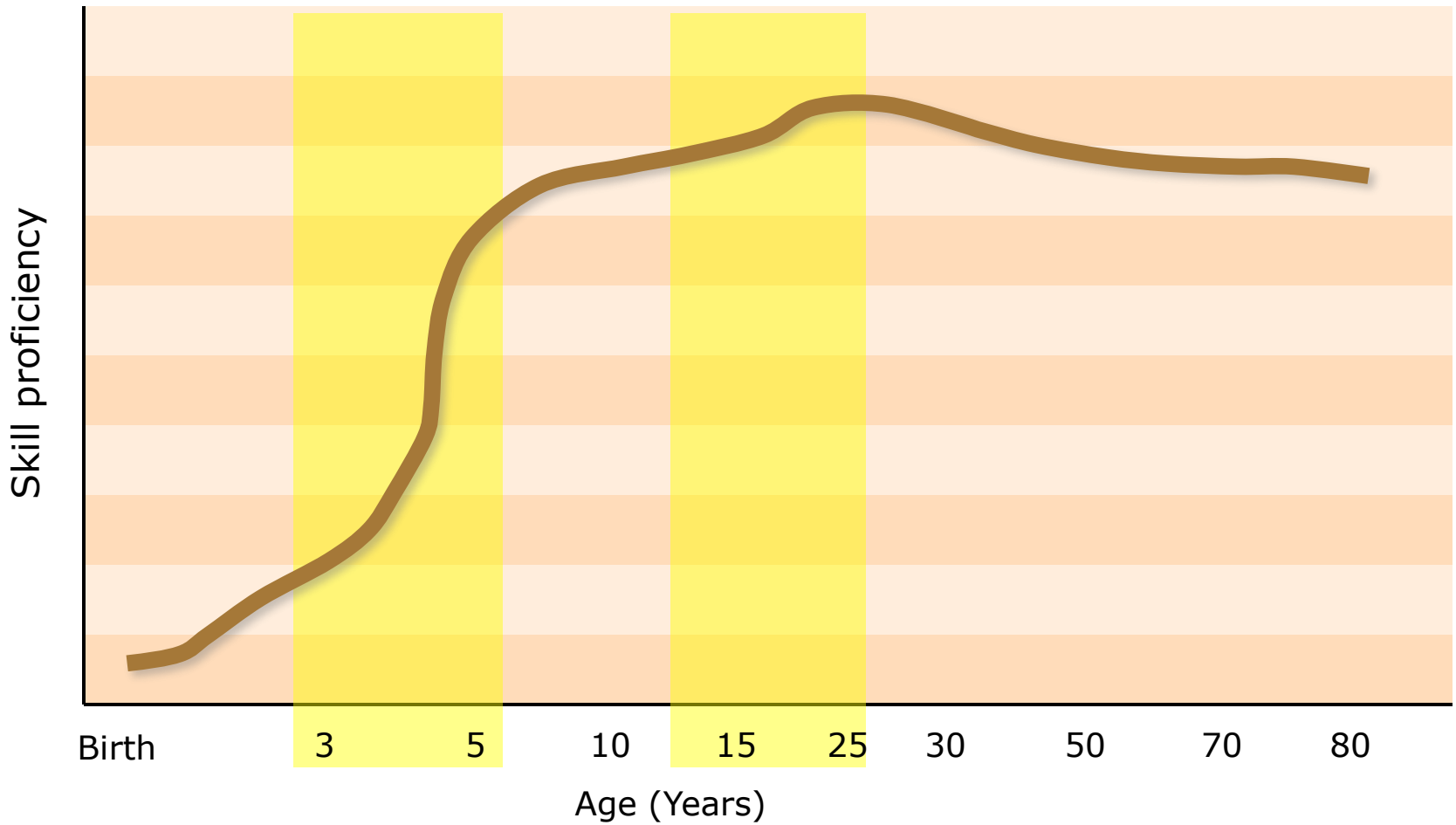
Inhibitory Control — filter thoughts and impulses to resist temptations and distractions



Working Memory — hold and manipulate information in our heads over short periods of time

Mental flexibility — adjust to changed demands, priorities, or perspectives

When Do Executive Function Skills Develop?



Weintraub, et al., (2011)

Building an "Air Traffic Control System" in the Developing Brain

	Working Memory	Inhibitory Control	Cognitive Flexibility
Adult	Remember multiple tasks, rules & strategies that may vary	Self-control, situationally appropriate responses	Revise actions & plans in changing circumstances
5-16 years	Ability to search varying locations, recall where something is found	Ignore irrelevant, peripheral stimuli and focus on central stimulus	Improvement in accuracy when switching focus and adaptation to changing rules
2- 5 years	Remember 2 rules (shoes here, coats there)	Delay eating a treat, follow arbitrary rule	Shift actions as rules change
9-16 months	Execute simple 2-step plan (means-to-end tasks)	Begin to maintain focus despite distractions	Seek alternate methods when 1st attempt fails

Correcting Popular Misconceptions of Science

- EF Skills do not develop automatically
  - Problems with these skills are not necessarily outgrown
- **Not “bad kids”**
  - Compromised or delayed EF skills

Effectiveness Factors for Building Executive Function

"The most effective way to improve EFs and academic achievement is probably not to focus narrowly on those alone but to also address children's emotional and social development … and children's physical development."

- Address stresses in their lives
  - Stress reduction practices
  - Deal with external causes
- Foster social interactions
- Progressively increase demand on EF skills
- Include repeated practice throughout the day
- Encourage vigorous physical exercise

Source: Diamond, et al. (2011)

Three Core Concepts in Early Development

3 Toxic Stress Derails Healthy Development

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Relationships Buffer Toxic Stress

- Learning how to cope with moderate, short-lived stress can build a healthy stress response system.

- Toxic stress—when the body's stress response system is activated excessively architecture.

- Without caring adults to buffe toxic stress can have long-tern consequences for learning, bel both physical and mental health.

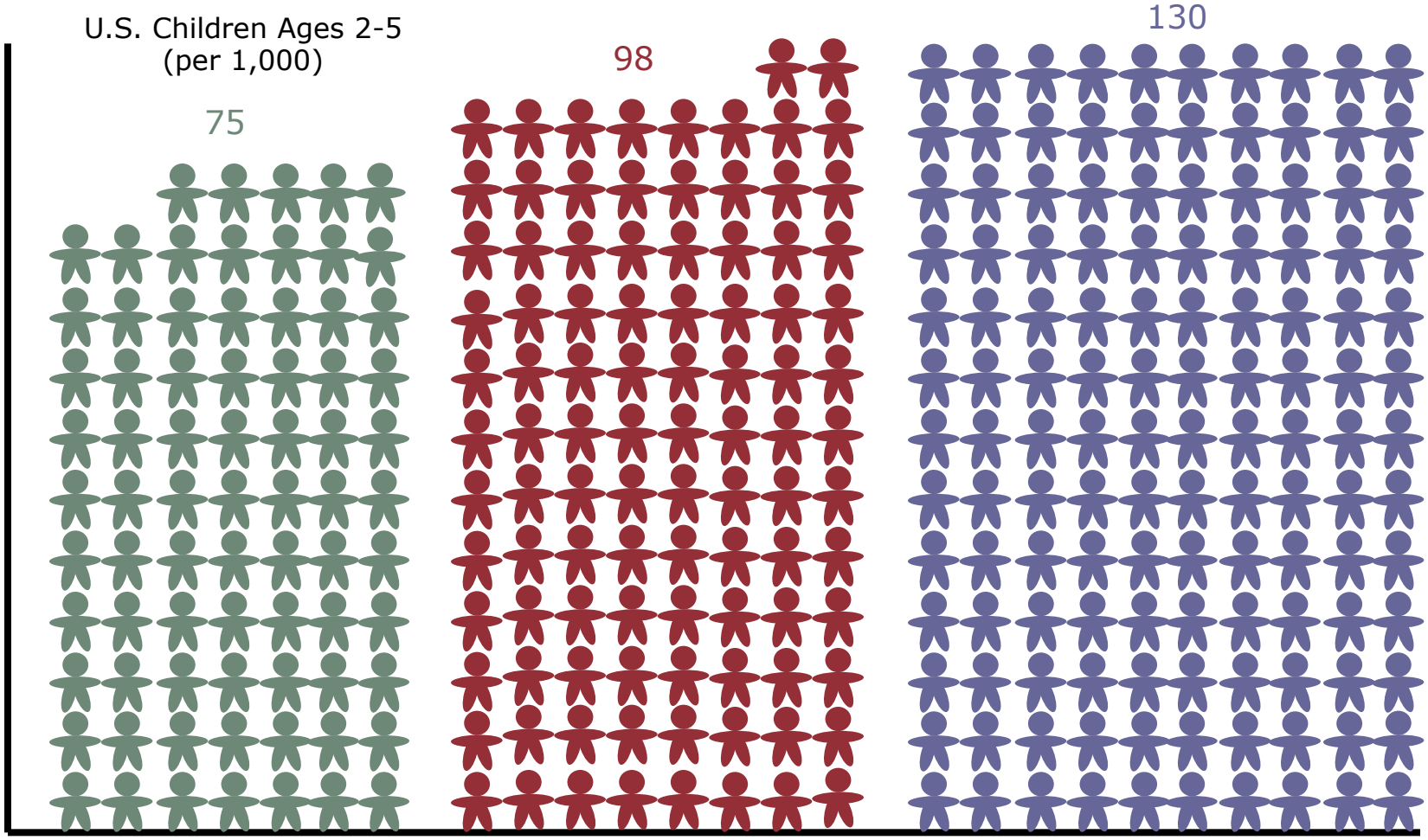
Three Levels of Stress Response

Positive
Brief increases in heart rate,
mild elevations in stress hormone levels.

Tolerable
Serious, temporary stress responses,
buffered by supportive relationships.

Toxic
Prolonged activation of stress response systems
in the absence of protective relationships.

Sources of Toxic Stress in Young Children



Maltreatment

Source: Finkelhor et al. (2005)

Parental Substance Abuse

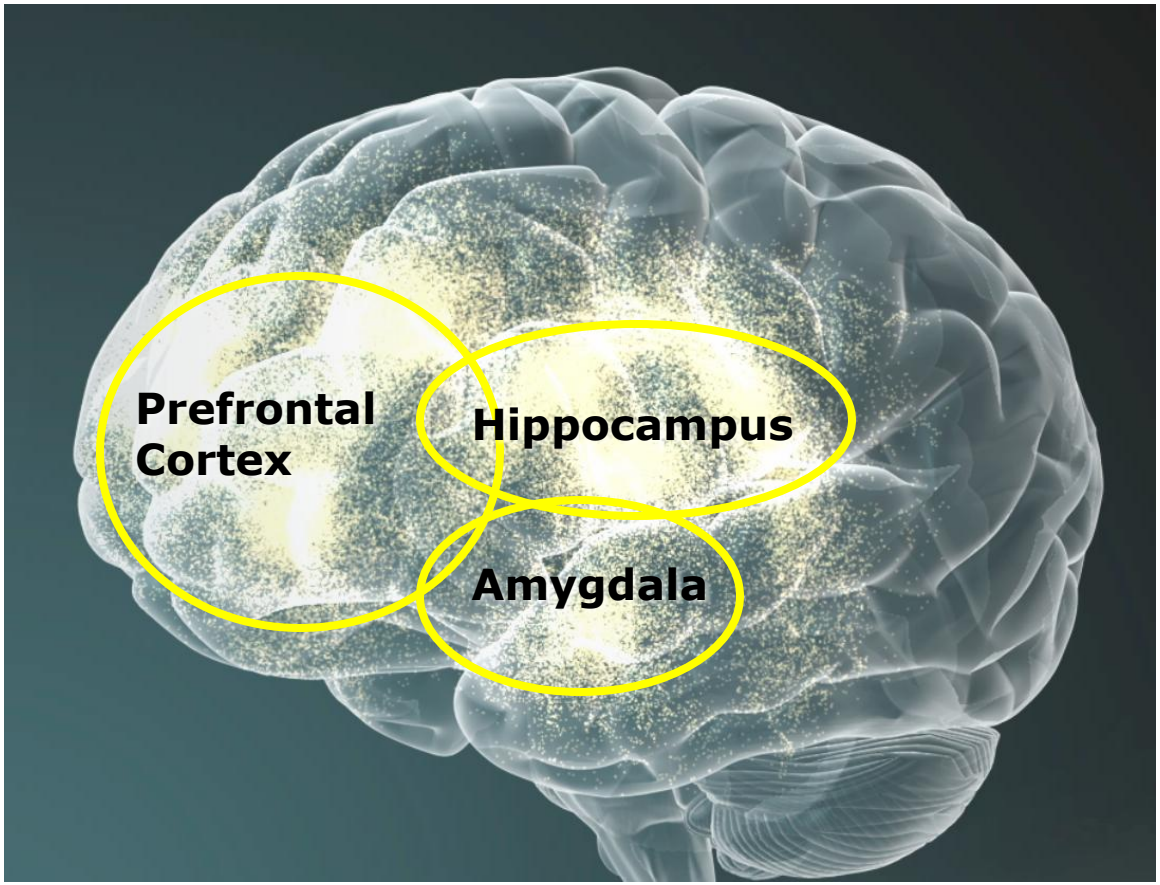
Source: SAMHSA (2002)

Postpartum Depression

Source: O-Hara & Swain (1996)

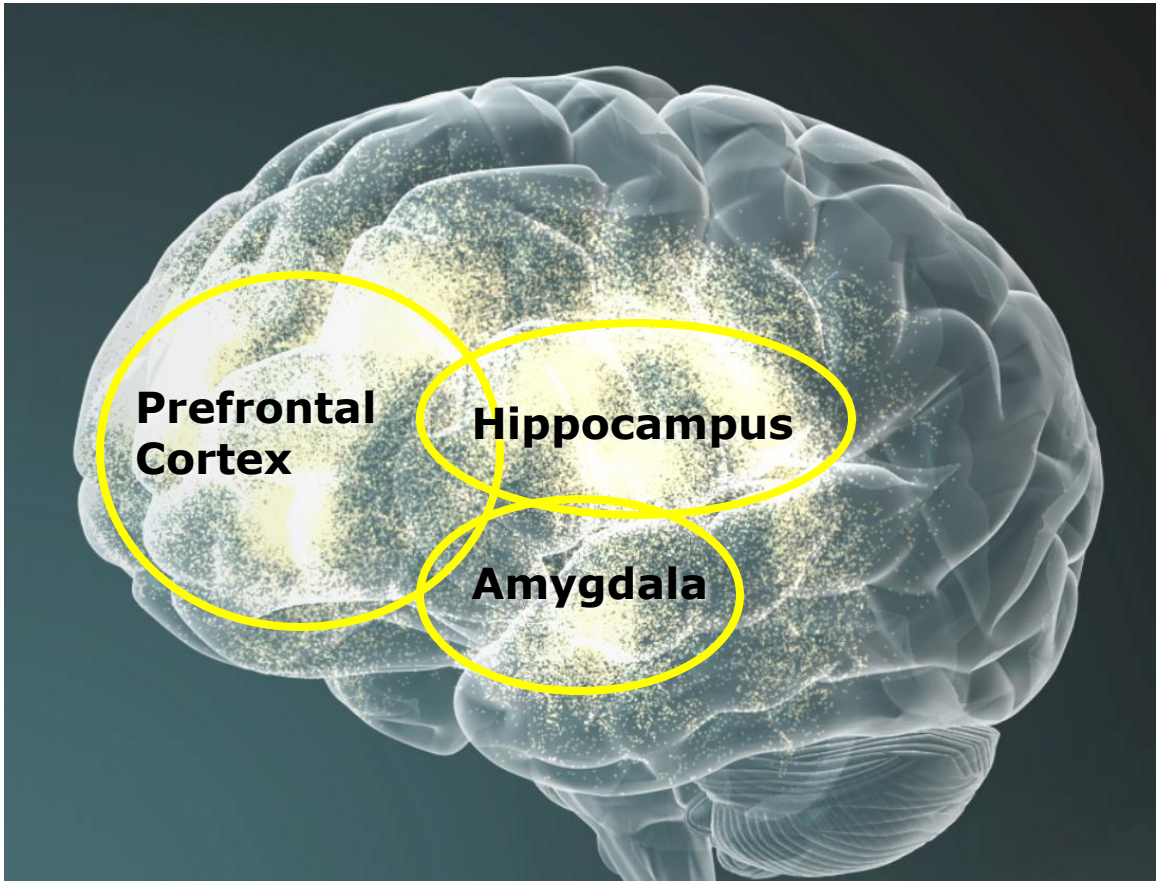
The Science of Learning

The Brain Architecture of Memory and Executive Function

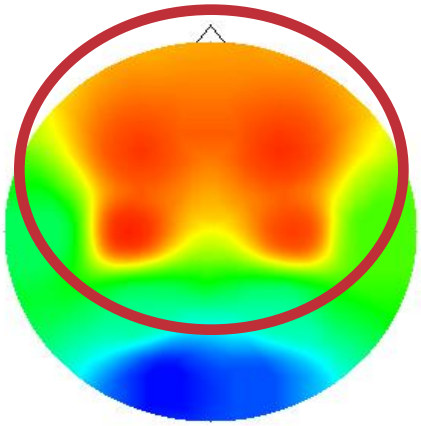


The Biology of Adversity

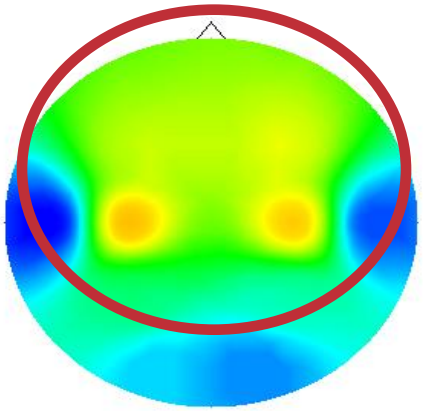
The Brain Architecture of Anxiety and Fear



Early Adversity Affects Brain Power



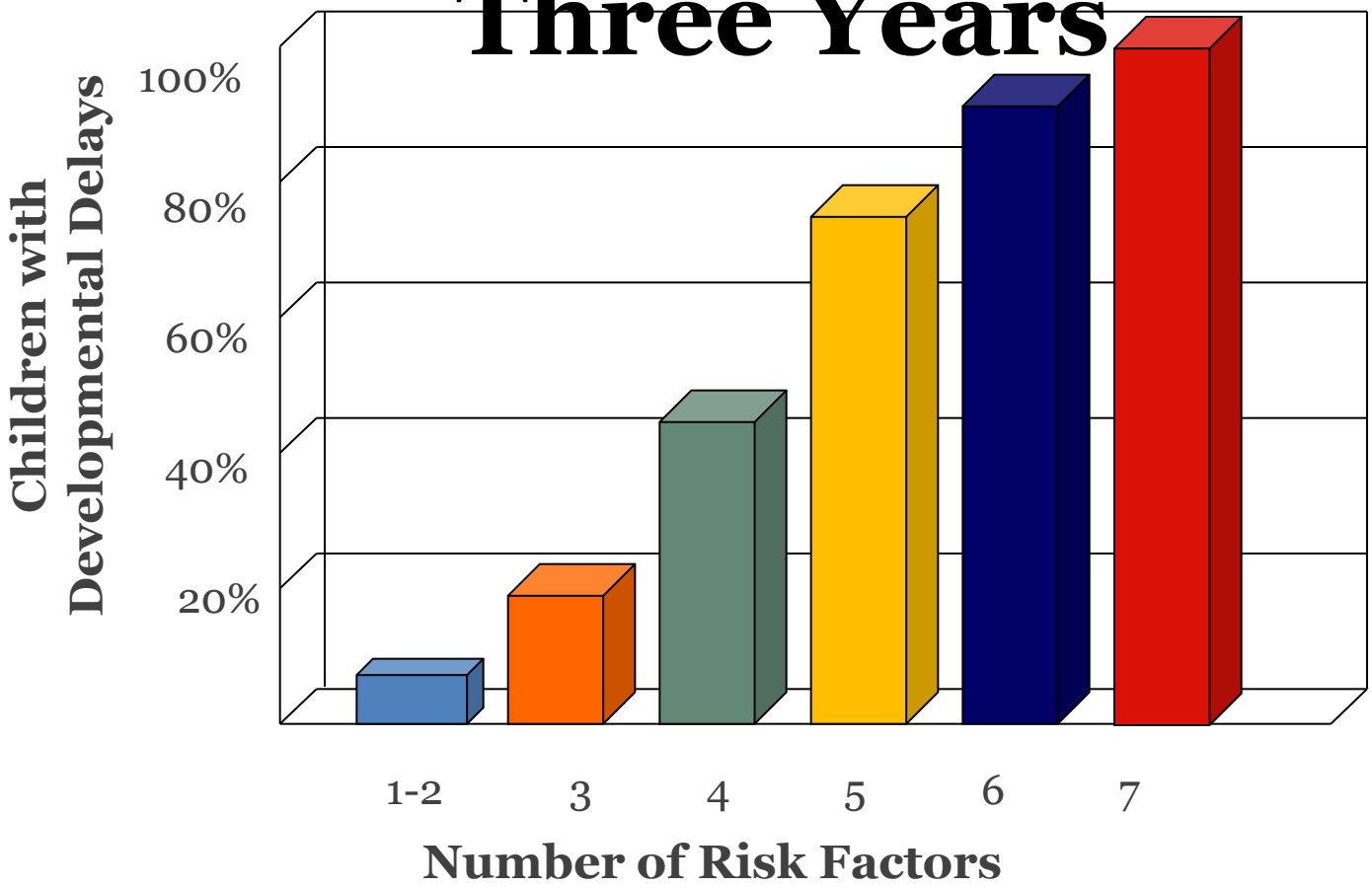
Positive Relationships



Extreme Neglect

Source: C.A. Nelson (2008); Marshall, Fox & BEIP (2004)

Significant Adversity Impairs Development in the First Three Years

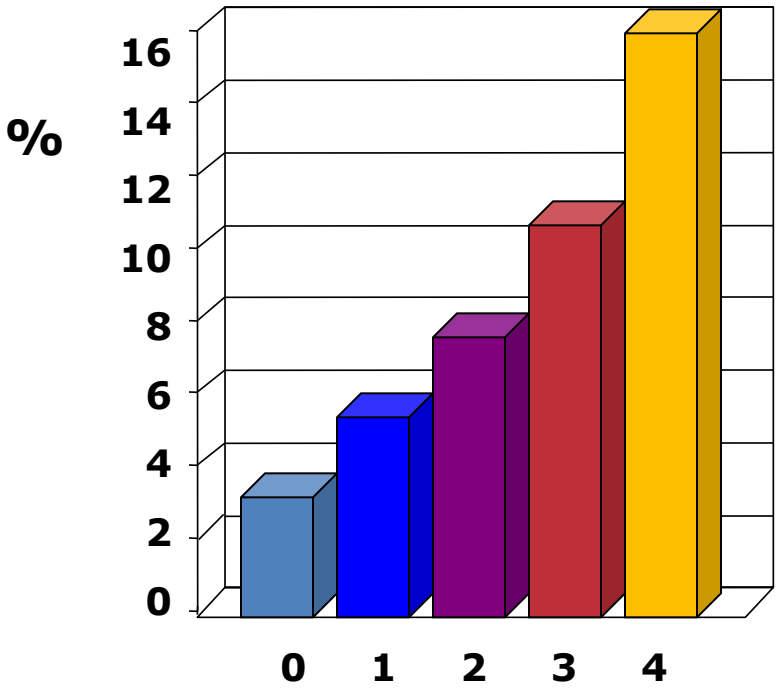


Data Source: Barth, et al. (2008)

Graph Courtesy: Center on the Developing Child at Harvard University

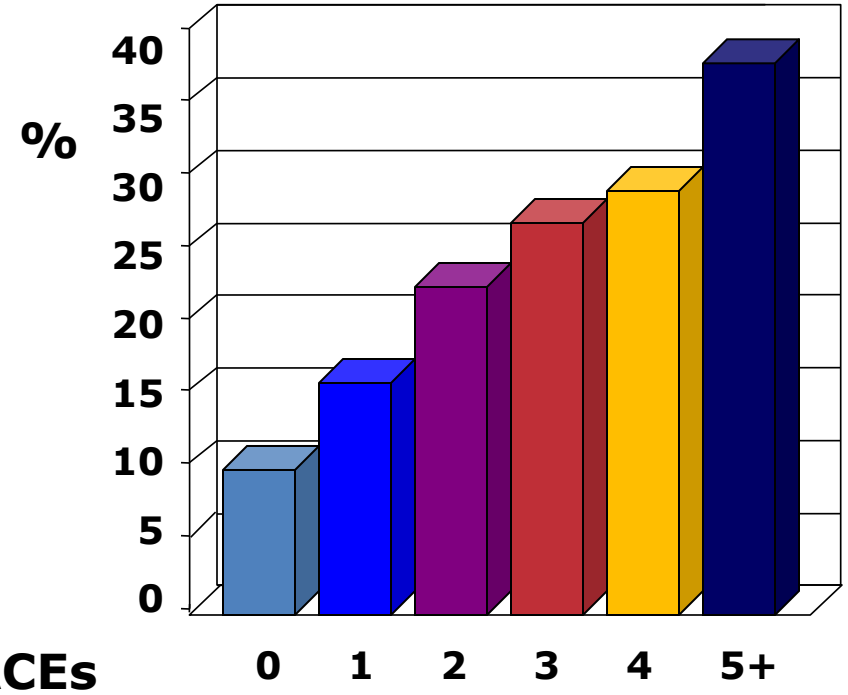
Risk Factors for Adult Substance Abuse are Embedded in Adverse Childhood Experiences

Self-Report: Alcoholism



Source: Dube et al, 2002

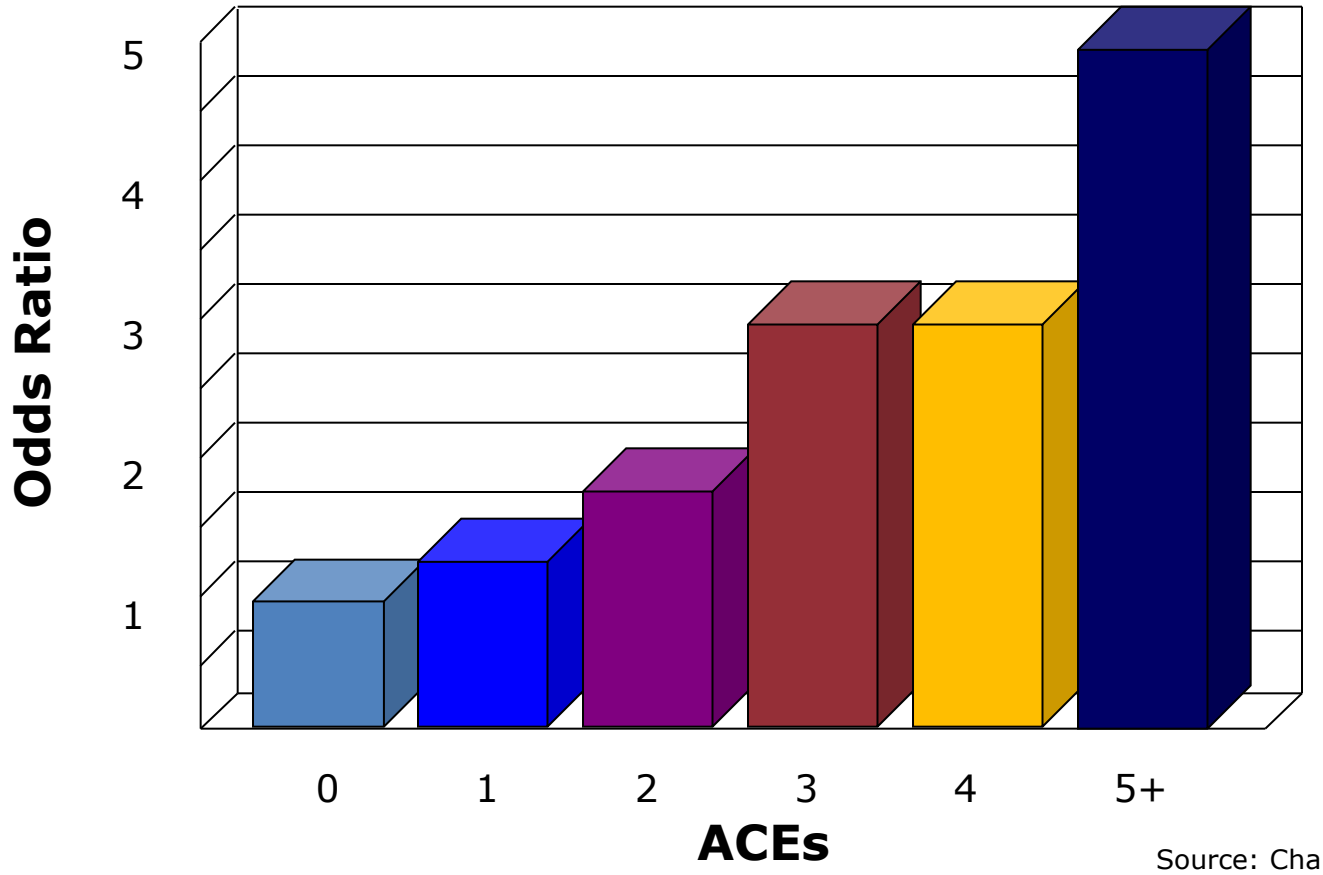
Self-Report: Illicit Drugs



ACEs

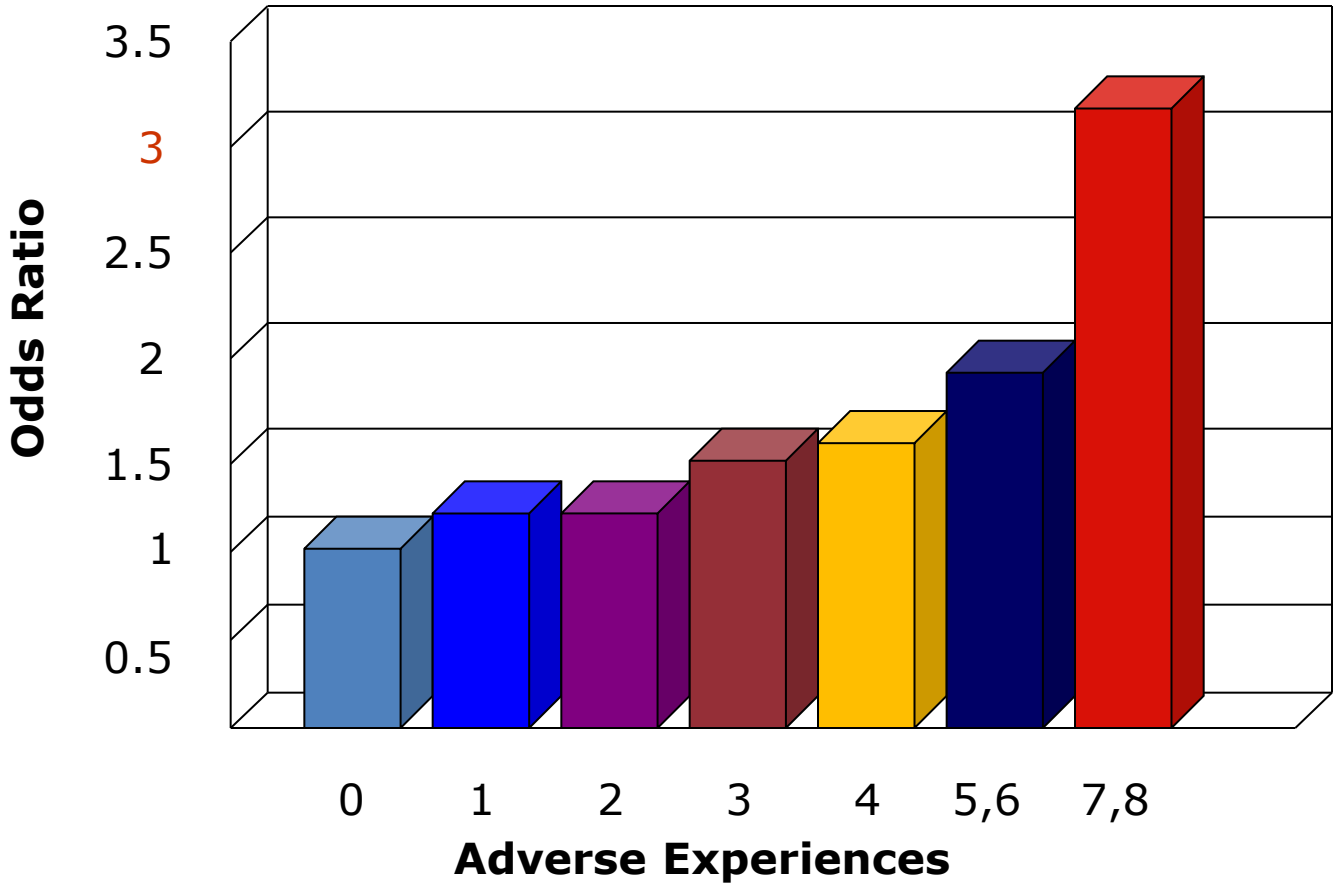
Source: Dube et al, 2005

Risk Factors for Adult Depression are Embedded in Adverse Childhood Experiences



Source: Chapman et al, 2004

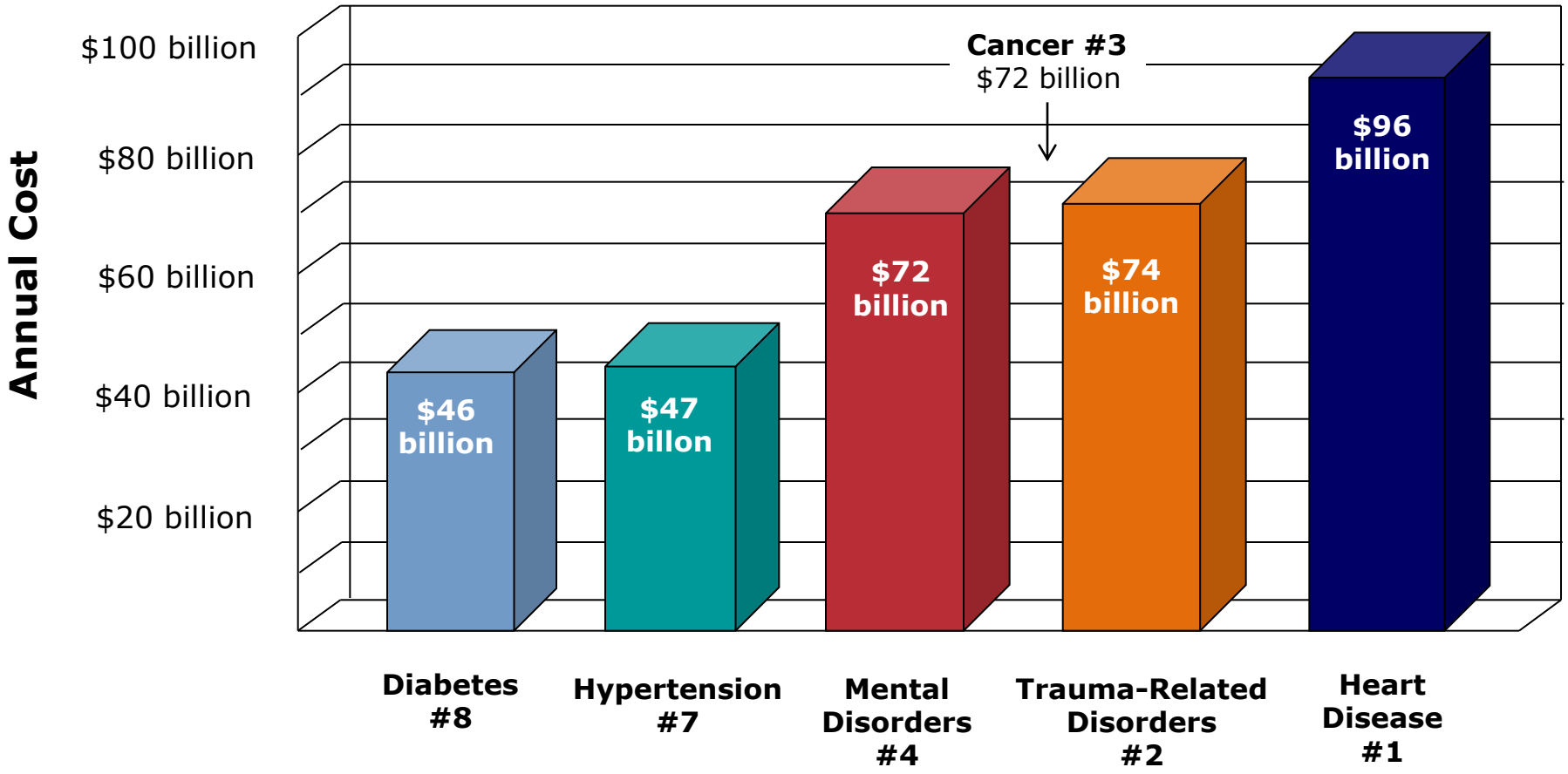
Risk Factors for Adult Heart Disease are Embedded in Adverse Childhood Experiences



Source: Dong, et al. (2004)

Chronic Diseases Associated With Childhood Adversity Dominate U.S. Health Care Costs

Five of Top Ten Diagnoses for Direct Health Expenditures = $335 billion



Source: Agency for Healthcare Research and Quality (2008)

Keys to Healthy Development

A balanced approach to emotional, social, cognitive, executive function skills, and language development, starting in the earliest years of life.

Supportive relationships and positive learning experiences that begin with parents but are strengthened by others outside the home.

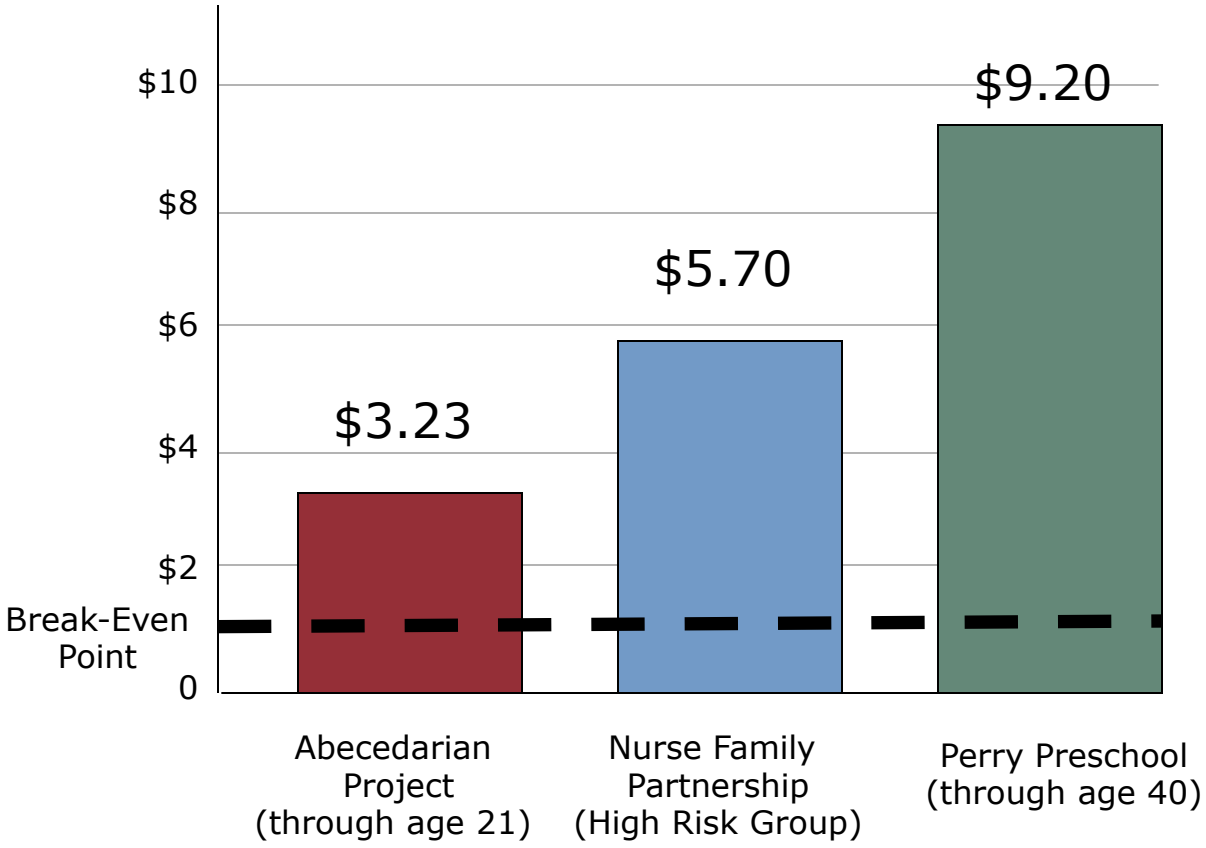
Highly specialized interventions as early as possible for children and families experiencing significant adversity.

For more on the science:

www.developingchild.harvard.edu

Cost/Benefit Analyses Show Positive Returns

Early Childhood Programs Demonstrate a Range of Benefits to Society



Total Return per $1 Invested

Sources: Karoly et al. (2005) Heckman et al. (2009)

Science-Policy Gap

Missed opportunities

- Early education policies that emphasize pre-academic instruction alone
- Expulsion of young children from early childhood programs because of unmanageable behavior
- Lack of services that directly address sources of toxic stress during the earliest years of life

Implications for Policy and Programs

- Efforts to support the development of EF skills deserve much greater attention
- Education professionals would be better equipped to understand and address behavioral and learning challenges with training and tools
- Parent/caregivers would benefit from greater access to tools and approaches to support EF
- Adding assessment of EF to the repertoire of evaluation tools will facilitate early identification and skill development

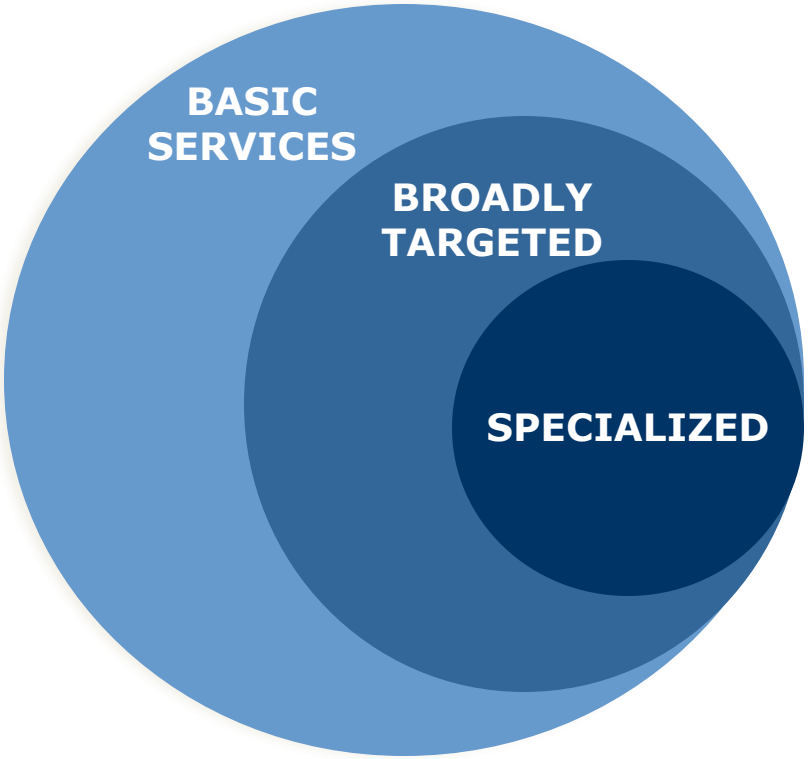
- **Work across disciplines**
- **Raise conceptual understanding of all stakeholders related to tenants of well-being**
- **Use a common language and lens**
- **Identify early and accurately the needs**
- **Intervene and manage with evidence based policy, practice and programs**

Science Points Toward 3 Types of Services to Ensure Healthy Development

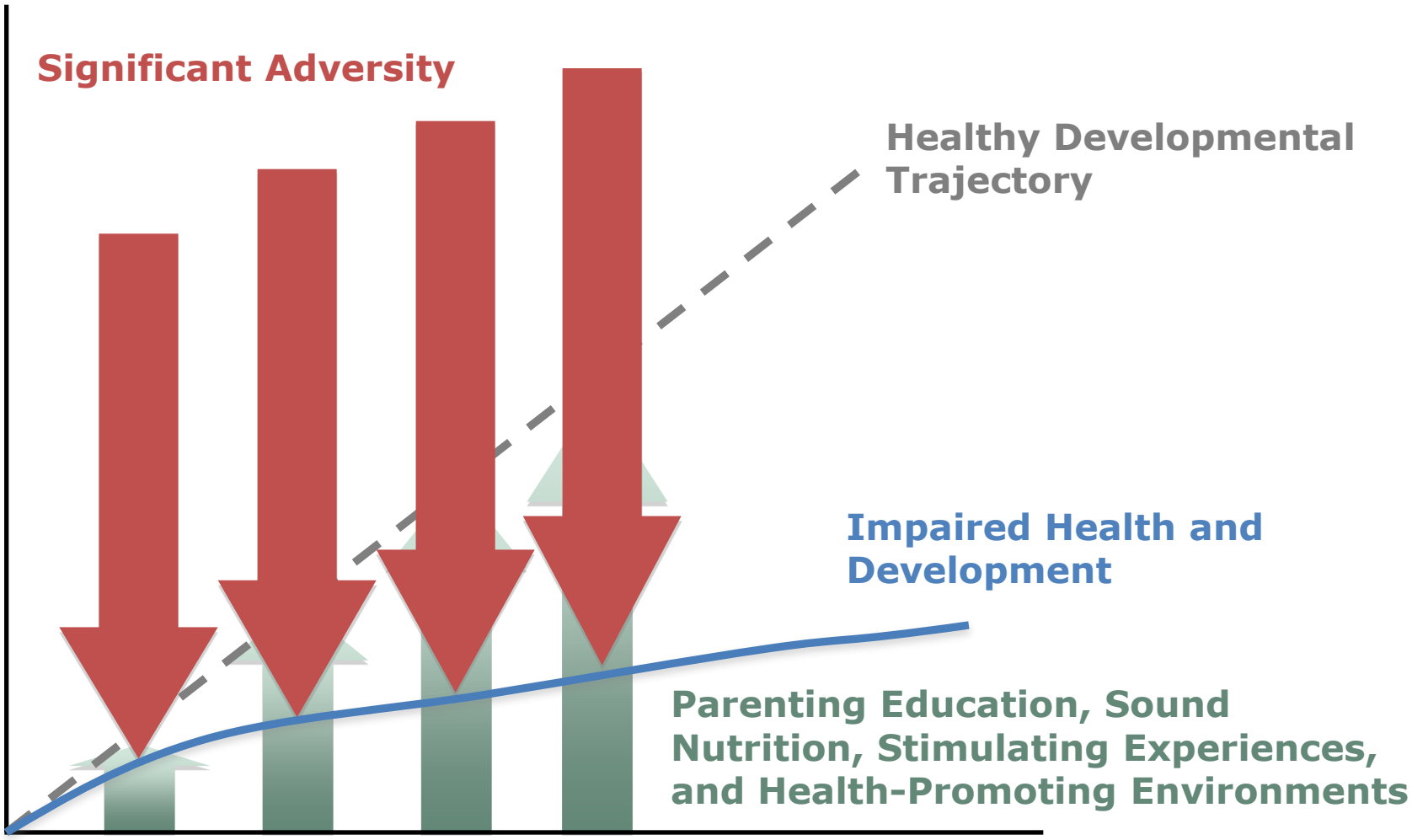
Basic health care, child care, and early learning services to help all children build and sustain strong bodies and brains.

Broadly targeted supports for children faced with major risk factors for poor development.

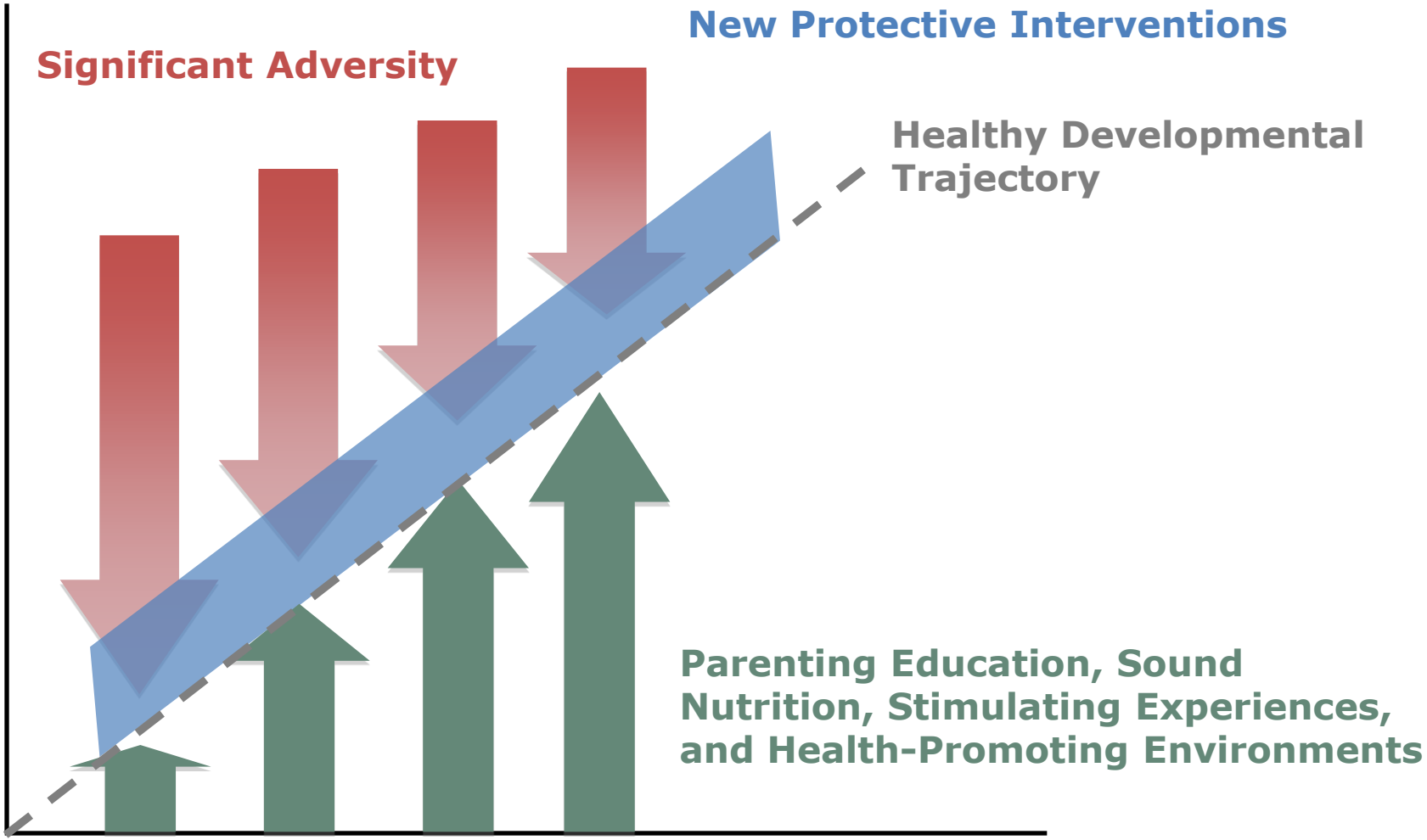
Specialized interventions for children and families with complex needs.



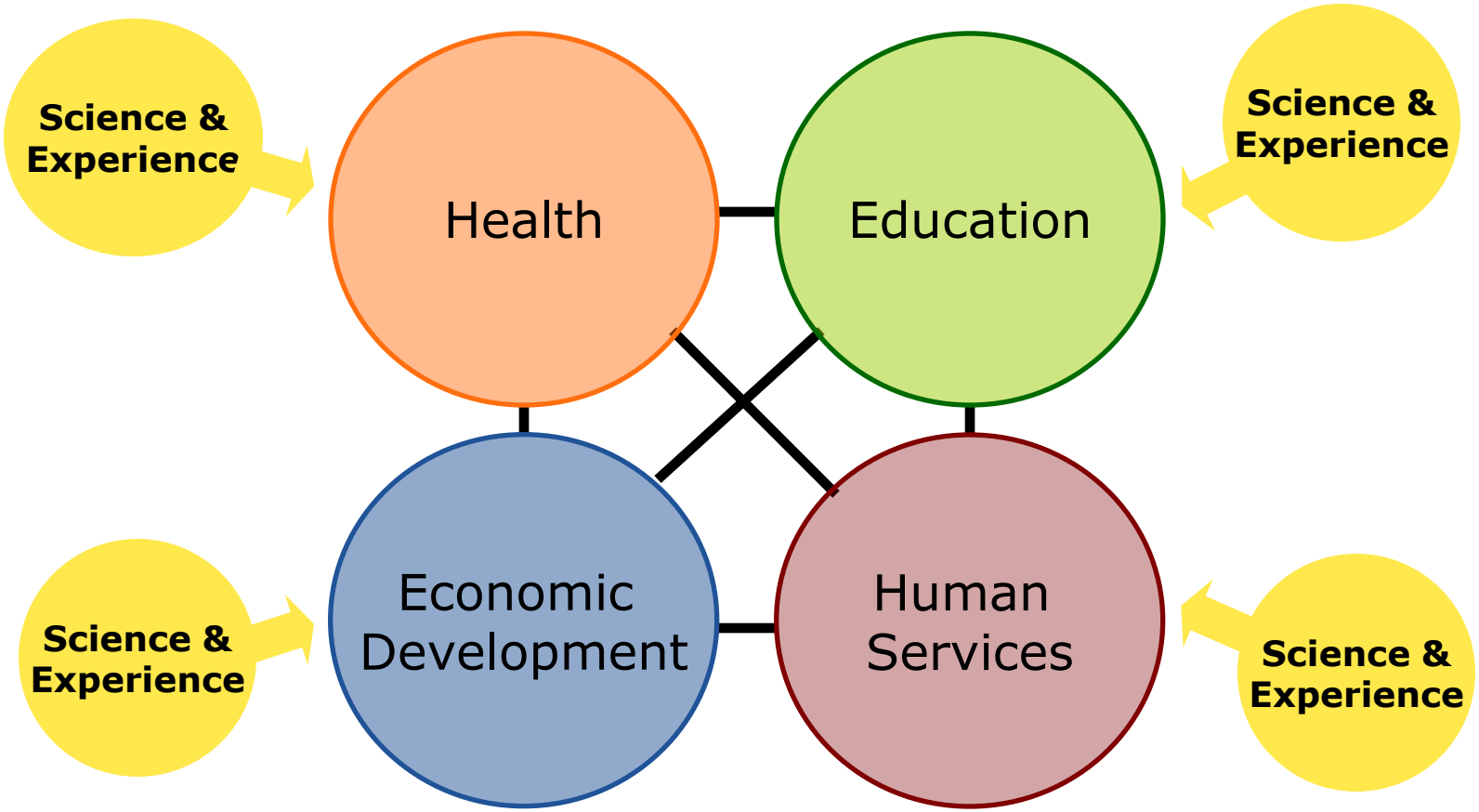
Current Conceptual Framework Guiding Early Childhood Policy and Practice



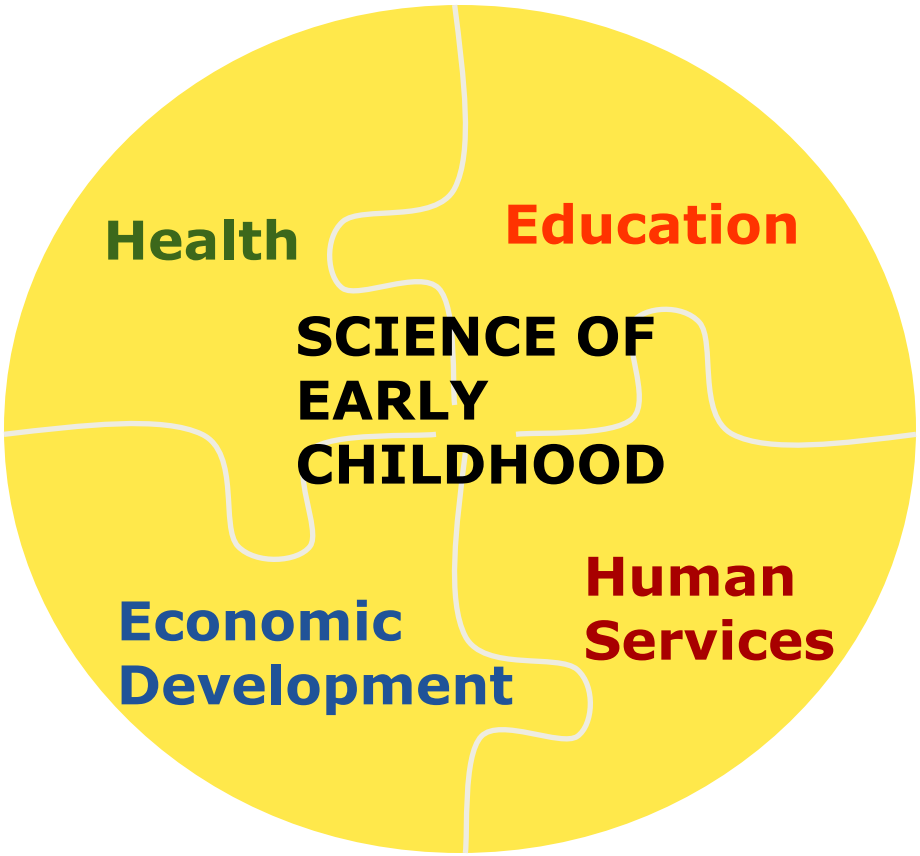
Building an Enhanced Theory of Change to Protect the Developing Brain



Multiple Sources of Knowledge Currently Inform Practice in Poorly Connected Sectors



An Integrated Science of Early Childhood Development Could Drive More Productive Investments Across Sectors



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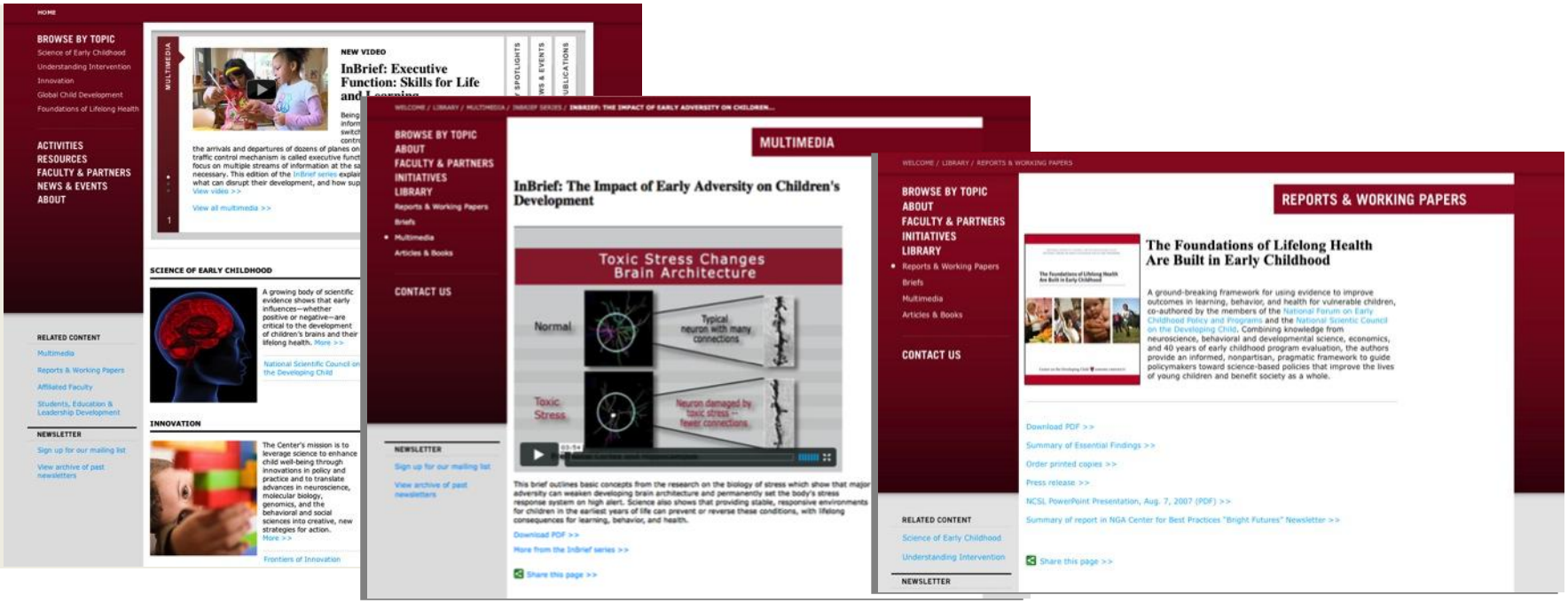

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Thank – You

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