"Toxic Stress and the Brain: the impact of trauma on the developing brain"

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McMaster University
Offord Centre for Child Studies
Council for Early Child Development


'All children deserve the right of full participation in community life'
—Dr. Dan Offord

The Wisdom of the Elders

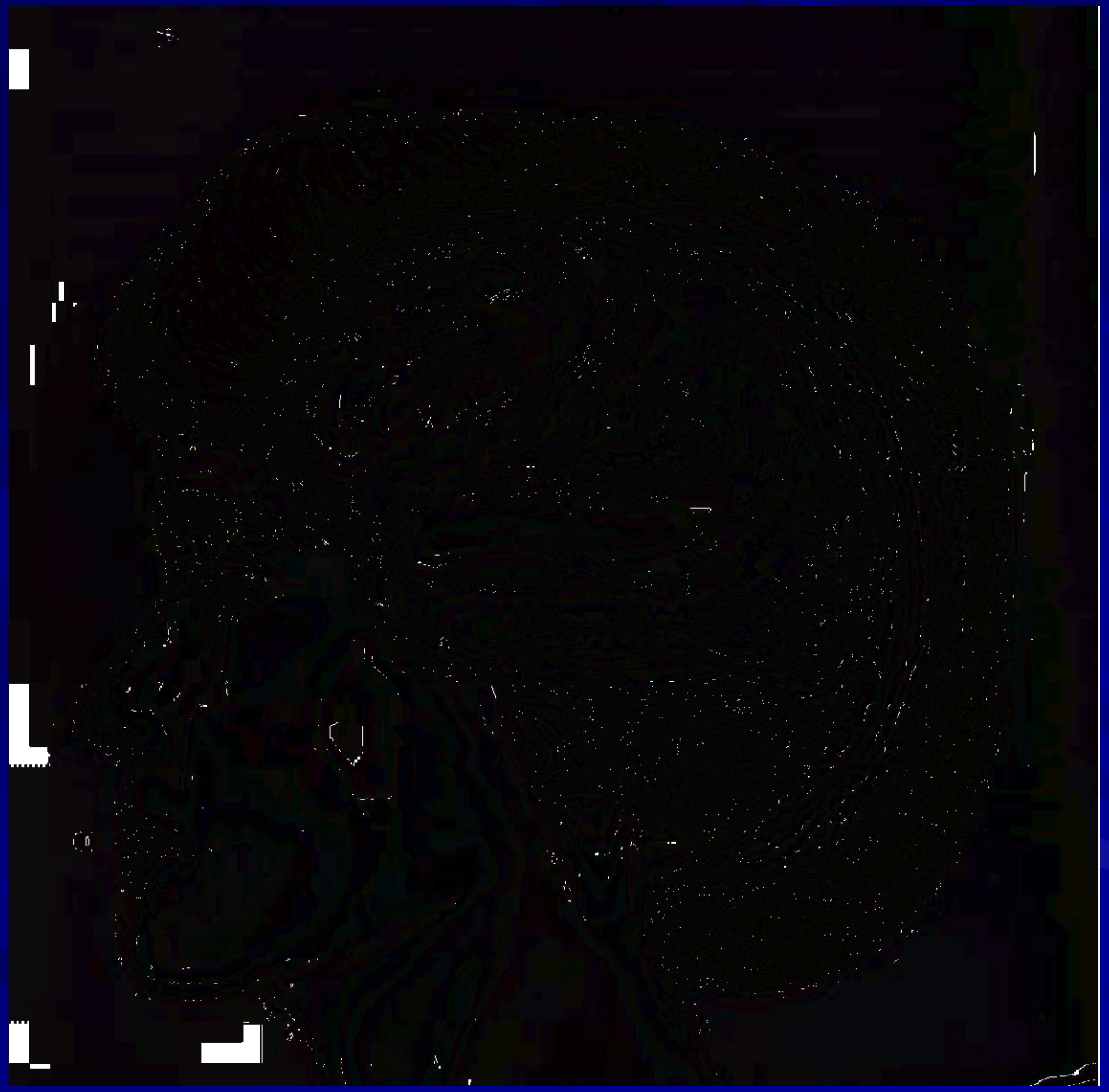
- Consider the interest of the next 7 generations when decisions are being made

Iroquois Nation

FNCFCSC

Time Magazine from the MEHRI Neuroscience lab

Watching the Brain Learn!!



The Hostage Brain , Bruce S. McEwen and Harold M. Schmeck, Jr., 1994.

The Brain Matters

- The human brain is the organ responsible for everything we do. It allows us to laugh, walk, love, talk.
- For each of us, our brain is a reflection of our experiences.
- The brain is an environmental organ. It reflects our environment.

Adapted from Bruce Perry

Why do we care about brain?

You are your brain.

BUT
Your brain is not just produced by your genes.

Your brain is sculpted by a lifetime of experiences . The most important time in brain development is the first few years of life.

Genes: Environment?

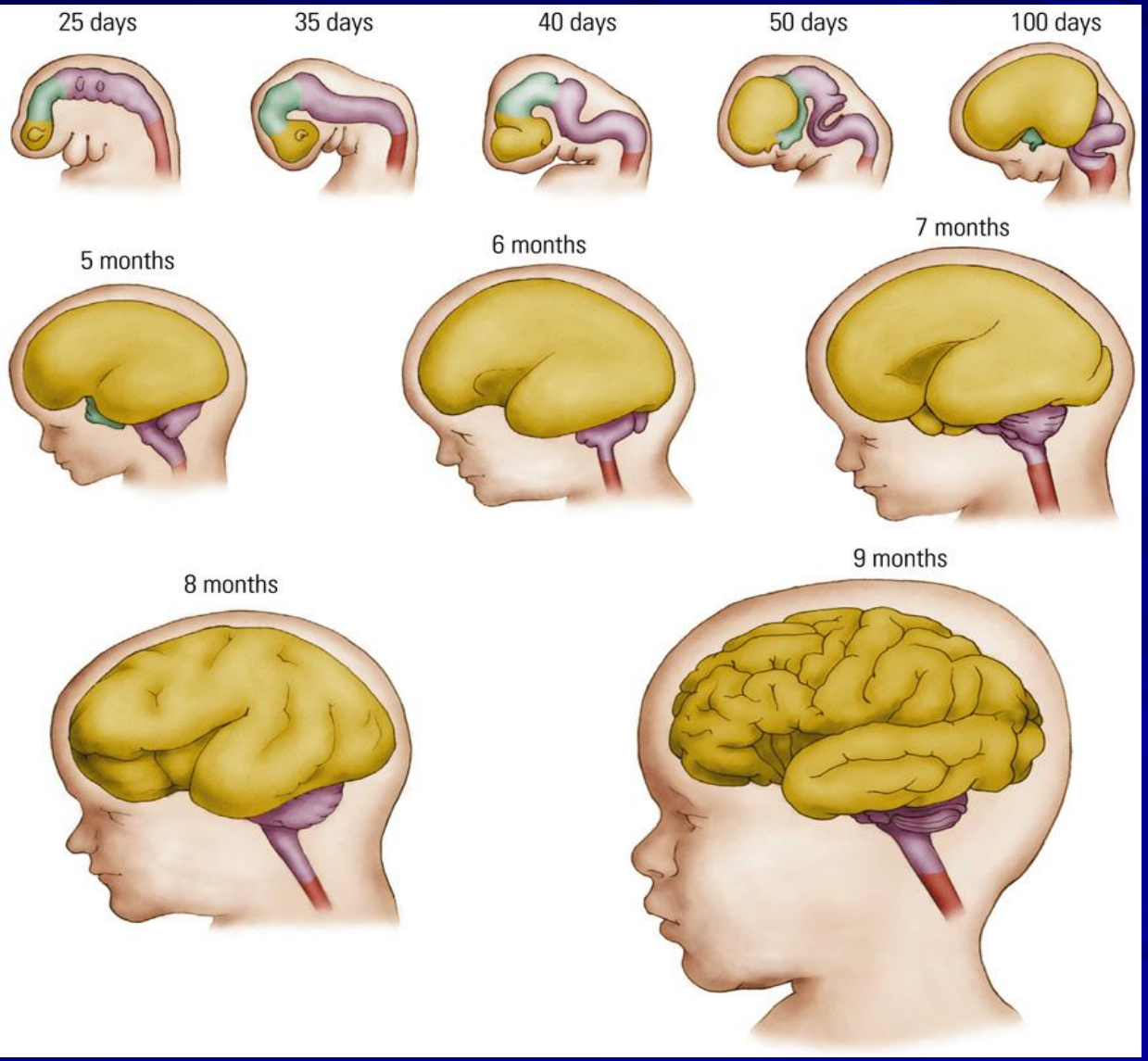
- Scientists used to say that intelligence was 80% genetic and 20% environmental.
- Now we tend to say that it's 20% genetic and 80% environmental"

Martin Westwell Flinders University

OR

Genes provide the hardware but it is early experience that is the software that drives the system

Brain Growth



Brain Plasticity

Massive growth
In first three years
But, not
done until
at least ….
Age 24+ years…
(Later in Males)

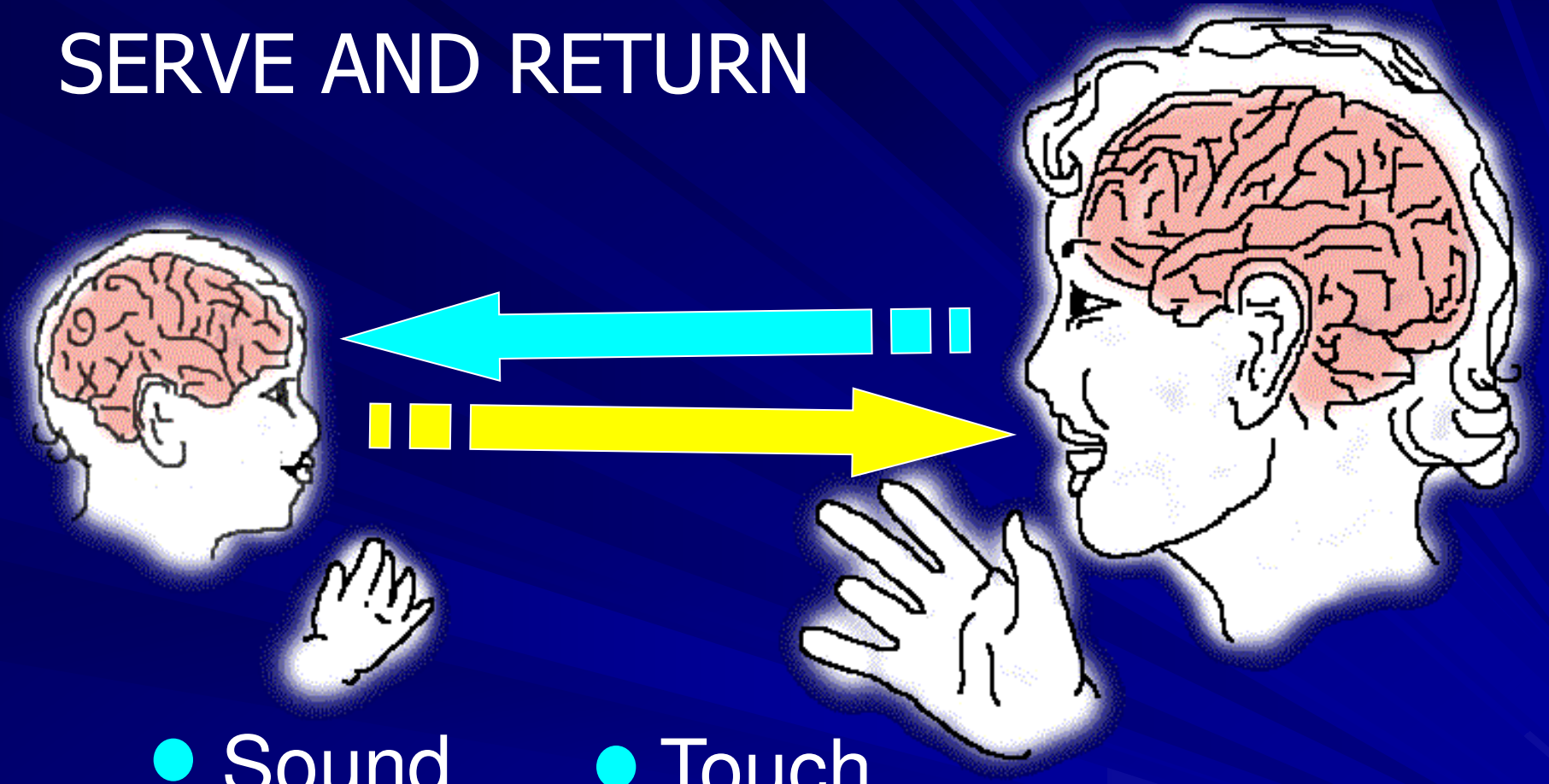
Dr R Gibb UofLethbridge

The early years of life matter

- because early experiences affect the architecture of the maturing brain.

- As it emerges, the quality of that architecture establishes either a sturdy or a fragile foundation for all of the development and behavior that follows --- and getting things right the first time is easier than trying to fix them later.

SERVE AND RETURN



- Sound
- Vision
- Smell
- Touch
- Proprioception
- Taste

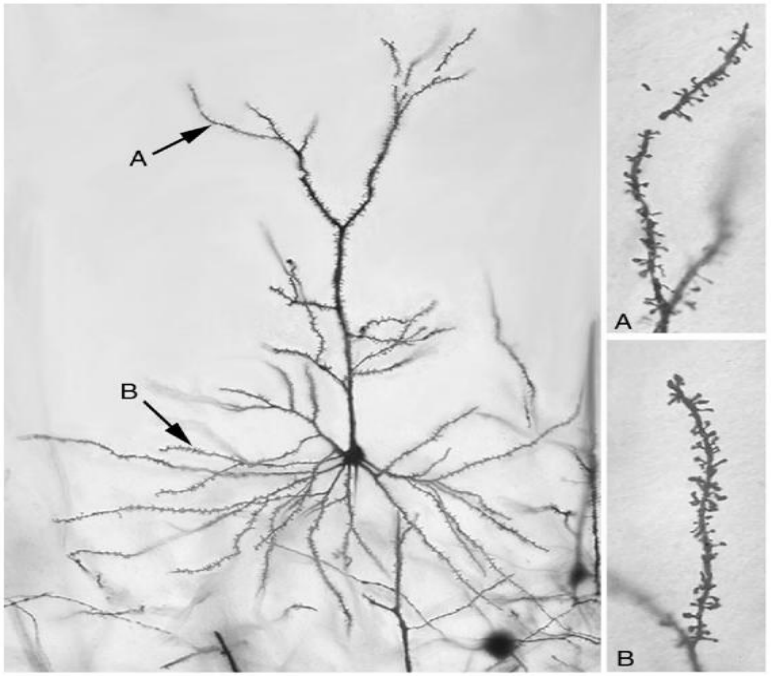
Neal Halfon
From Aitken and Trevarthen

Brains and Skills are Shaped by the "Serve and Return" Nature of Human Interaction

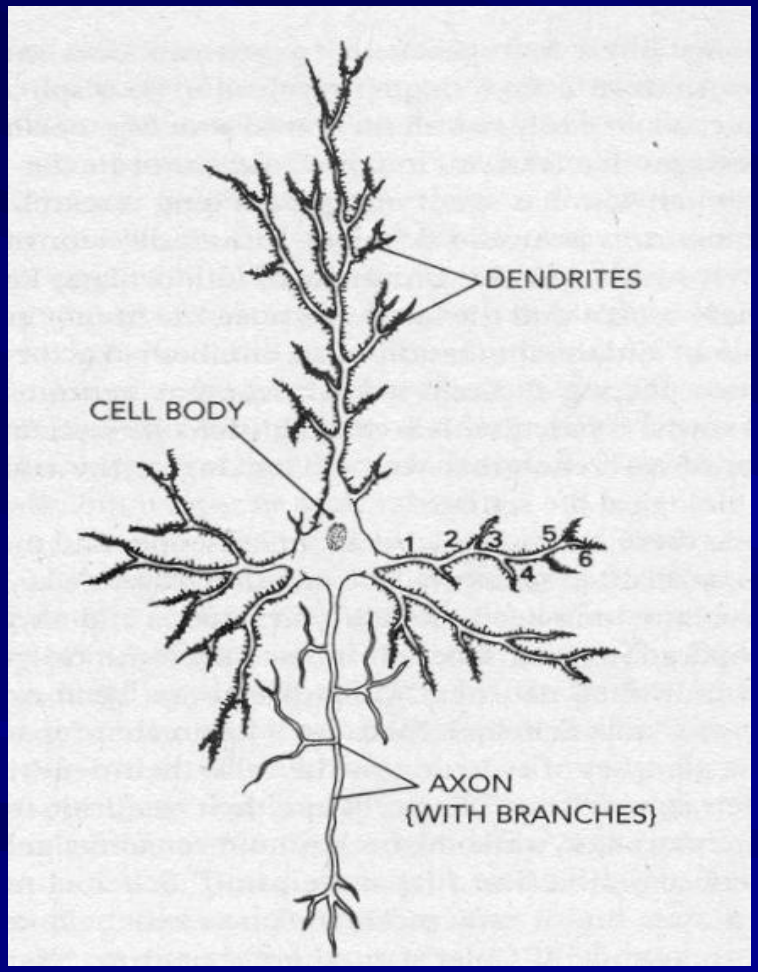
Experience Shapes Brain Architecture by Over-Production Followed by Pruning

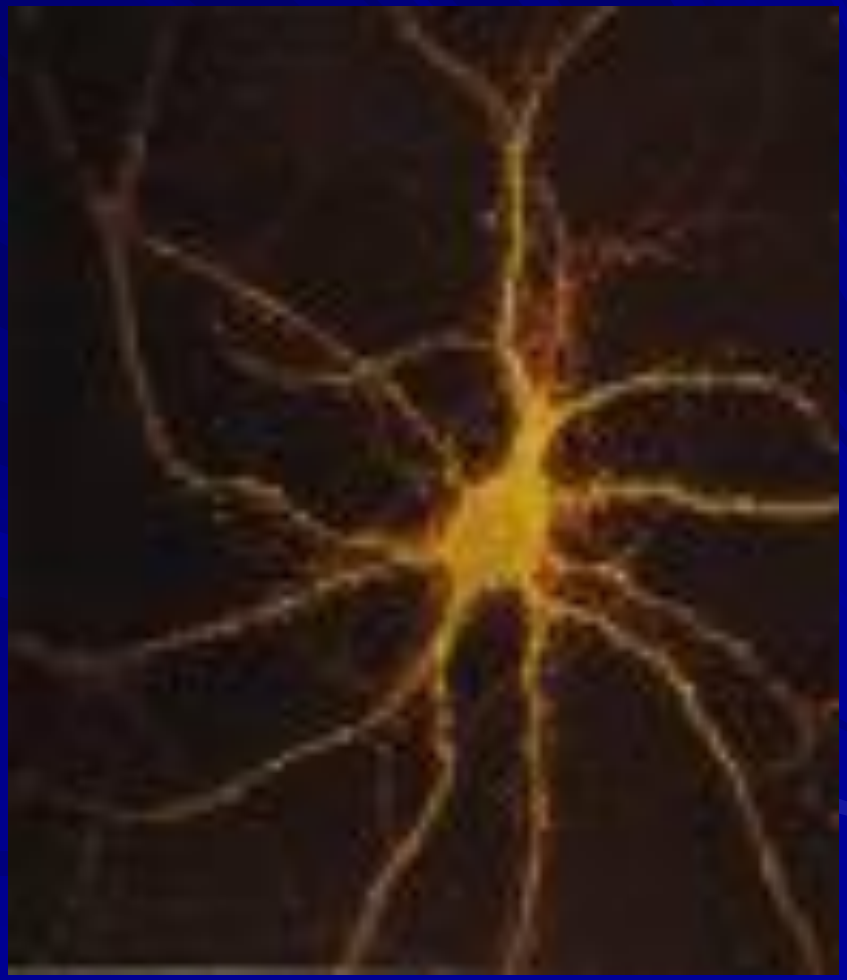
(700 synapses formed per second in the early years)

birth

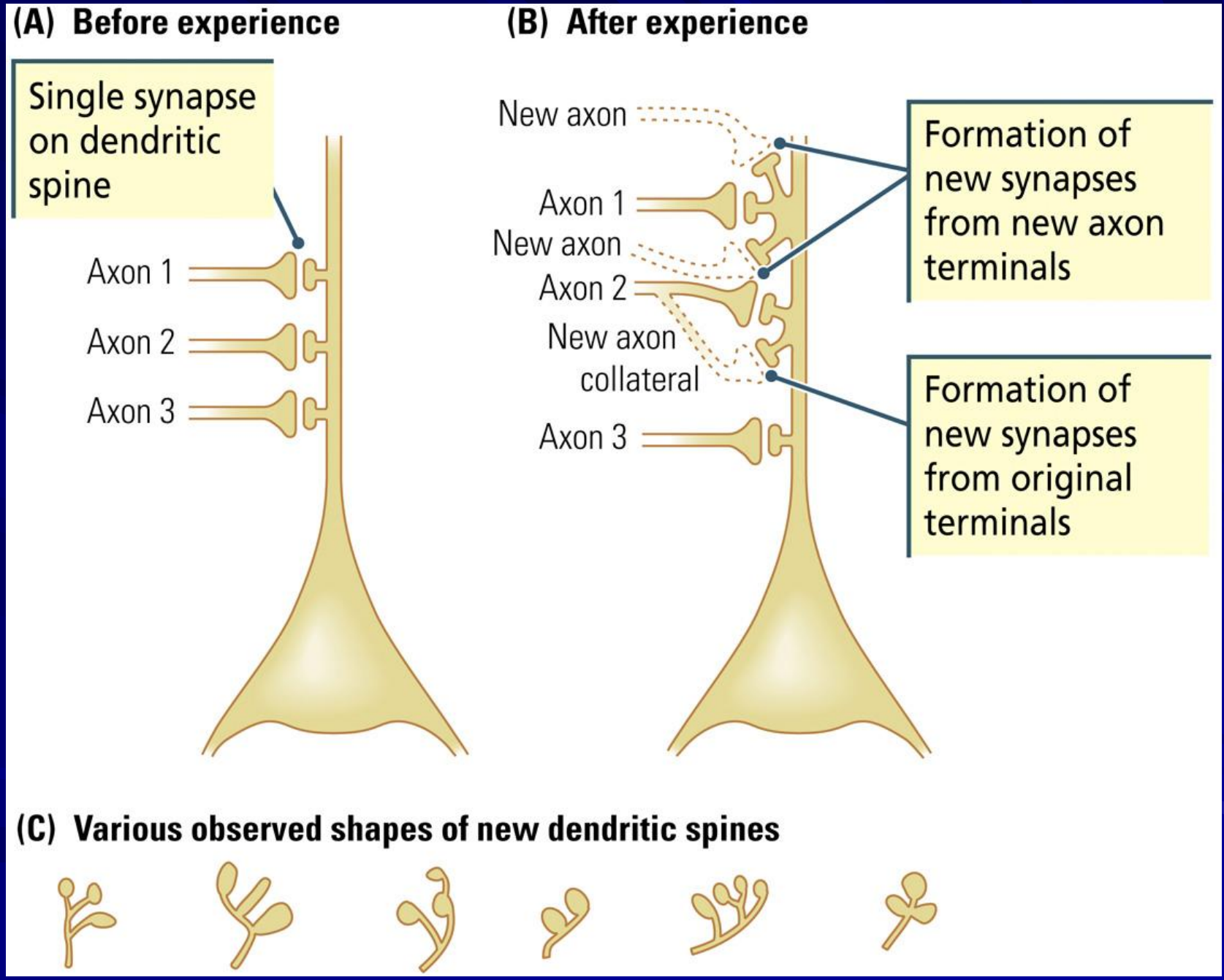


"The nerve cell, or neuron resembles a miniature tree…" (p. 21)



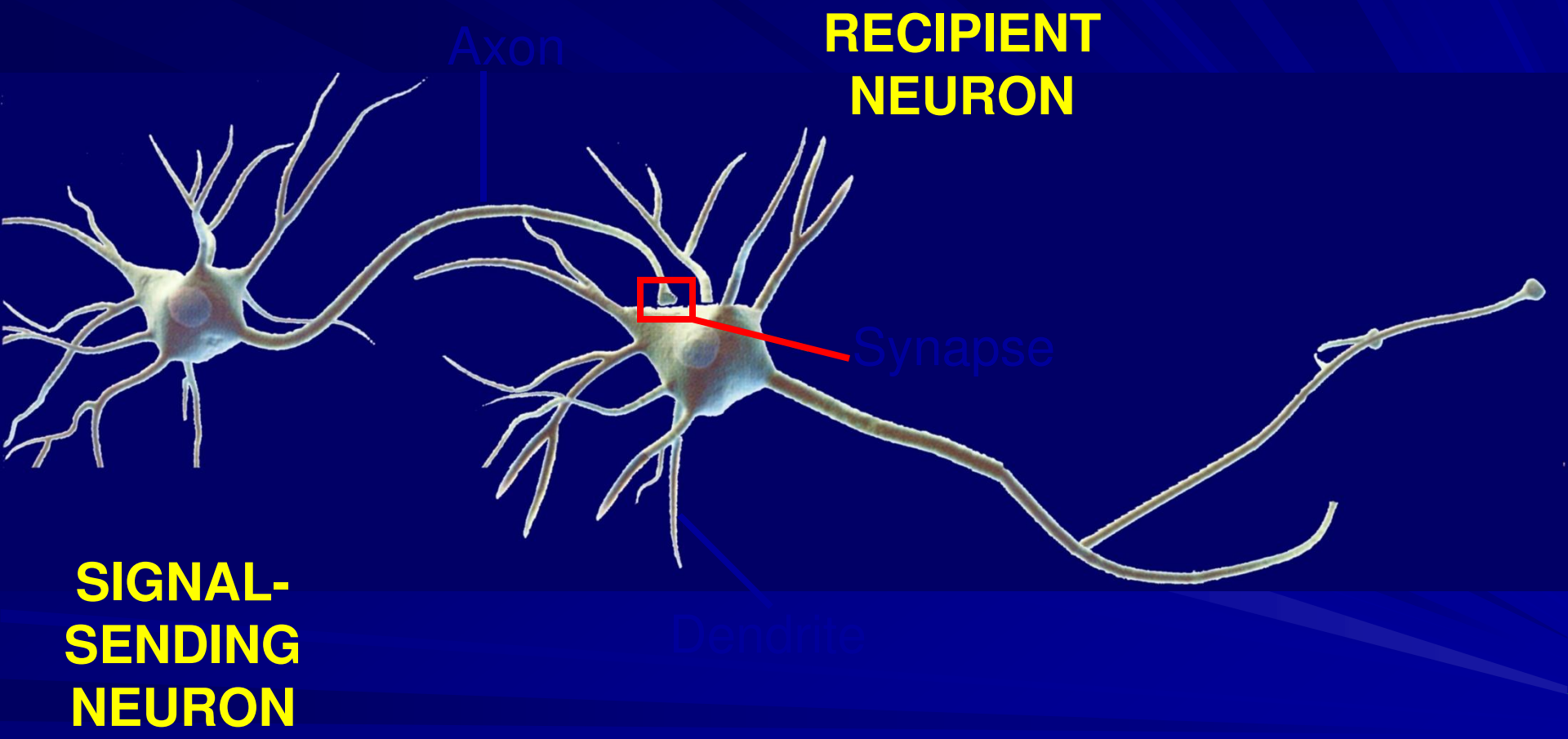


Diamond & Hopson, 1998

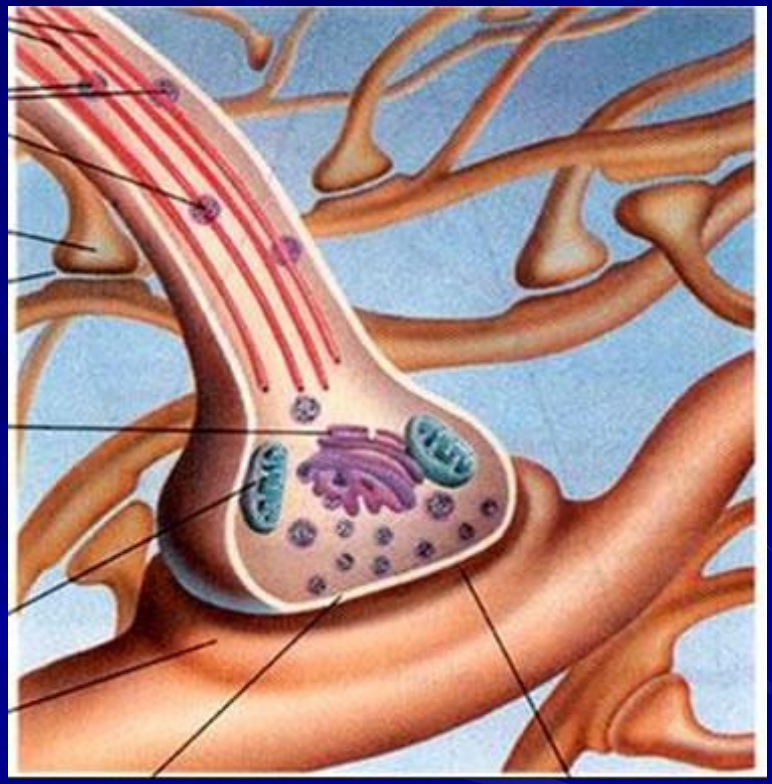


Dr Robin Gibb U of Lethbridge

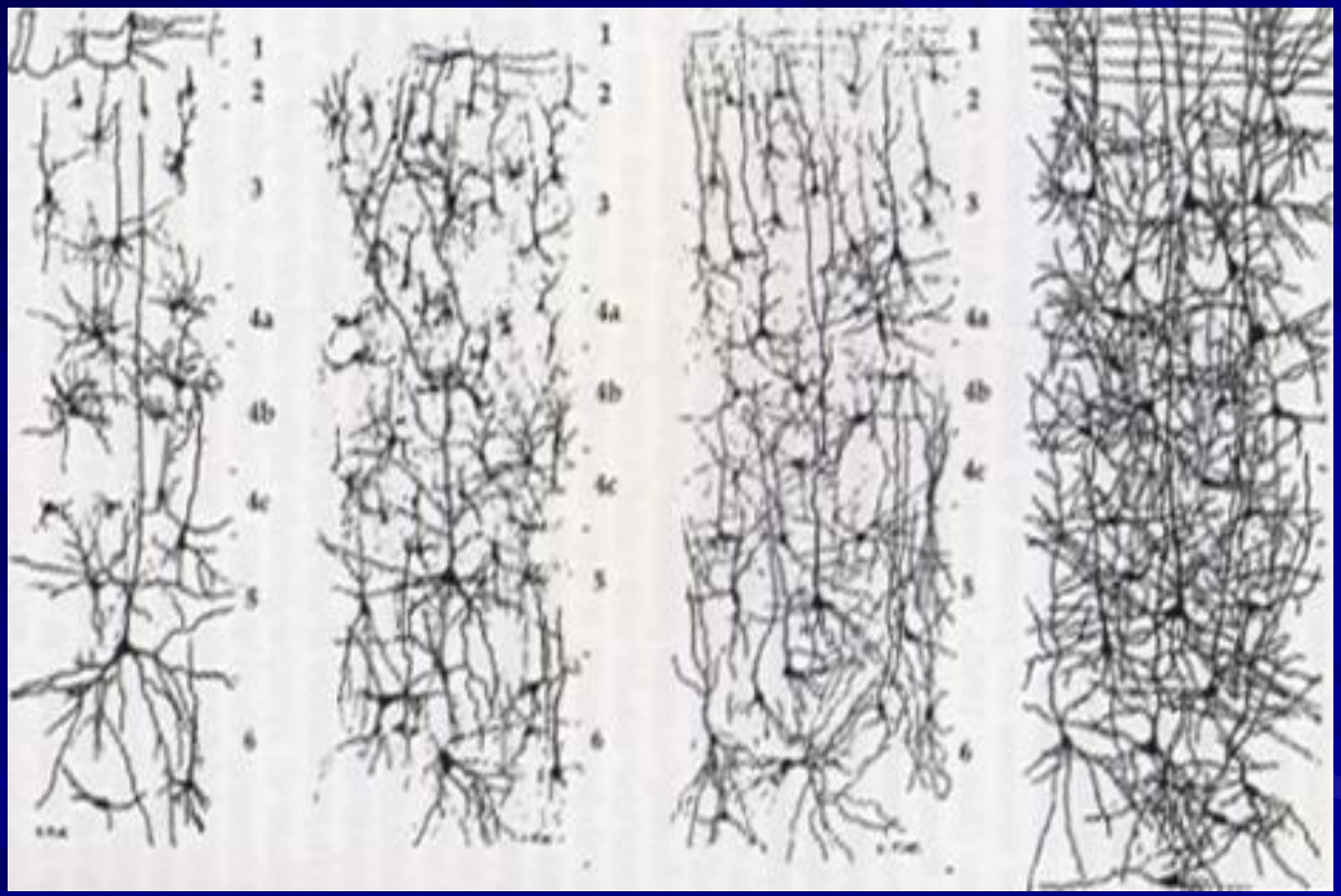
Two Neurons


Axon
RECIPIENT NEURON
Synapse
SIGNAL-SENDING NEURON
Dendrite

SYNAPSE



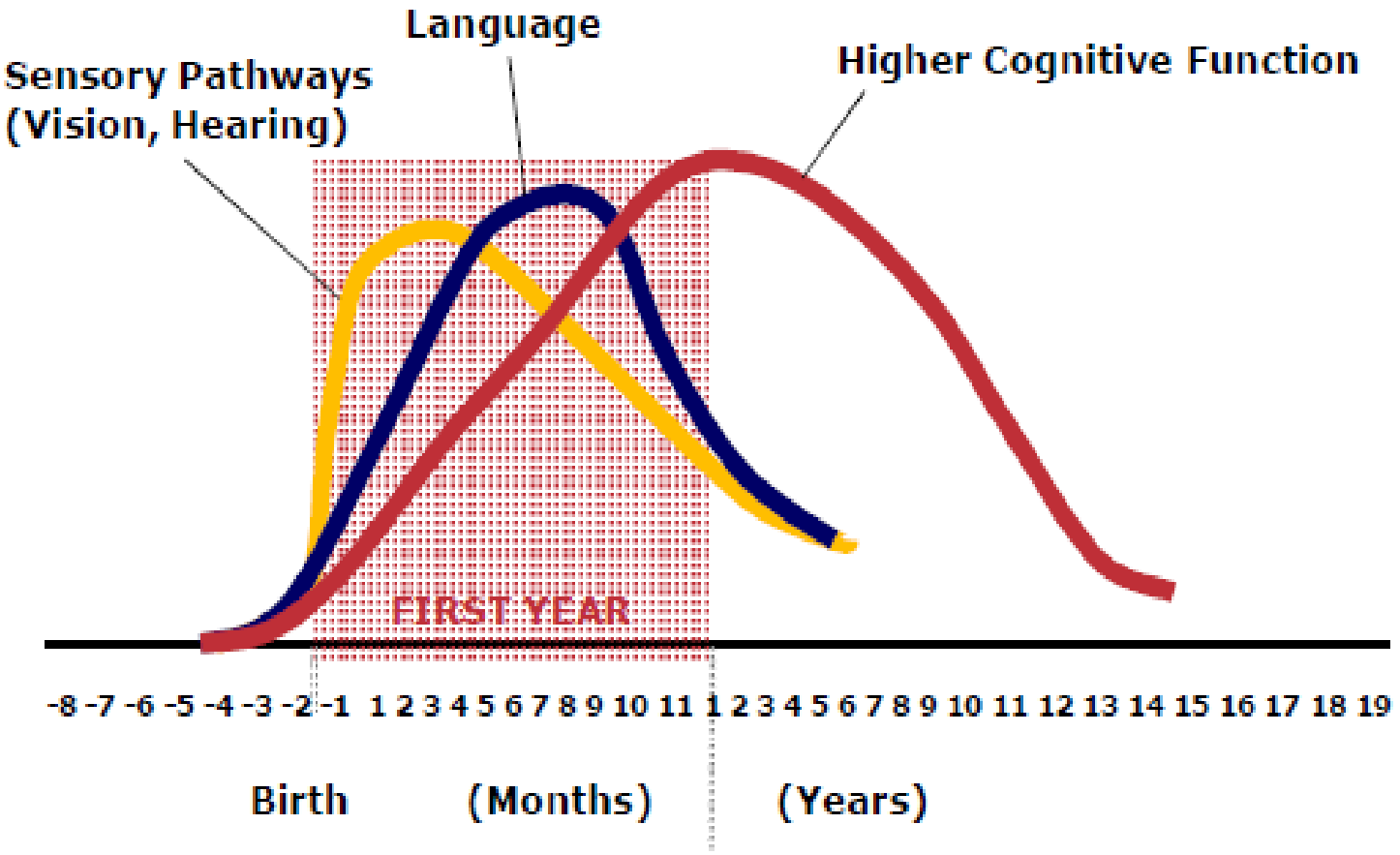
Brain Growth in the Early Months



newborn 1 month 3 months 6 months

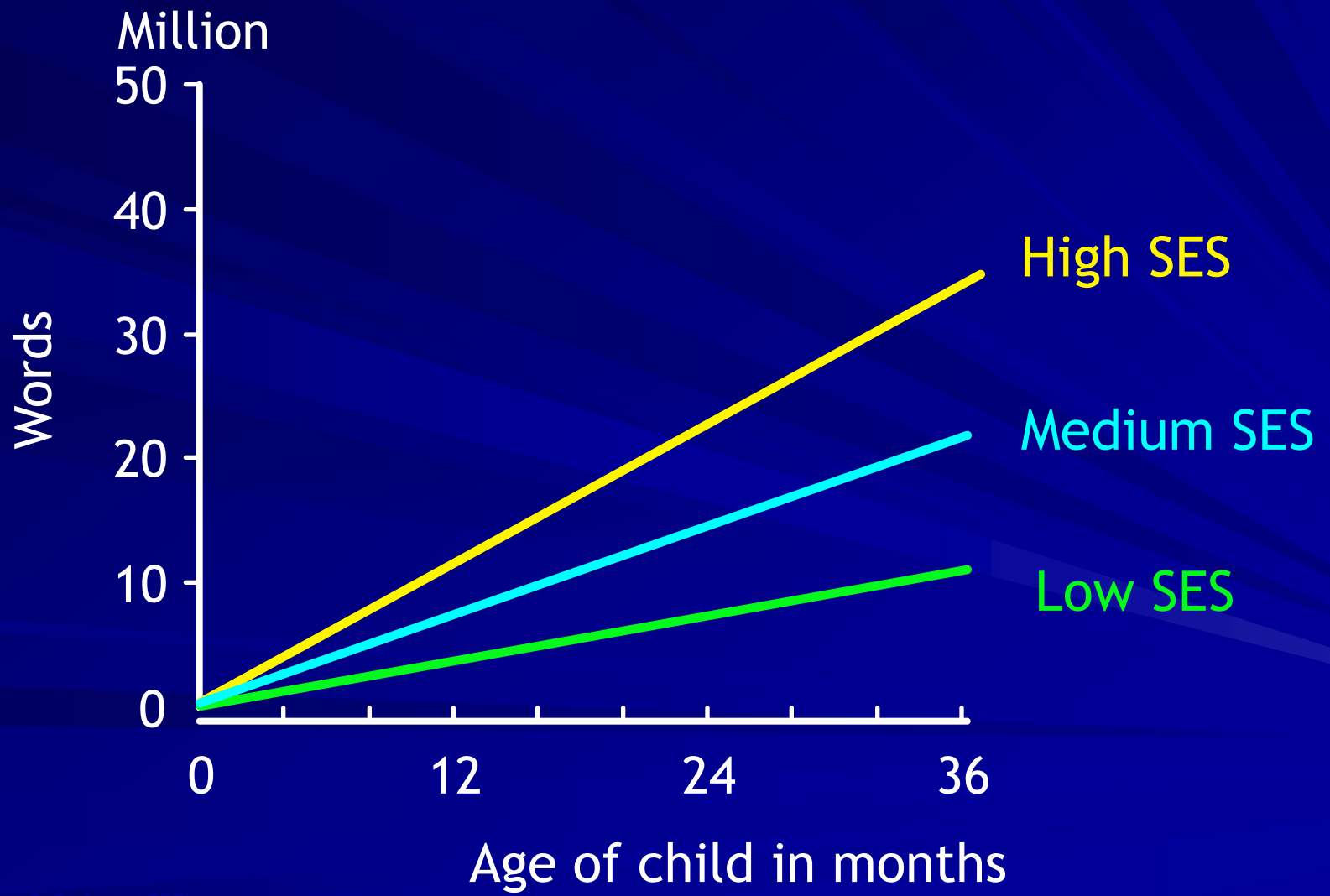
ZERO TO THREE® POLICY CENTER

Neural Circuits are Wired in a Bottom-Up Sequence



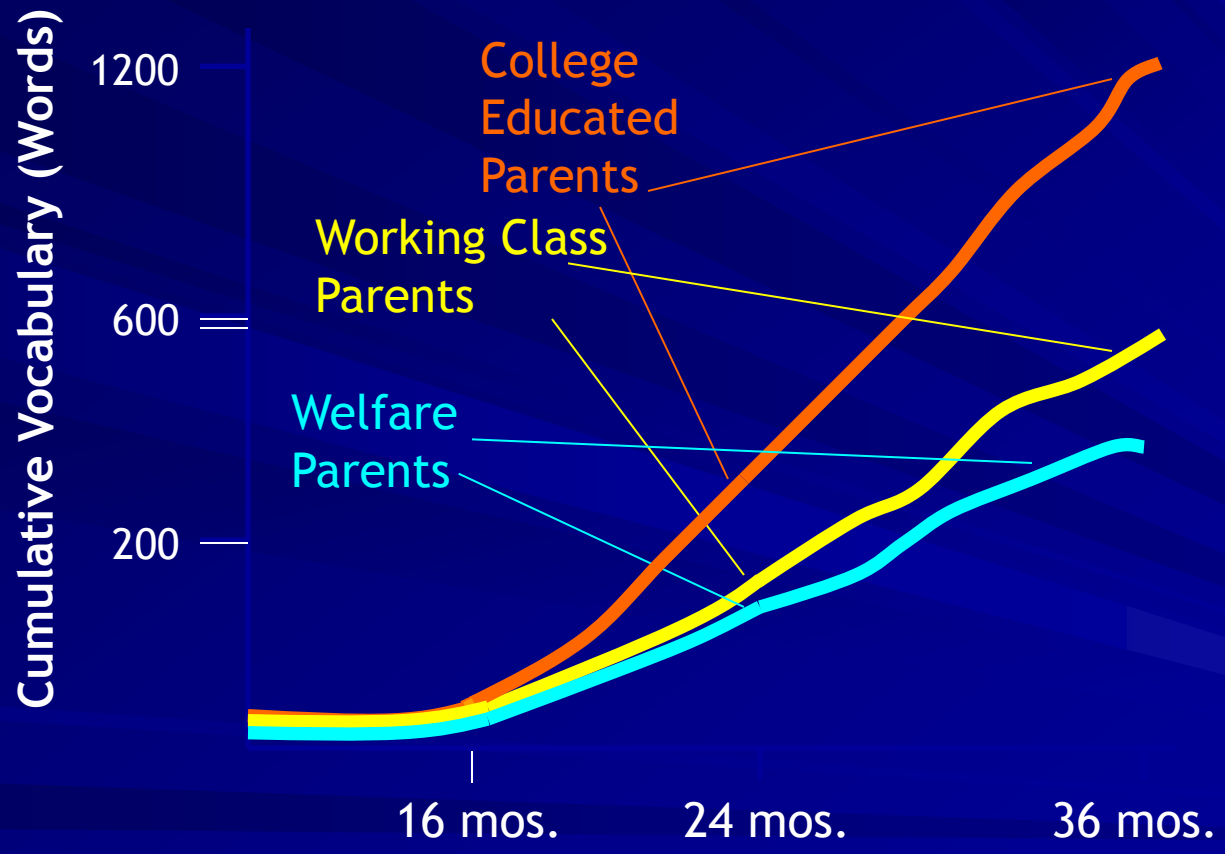
Source: C.A. Nelson (2000)

Estimated Cumulative Difference in Language Exposure by 3 Years of Age



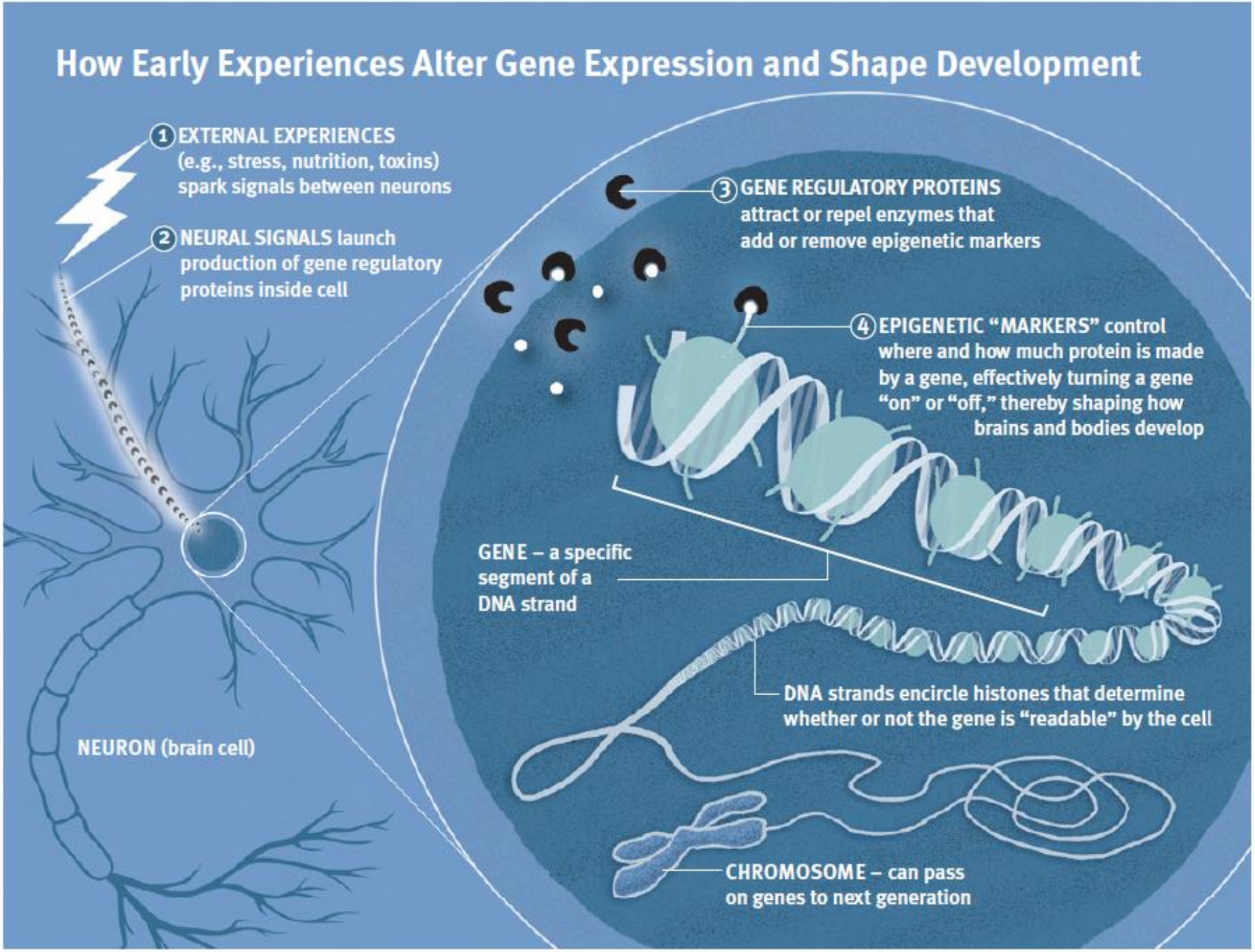
Source: Hart & Risley (1995)

Disparities in Early Vocabulary Growth



Source: Hart & Risley (1995) Slide by The National Center for Early Development & Learning

How Early Experiences Alter Gene Expression and Shape Development



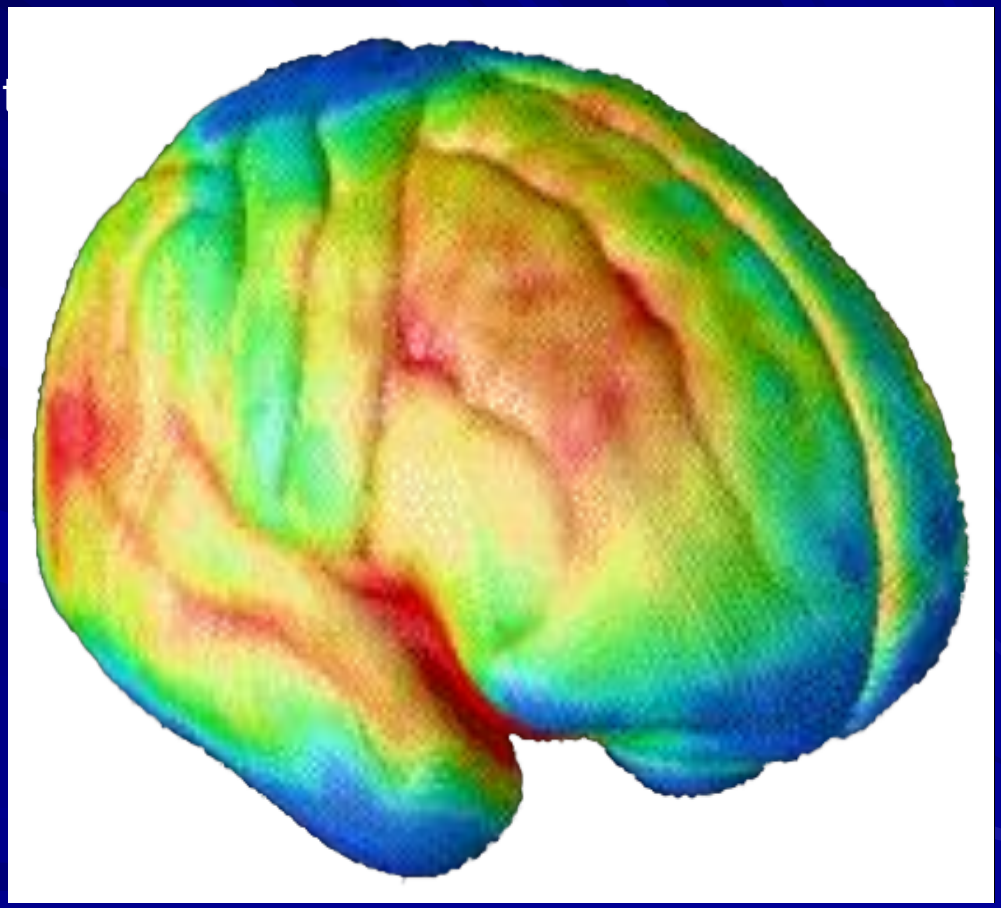
Brain Development

Mentor
Prevention • Opportunity • Protection
www.mentorfoundation.org

Maturation Occurs from Back to Front of the Brain

Images of Brain Development in Healthy Youth (Ages 5 – 20)

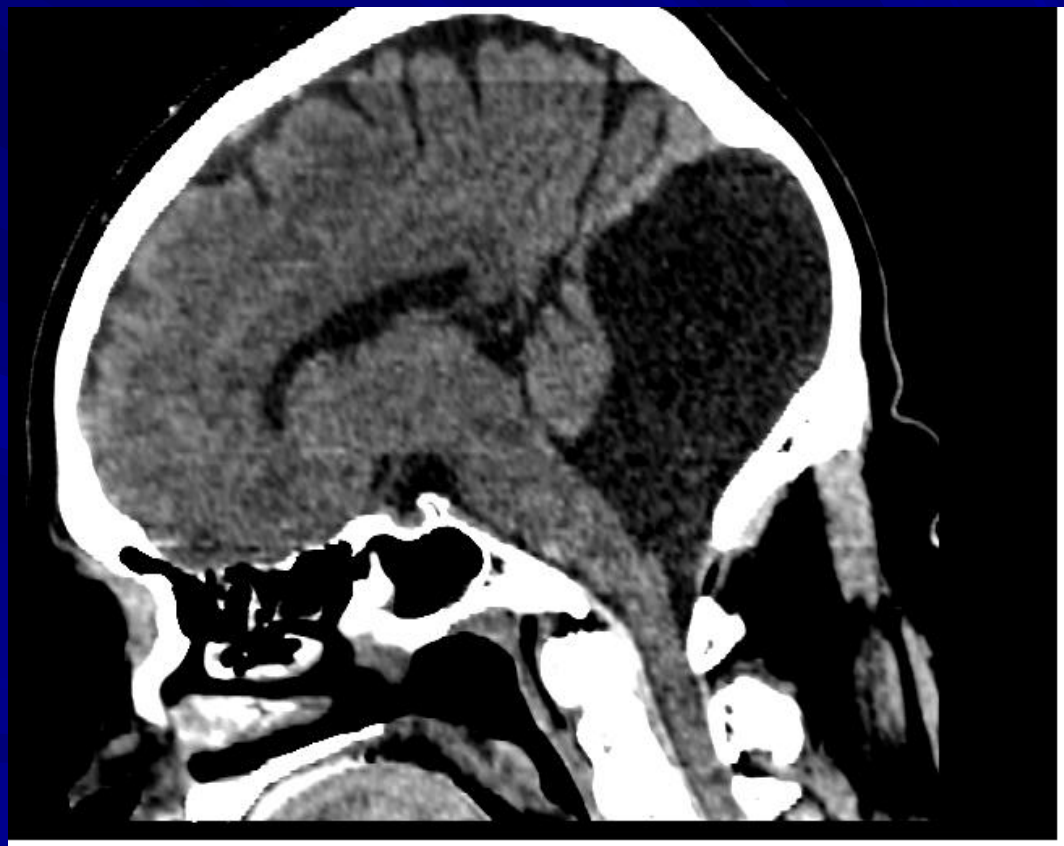
Blue represents maturing of brain areas



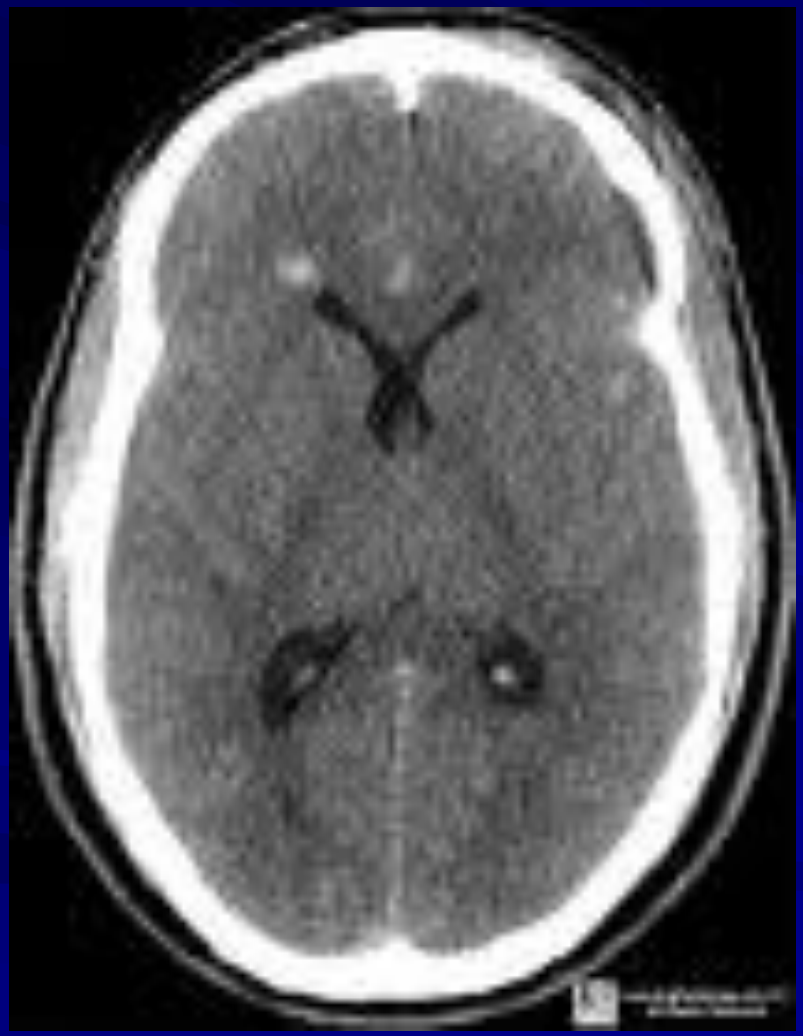
Source: Gogtay, Giedd, et al., 2004.

Gogtay, N., Giedd, J.N., et al. (2004)
Dynamic mapping of human cortical development during childhood through early adulthood
Proceedings of the National Academy of Sciences, 101 (21), 8174 – 8179

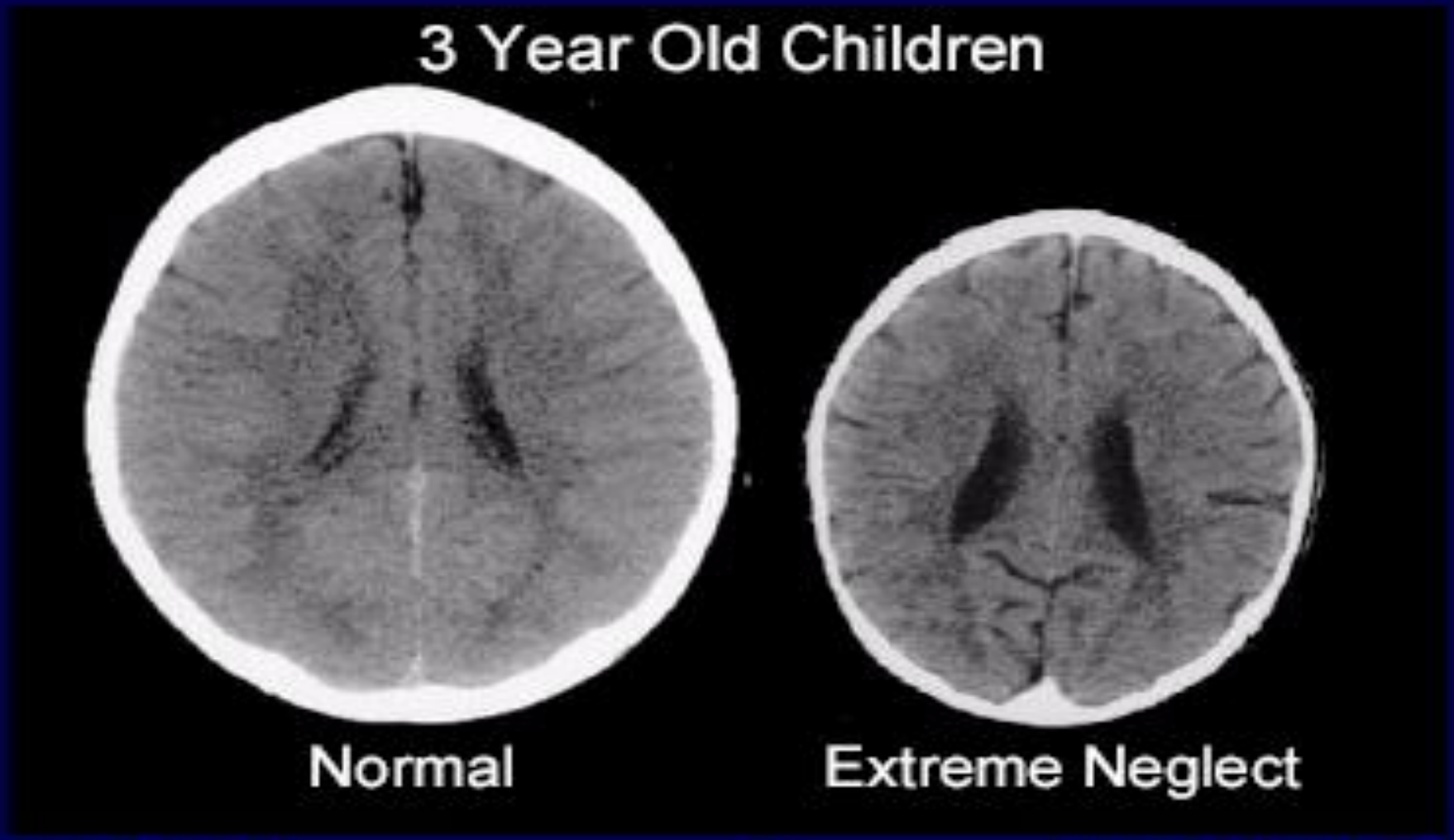
Brain Plasticity
Incidental Finding in 55 year old man



Brain Plasticity



USE IT OR LOSE IT !



Three Levels of Stress

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

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

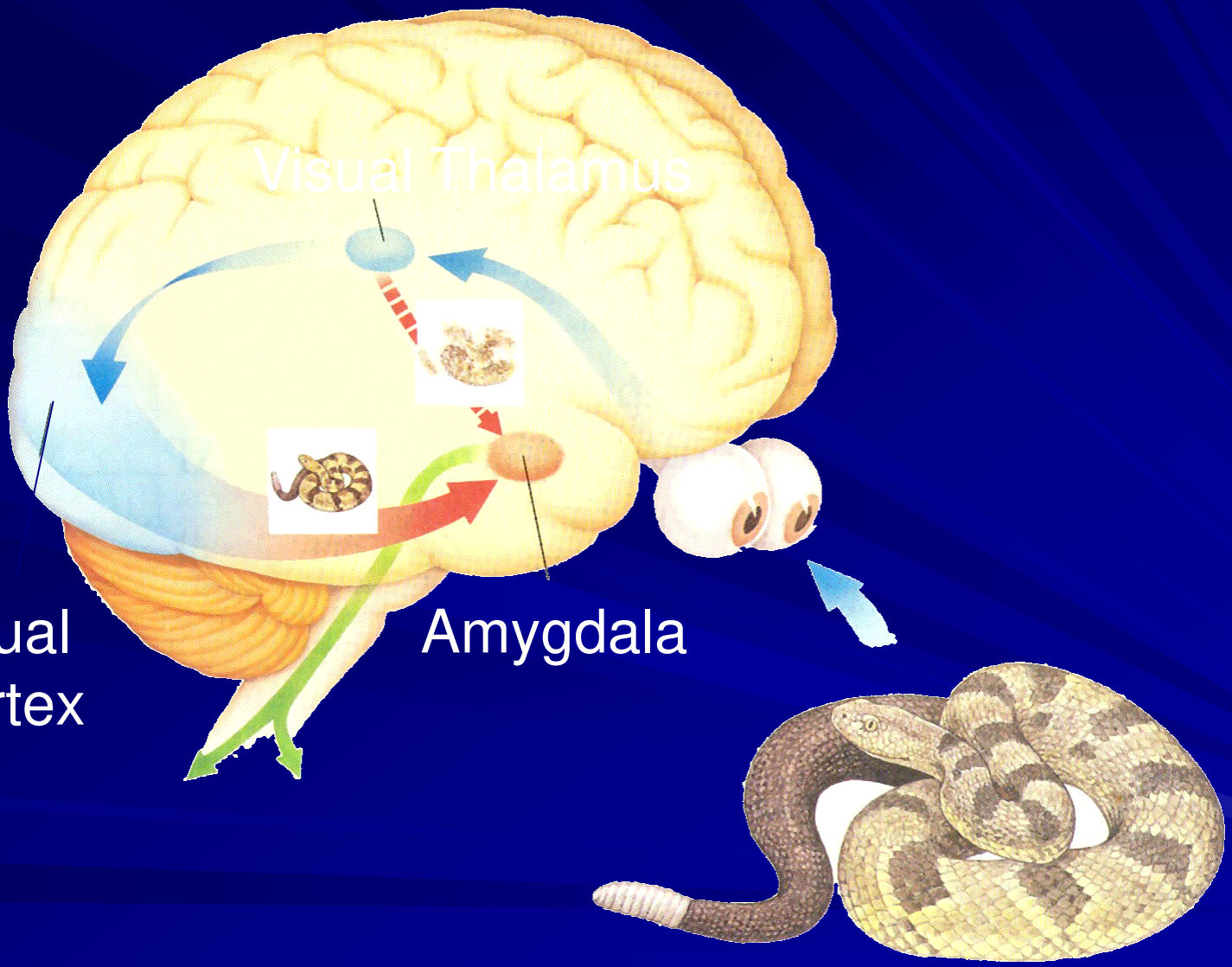
Toxic
Prolonged activation of stress response systems
in the absence of protective relationships.

Stress …..don't go NUTS

- Novelty,
- Unpredictability,
- Threat to the ego,
- Sense of loss of control

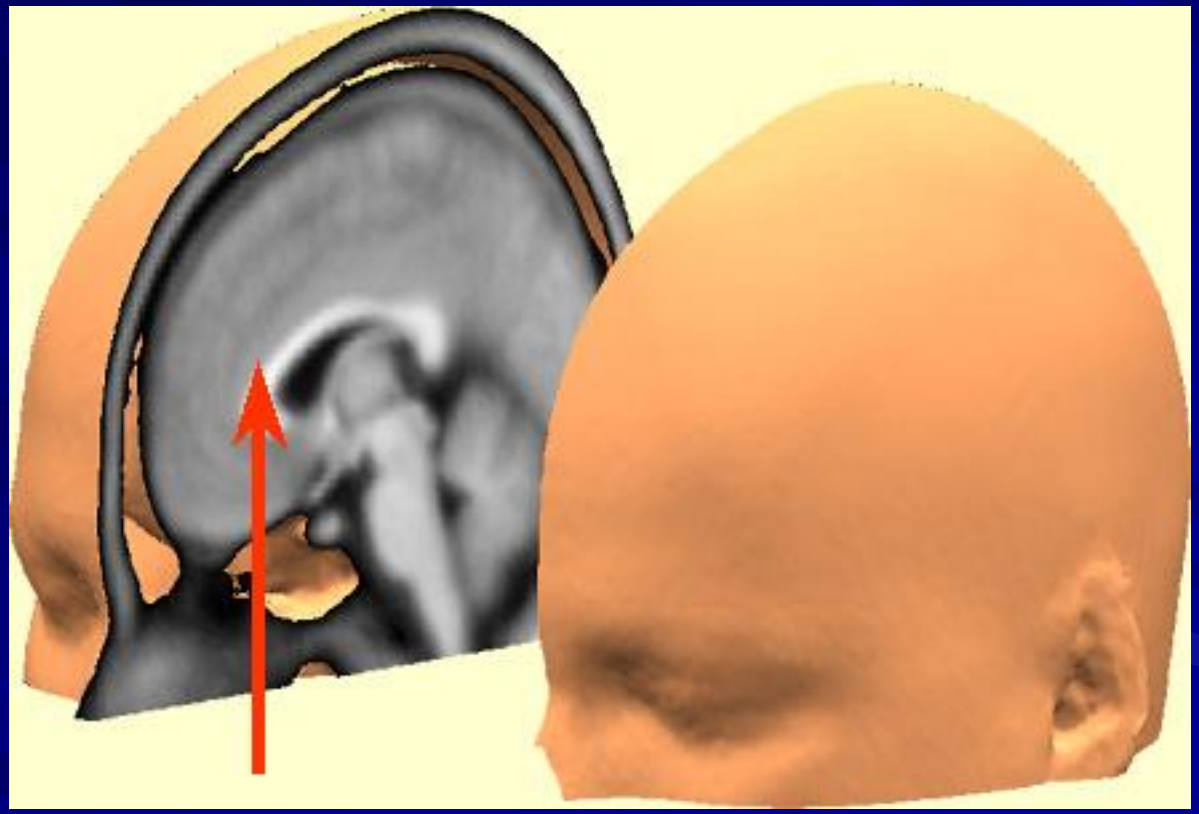
- Dr Sonia Lupien Centre for Studies on Human Stress

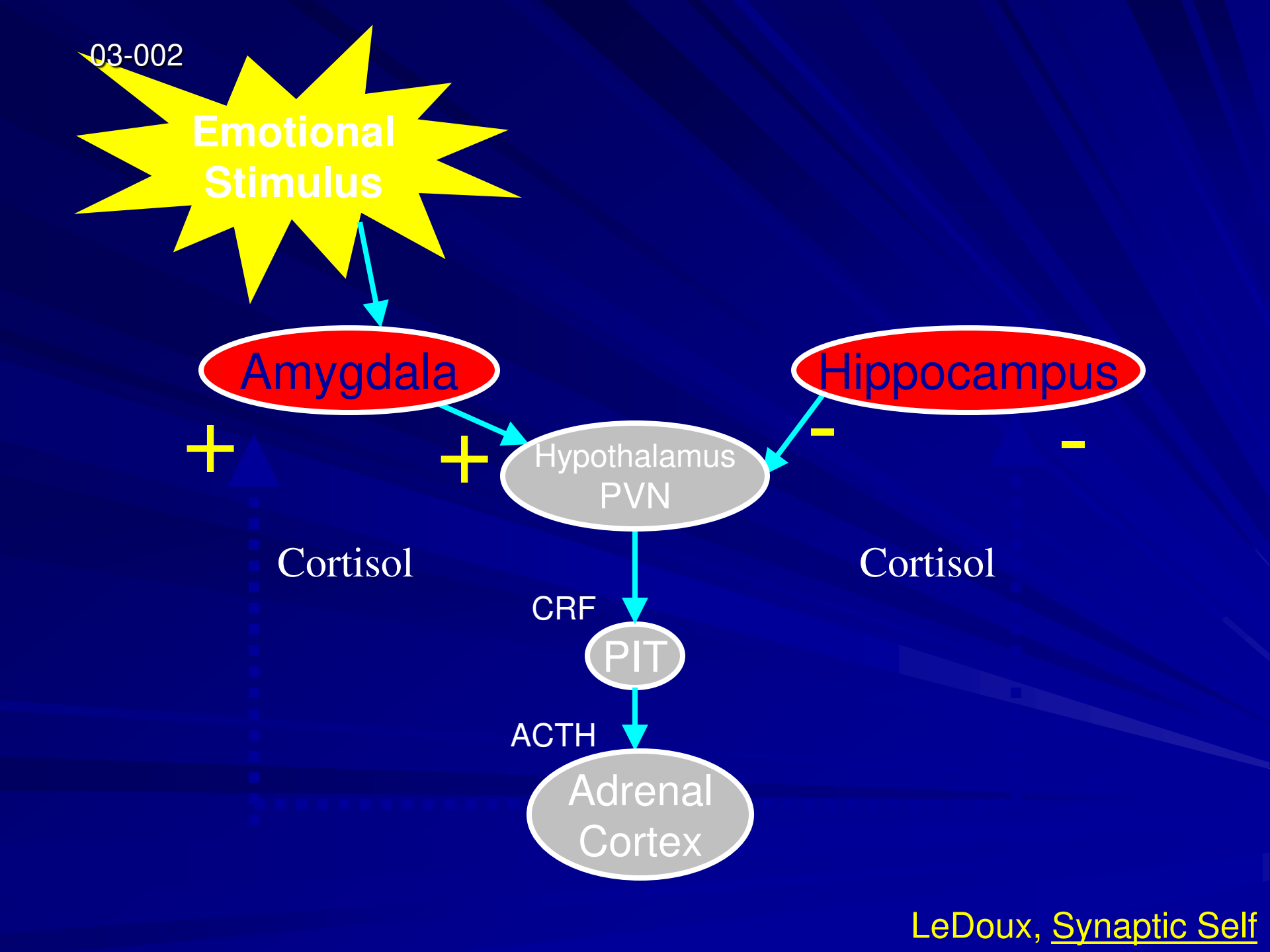
The Fear Response: Fight or Flight and Stress



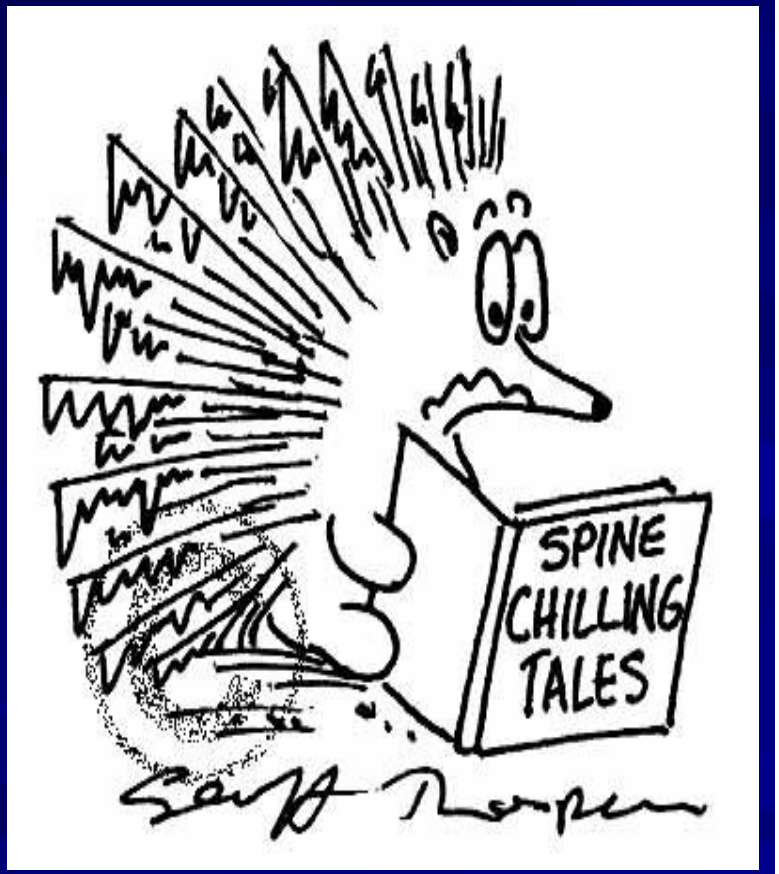
Scientific American
The Hidden Mind, 2002, Volume 12, Number 1

Anterior Cingulate Cortex




03-002
Emotional Stimulus
Amygdala
Hippocampus
+
+
-
-
Hypothalamus PVN
Cortisol
Cortisol
CRF
PIT
ACTH
Adrenal Cortex
LeDoux, Synaptic Self

Amygdala and Hippocampus



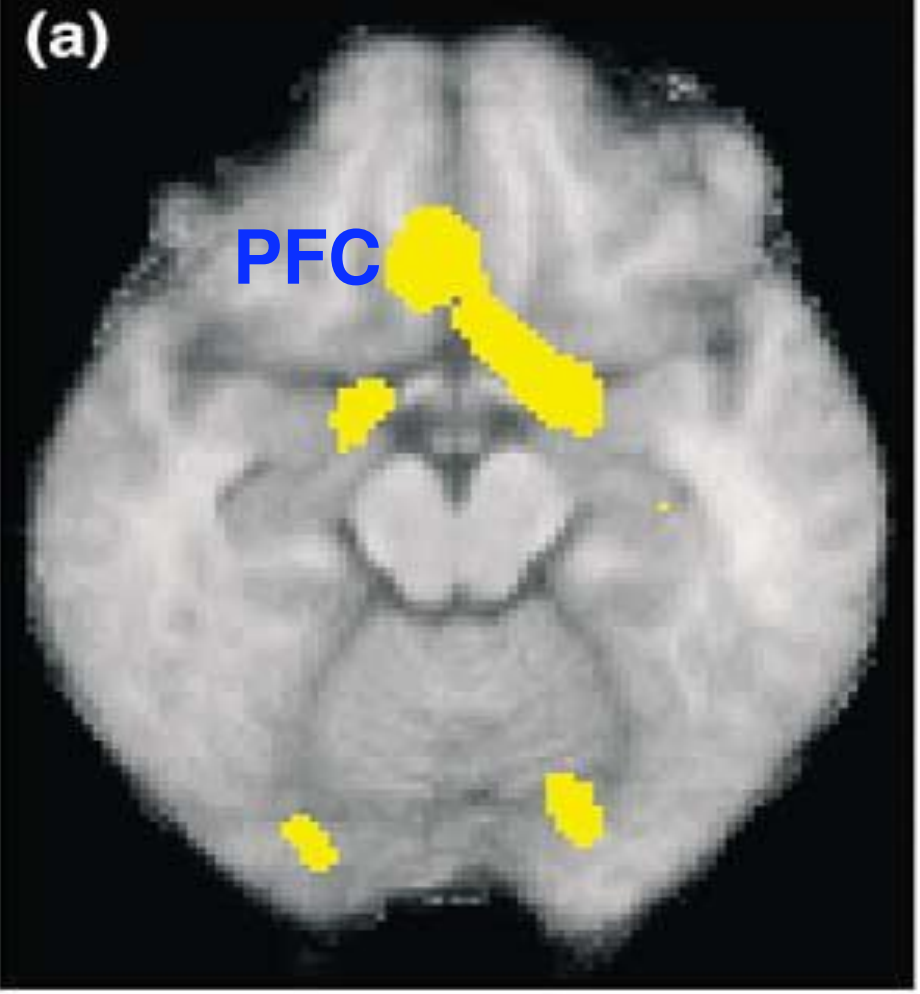
Cortisol can be bad for the brain

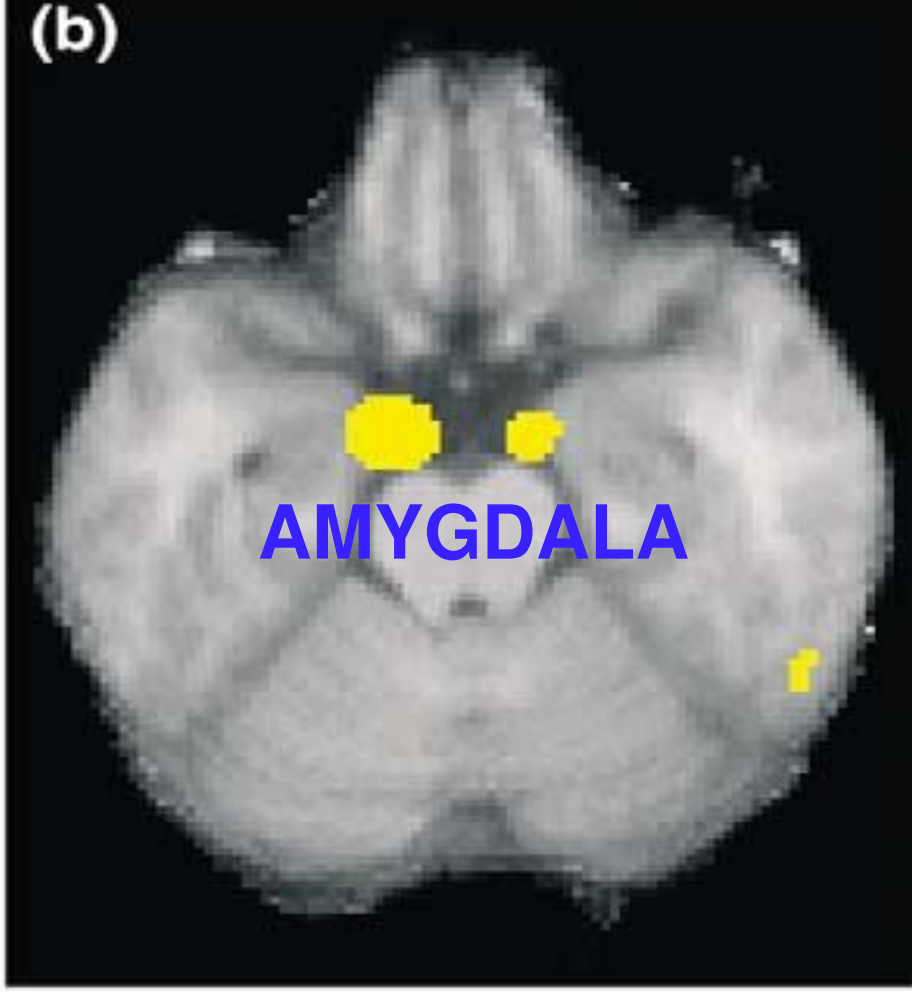
Hippocampus

- high sterol levels cause loss of dendrites and cell death

Frontal brain

- attention deficits



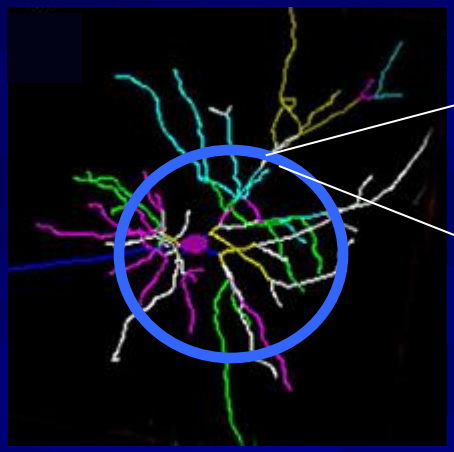


A: Positive emotional state, flow through amygdala to PFC and better memory test results.

B: Stressed state: No passage of information to PFC & lower memory testing short and long-term. (Hamman,et al. *Cognitive Neuroscience*.)

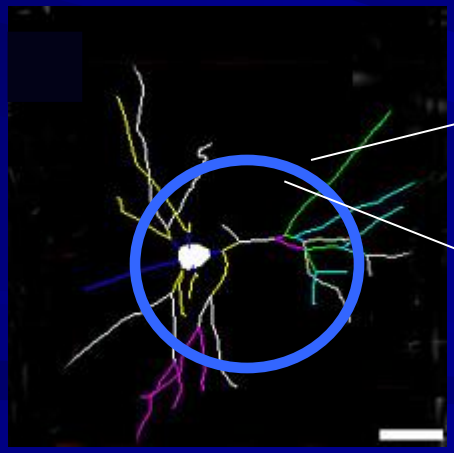
Toxic Stress Changes Brain Architecture

Normal



Typical neuron—
many connections

Toxic
stress



Damaged neuron—
fewer connections

Prefrontal Cortex and
Hippocampus

Sources: Radley et al. (2004)
Bock et al. (2005)

Center on the Developing Child
HARVARD UNIVERSITY

Understanding the Long-Term Impacts of Significant Adversity Early in Life

Research on biological stress response systems illustrates how adversity raises heart rate, blood pressure, and stress hormone levels, which can impair brain architecture, immune status, metabolic systems, and cardiovascular function.

These scientific findings help explain how poverty, maltreatment, and discrimination can "get under the skin" and have life-long impacts on learning capacity, behavior, and physical and mental health.

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Sources of Toxic Stress in Young Children

- **Risk Factors**
  - Neglect
  - Abuse
  - Exposure to Violence
  - Parental Mental Illness
  - Parental Substance Abuse
  - Homelessness/High Mobility
  - Death of parent
  - Incarceration of Parent
  - Etc.

Neglect, Stress, and the Developing Brain

- The stress response system in the brain is fully operational at birth but the cerebral cortex is not yet mature
- Babies can *experience* stress but are highly dependent on caregiver to *manage* stress
- Chronic stress can impair the developing brain

Still Face Experiment

Neglect and Self-Regulation

- SR is the ability to manage emotions and behaviour independently
- Is considered by some to be a central organizing feature of human development
- Most mental illnesses can be thought of as a problem of self-regulation
- Babies learn to self-regulate from their caregiving experiences

Cortisol & Brain Development

Cortisol affects the parts of the brain that

- regulate stress
- store memory
- Are involved in planning and executing complex functions
- Are involved in language

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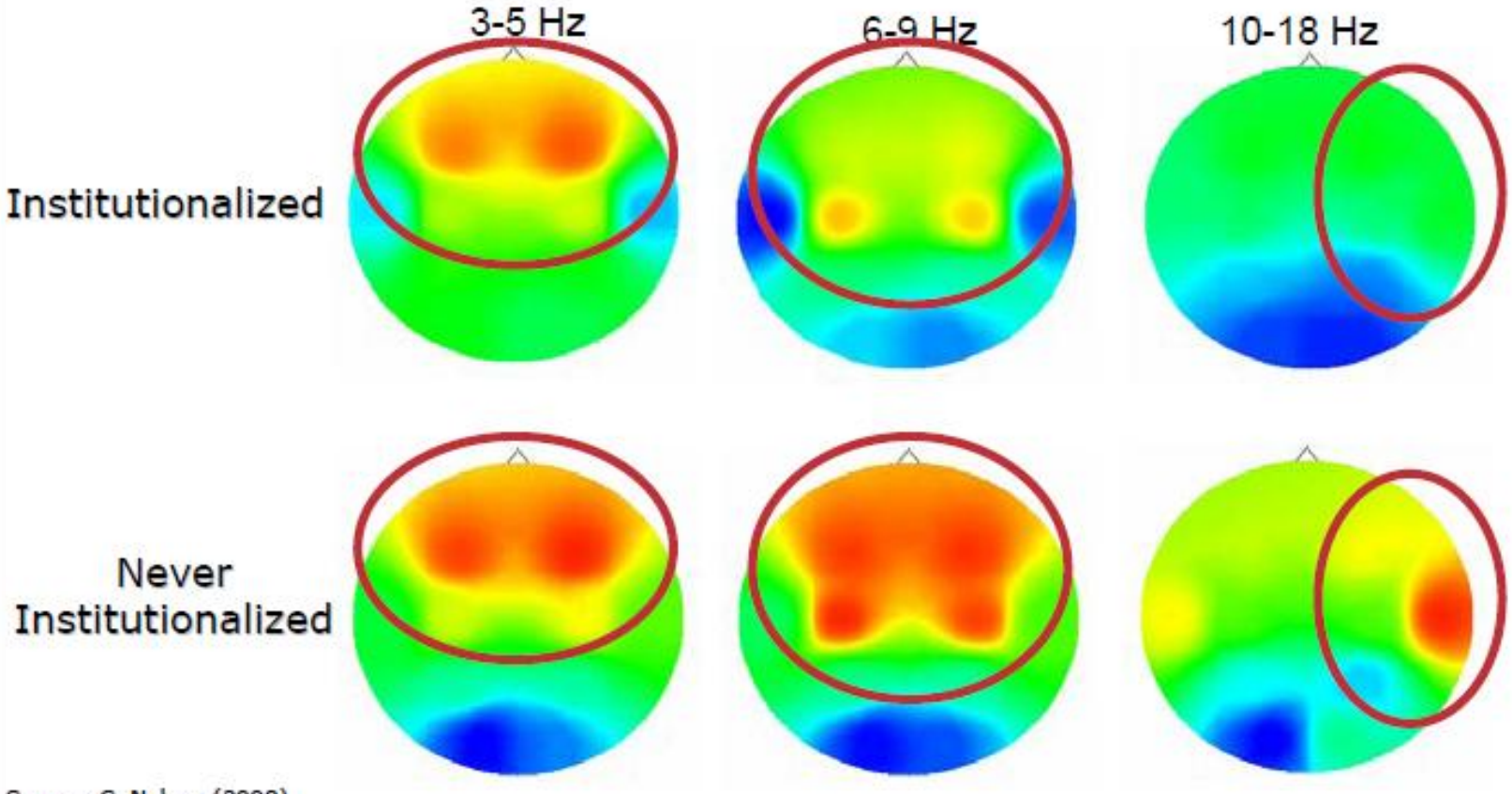
Extreme Neglect Diminishes Brain Power



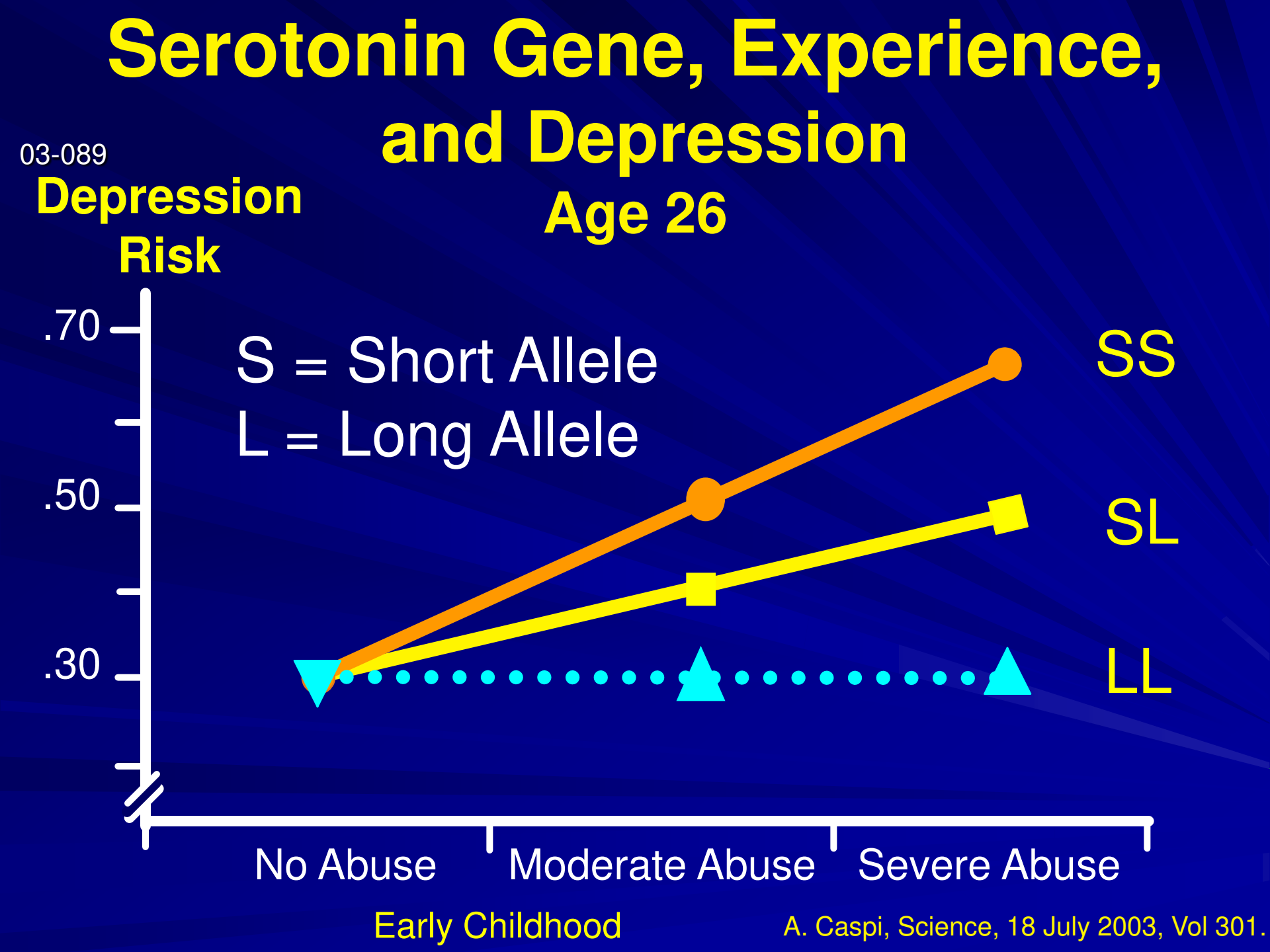
Source: C. Nelson (2008)

Hippocampus

Bock et al. (2005)

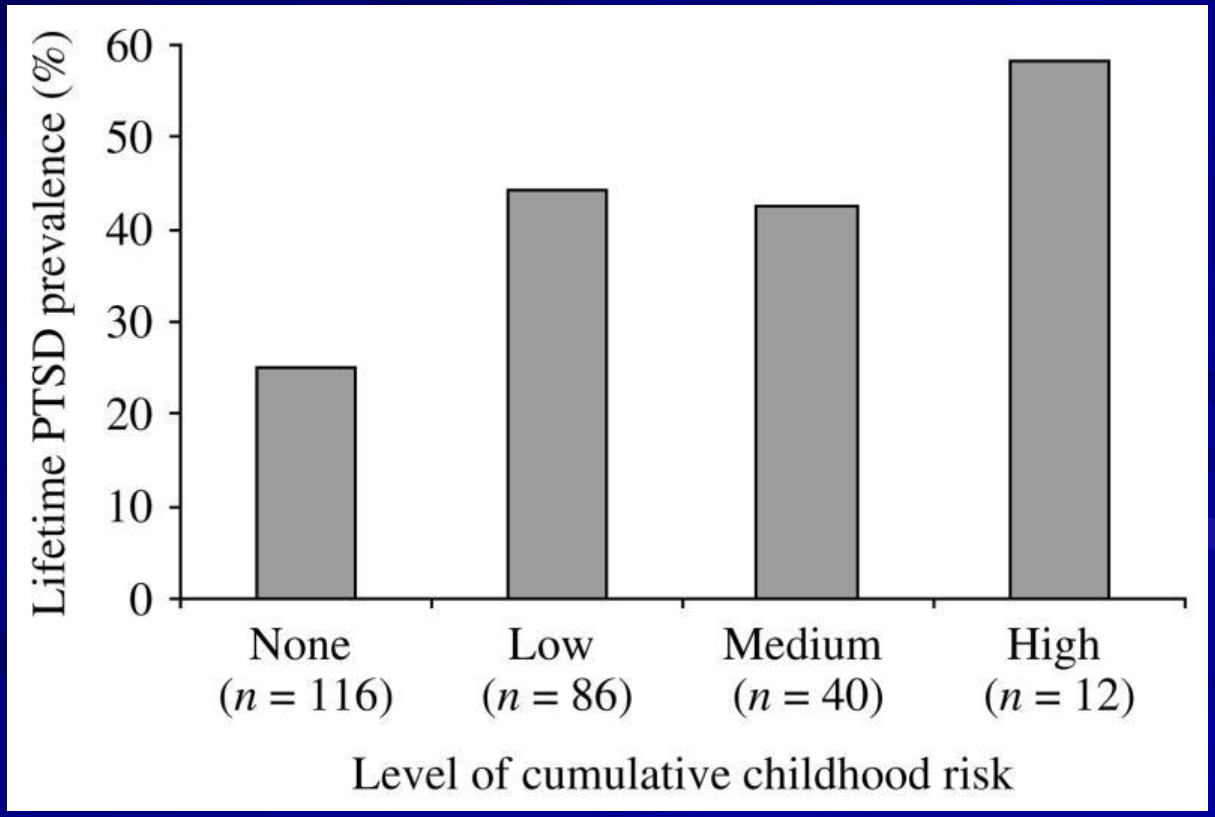
Serotonin Gene, Experience, and Depression

03-089



A. Caspi, Science, 18 July 2003, Vol 301.

Childhood Adverse Experiences Double the Risk for Adult PTSD: The 40-Year Dunedin Longitudinal Study



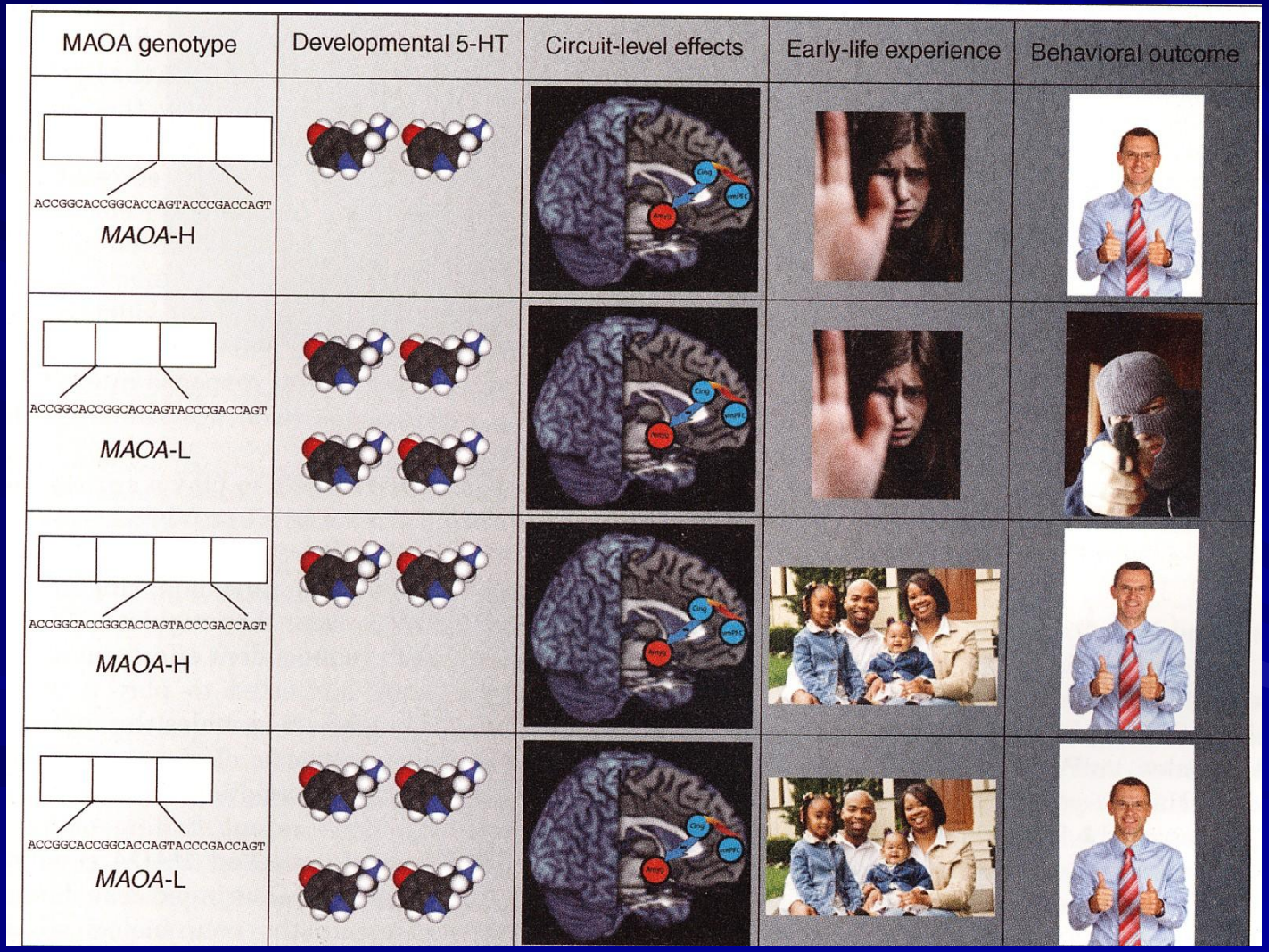
Source: Koenen et al., 2008

Human aggression and the MAO-A gene

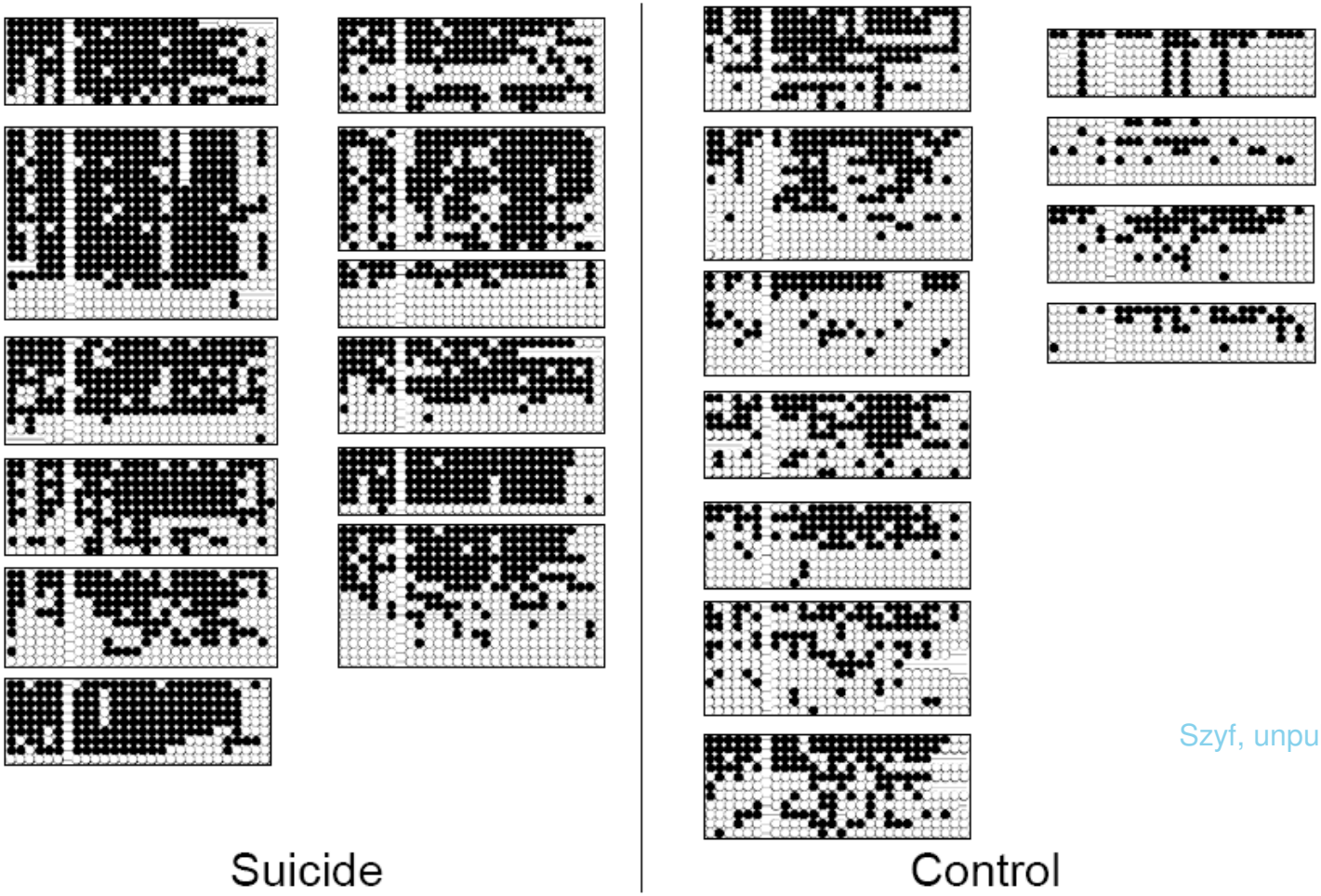
Buckholtz & Meyer Lindenberg, 2008

Nature

Nuture



Differences in methylation of the promoter of the rRNA genes in hippocampus: suicide and control subjects



Szyf, unpublished

Adverse Childhood Experiences Are Common

- *Health Consequences of Early Life Trauma*
  Vincent Felitti, M.D.,
- Health in all domains is related to childhood experience
- Health risks:
  - Stroke
  - Heart disease
  - Depression and suicide
  - Substance abuse
  - Smoking

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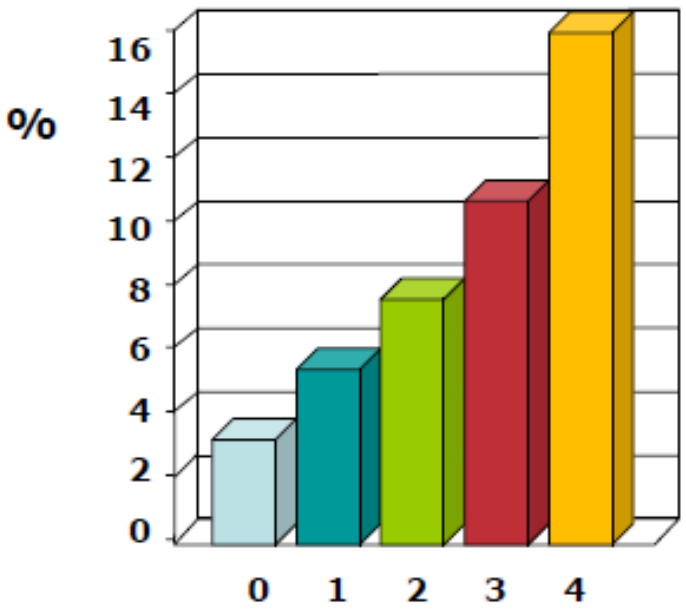
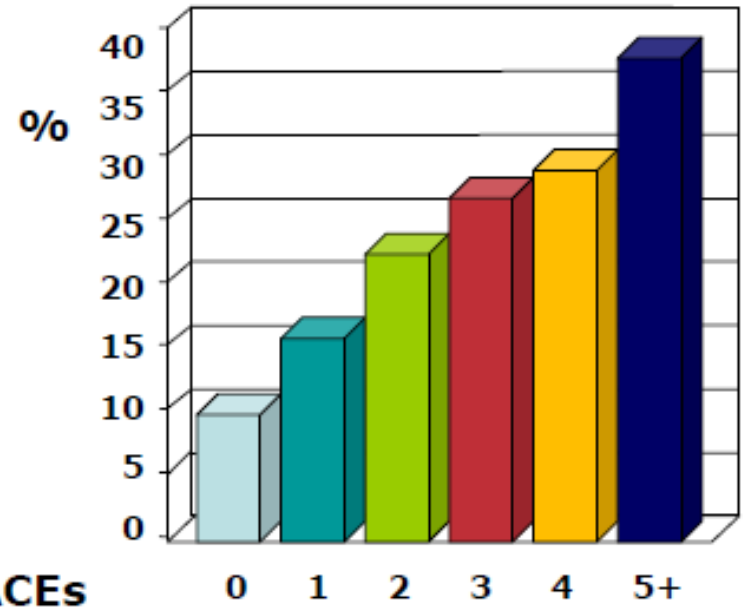
Risk Factors for Adult Substance Abuse are Embedded in Adverse Childhood Experiences

Self-Report: Alcoholism



Source: Dube et al, 2002

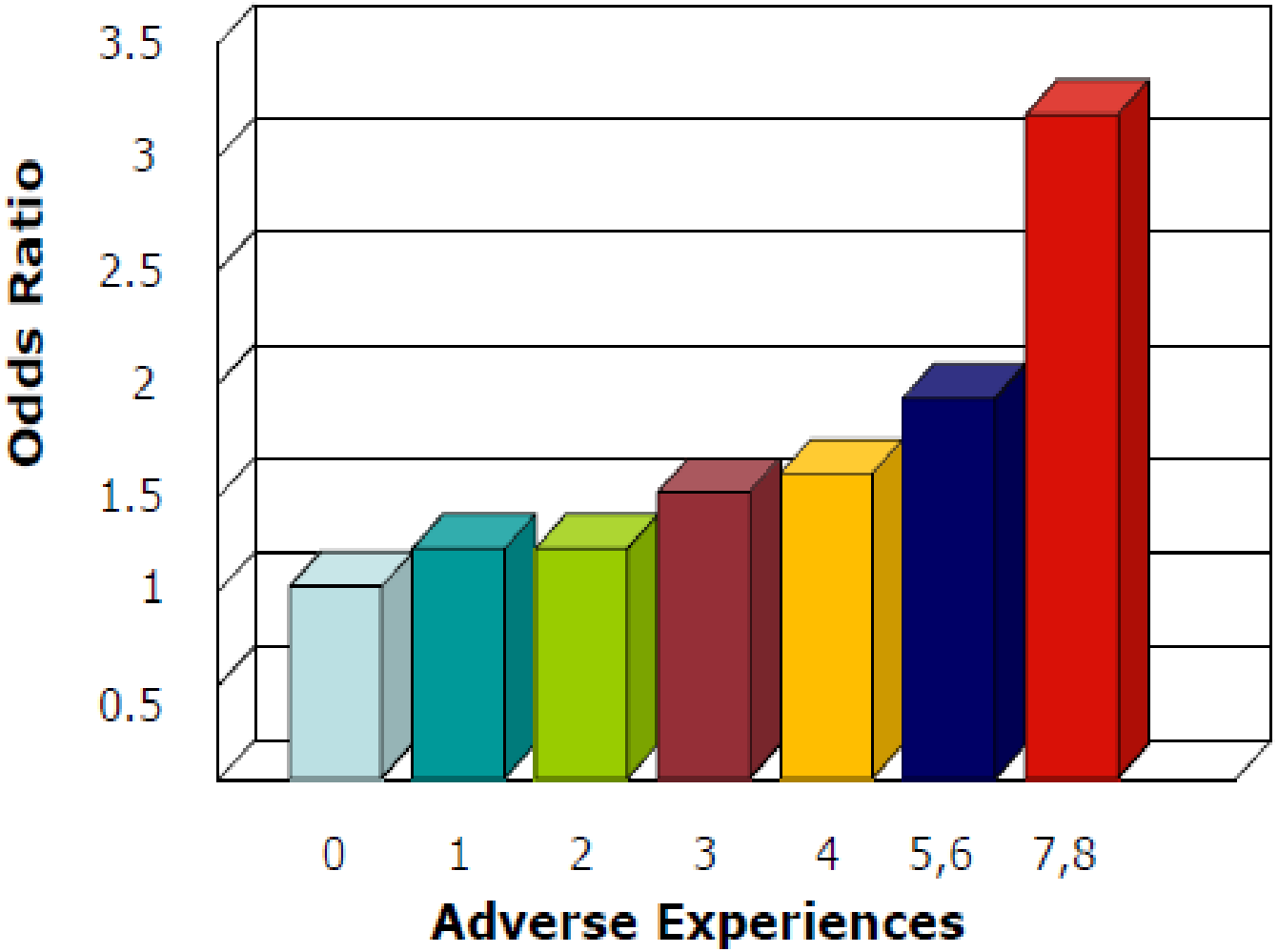
Self-Report: Illicit Drugs



Source: Dube et al, 2005

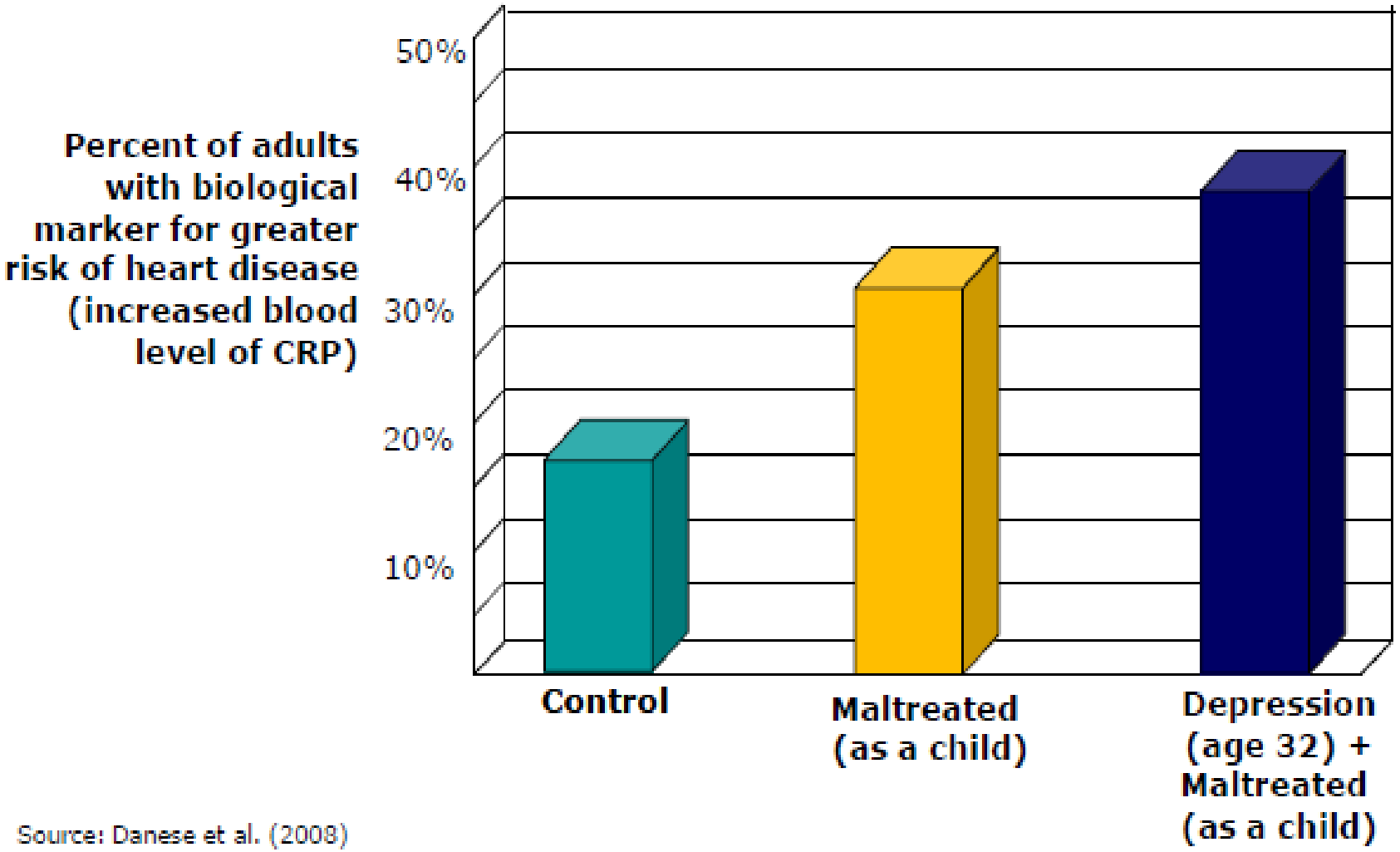
Source: Barth et al. (2008)

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



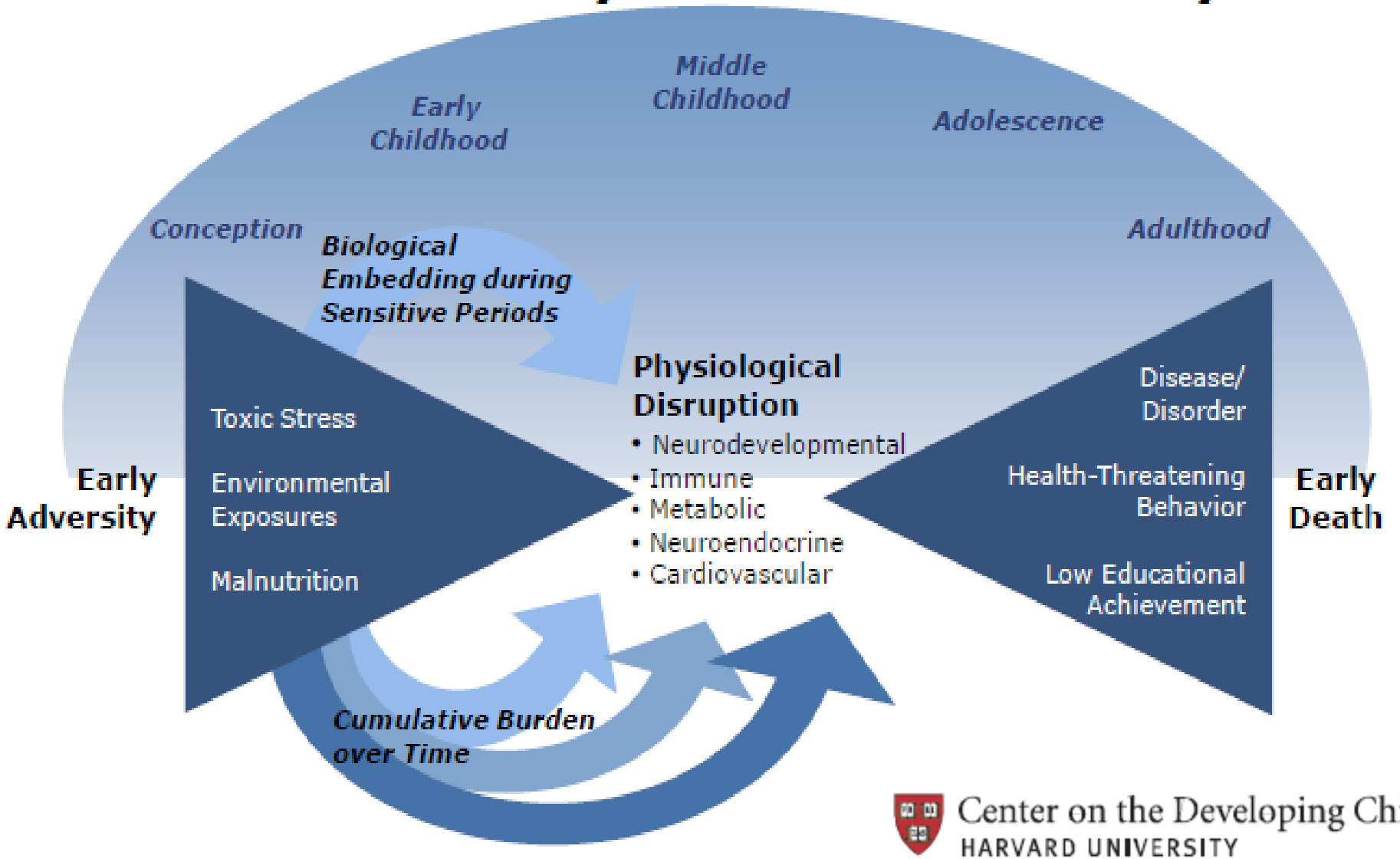
Source: Dong et al. (2004)

New Biological Evidence Links Maltreatment in Childhood to Greater Risk of Adult Heart Disease



Source: Danese et al. (2008)

The Childhood Roots of Health Disparities: How Adversity is Built Into the Body



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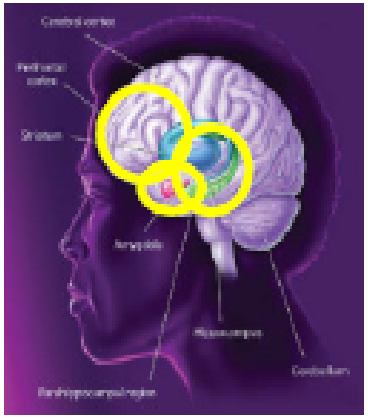
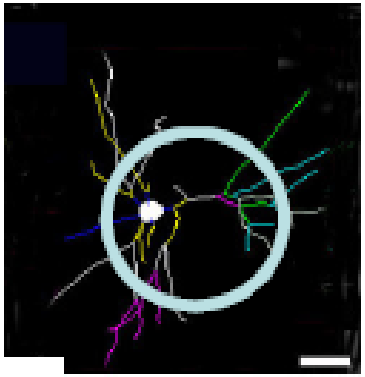
Keys to Healthy Brain Development

Supportive relationships and positive learning experiences that begin in the home but can be strengthened by outside assistance when families need help.



A balanced approach to emotional, social, cognitive, and language development.

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



“The Power of One”
Collected all together is Massive