



# The Urban Child Institute



**Because We Care About Our Children**

[www.TheUrbanChildInstitute.org](http://www.TheUrbanChildInstitute.org)

**Hank Herrod, MD**

# Optimizing Early Brain Development: Can It Make a Difference in Memphis?

**We Believe The Answer Is Yes!!**

# Why Is a Healthy Early Childhood So Important?

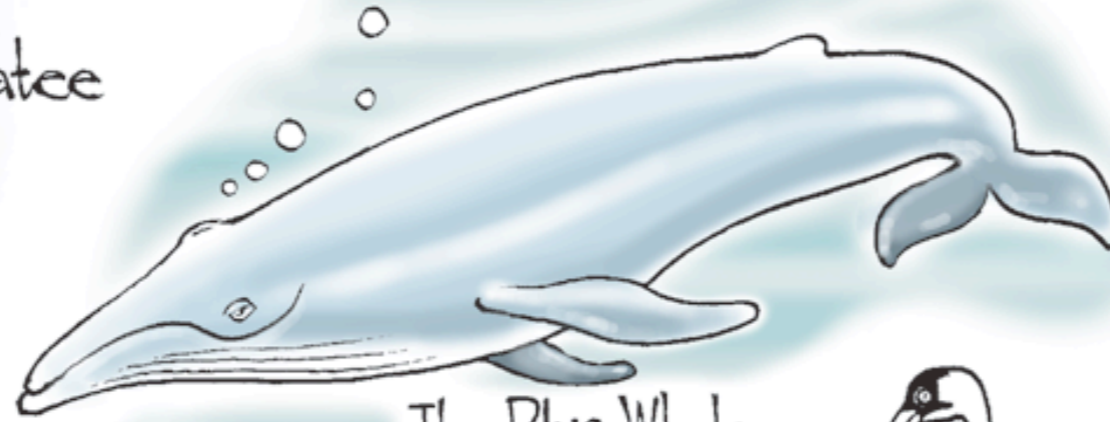
- The healthy development of children provides a strong foundation for healthy and competent adulthood, responsible citizenship, economic productivity, strong communities, and a sustainable society.  
Source: J. Shonkoff Harvard's Center on the Developing Child
- Converging evidence from biology, economics, sociology, psychology, support the concept of the importance of brain development in early childhood as crucial to ultimate adult outcomes.



# A BRIEF LIST OF ENDANGERED SPECIES



The Manatee



The Blue Whale



The Golden-Cheeked Warbler



The Spotted Owl



The Green Turtle



The Whooping Crane



The Urban Child

# The Urban Child Institute: Mission

Our mission is to increase awareness of the importance of optimal brain development from conception to three years of age in Memphis and Shelby County.

# TUCI Structure

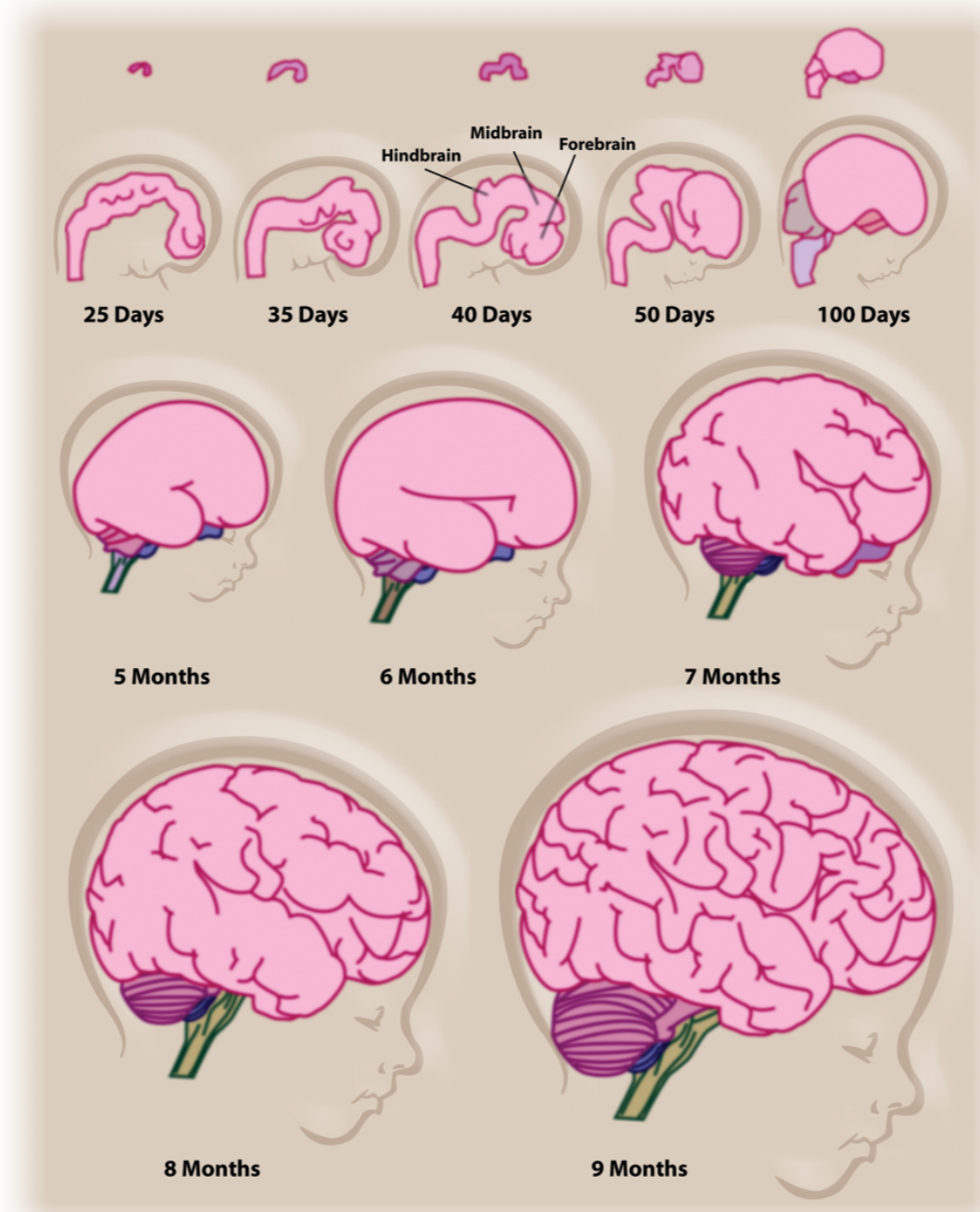
- Emphasis on early brain development
- TUCI houses social scientists from UM, epidemiologists and bio-statisticians from UTHSC, employed staff
- Focus areas: Data ➡ Dissemination ➡ Policy
- Community-focused investments
  - ❖ Neighborhood Christian Center
  - ❖ Conditions affecting neurocognitive development and learning in early childhood (CANDLE) study

# The Human Brain





# The Brain from Conception to Birth

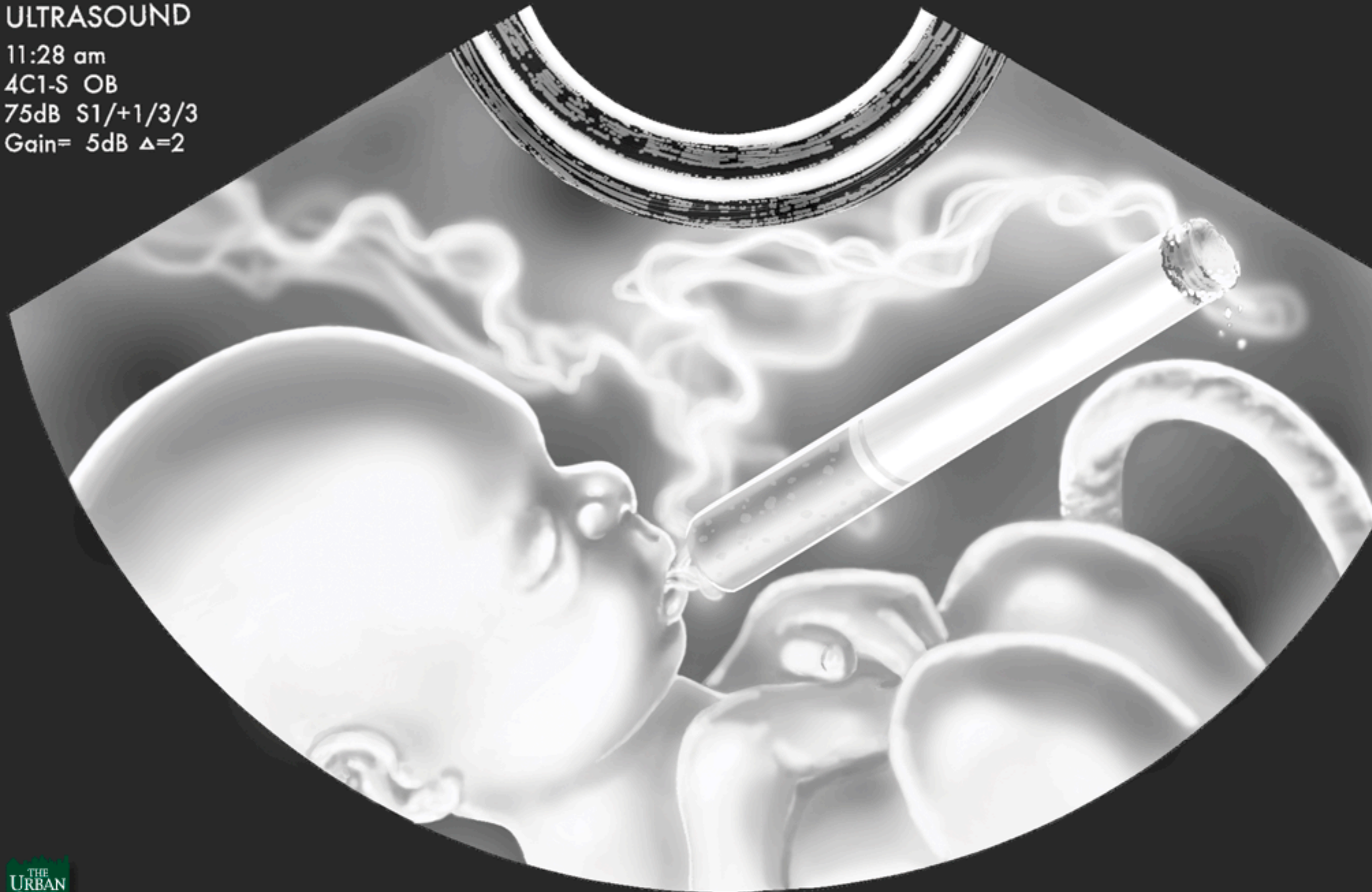


# How Does the Mother's Lifestyle Influence the Fetal Brain?

- Almost **anything** Mom does can affect the fetus both positively and negatively
- Examples
  - Environmental exposures
  - Substance abuse
  - Nutrition
  - **Stress**

UNIT 649399 LR  
20F: MOTHER, SMOKER  
ULTRASOUND

11:28 am  
4C1-S OB  
75dB S1/+1/3/3  
Gain= 5dB  $\Delta=2$





# Normal Brain (L) and Brain Exposed to Excessive Alcohol (R)





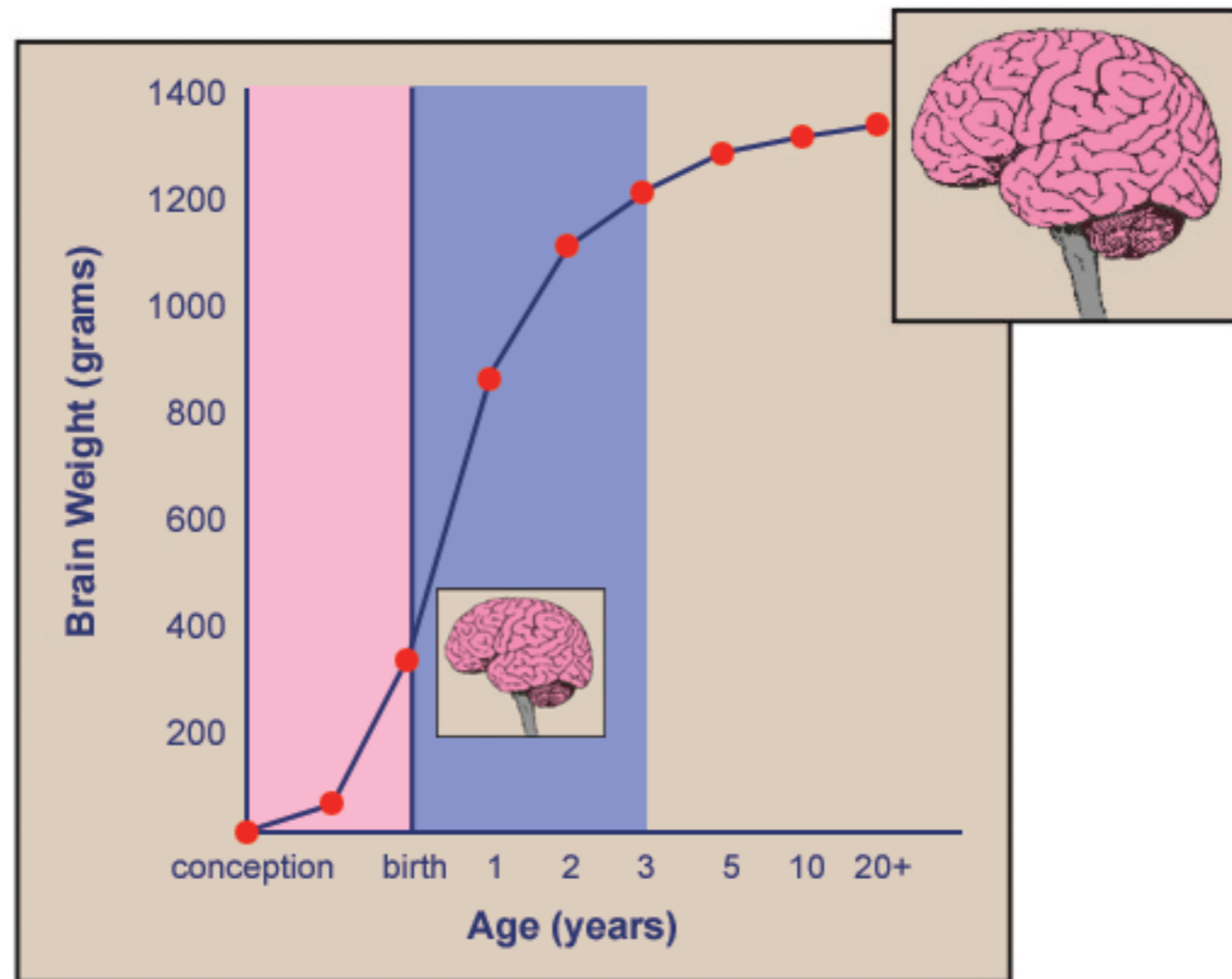
# Maternal Nutrition: The Relationship Between Neural Tube Defects and Folic Acid



# Status of the Brain at Birth

- 100 billion neurons present
- Each neuron can have up to 10,000 synapses
- The developing brain as an architectural project:  
Plans (blueprint – genes) and hardware (foundation, framing, exterior, interior – neurons, glial cells) are in place but connections (insulation, mechanics, making it work –synapses) not yet made
  - Quality building supplies (nutrition, nurturing, experiences)
  - Master carpenter (experiences)
- Use it or lose it
- Do it early – it's too expensive and difficult to fix it later

# The Developing Brain: From Birth to Adolescence



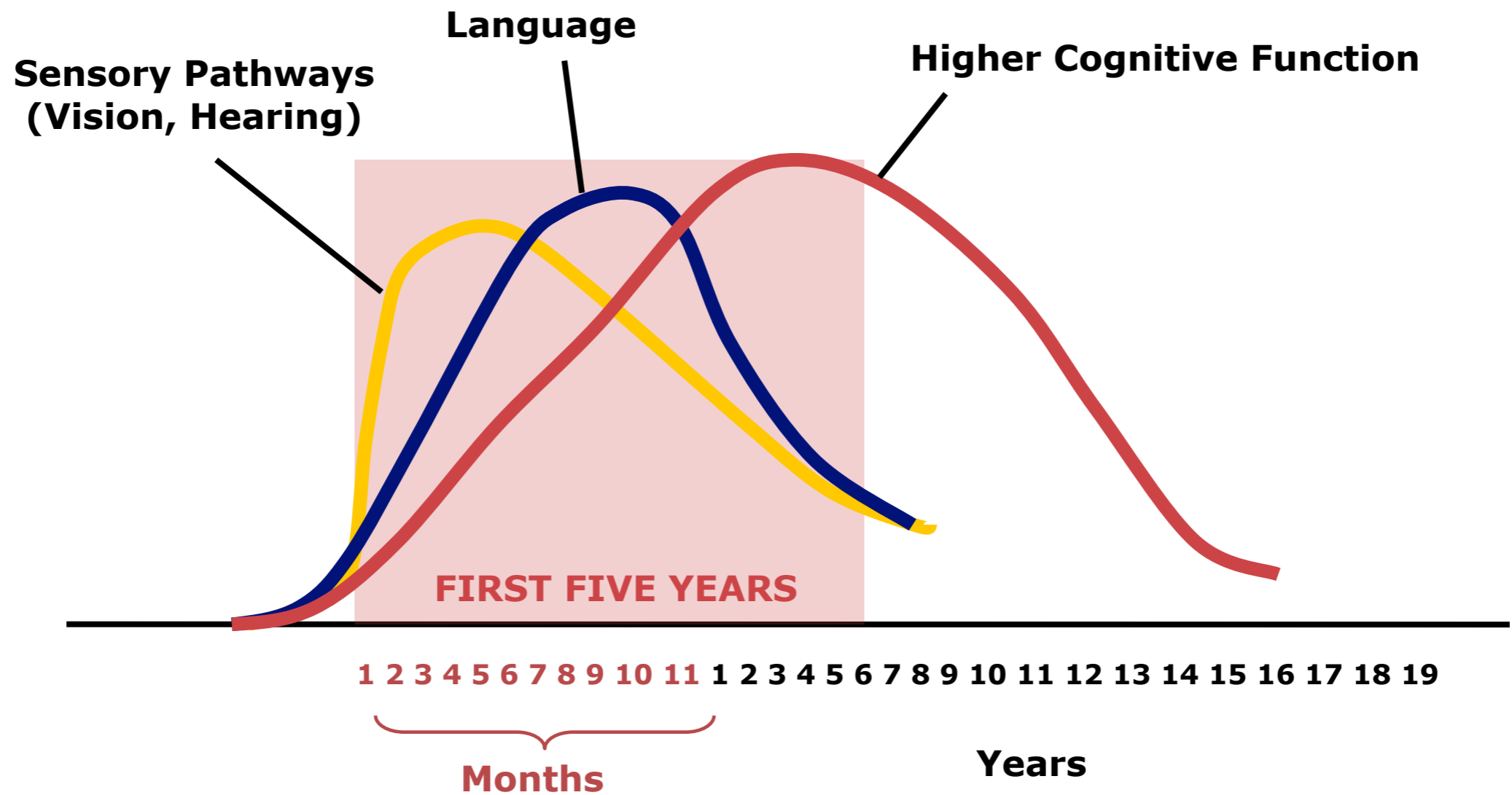
**Both Nature** (Genes) and **Nurture** (Environment)  
are important for optimal brain development

# The Developing Brain Has Periods of Exceptional Sensitivity to the Effects of Experience and Environment

- Maturing neural circuits are influenced by molecular events that are triggered by external factors  
e.g., vision, hearing, language, responses to social cues
- Sensitive periods occur at different ages for different parts of the brain

# Neural Circuits are Wired in a Bottom-Up Sequence

(700 synapses formed per second in the early years)



Source: C.A. Nelson (2000)



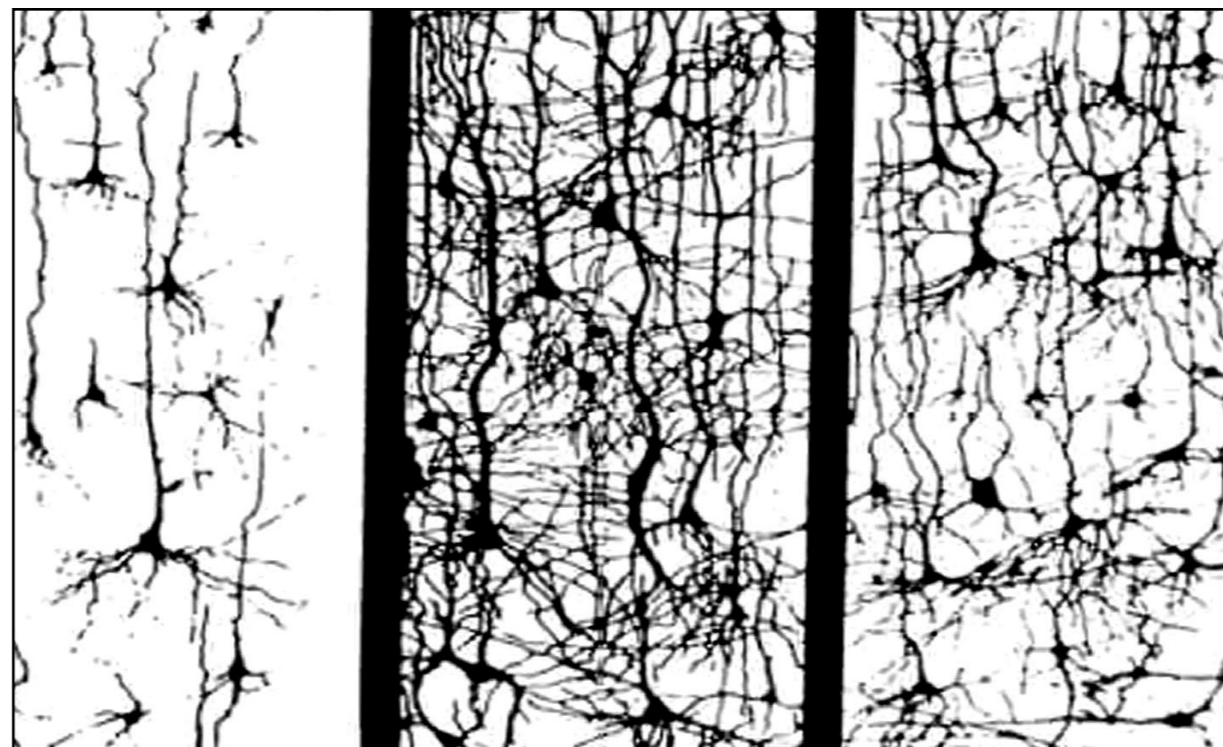
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# Pruning Effects, Neuron Density, and Synaptic Connections in Development: **Use It or Lose It**

3 mos

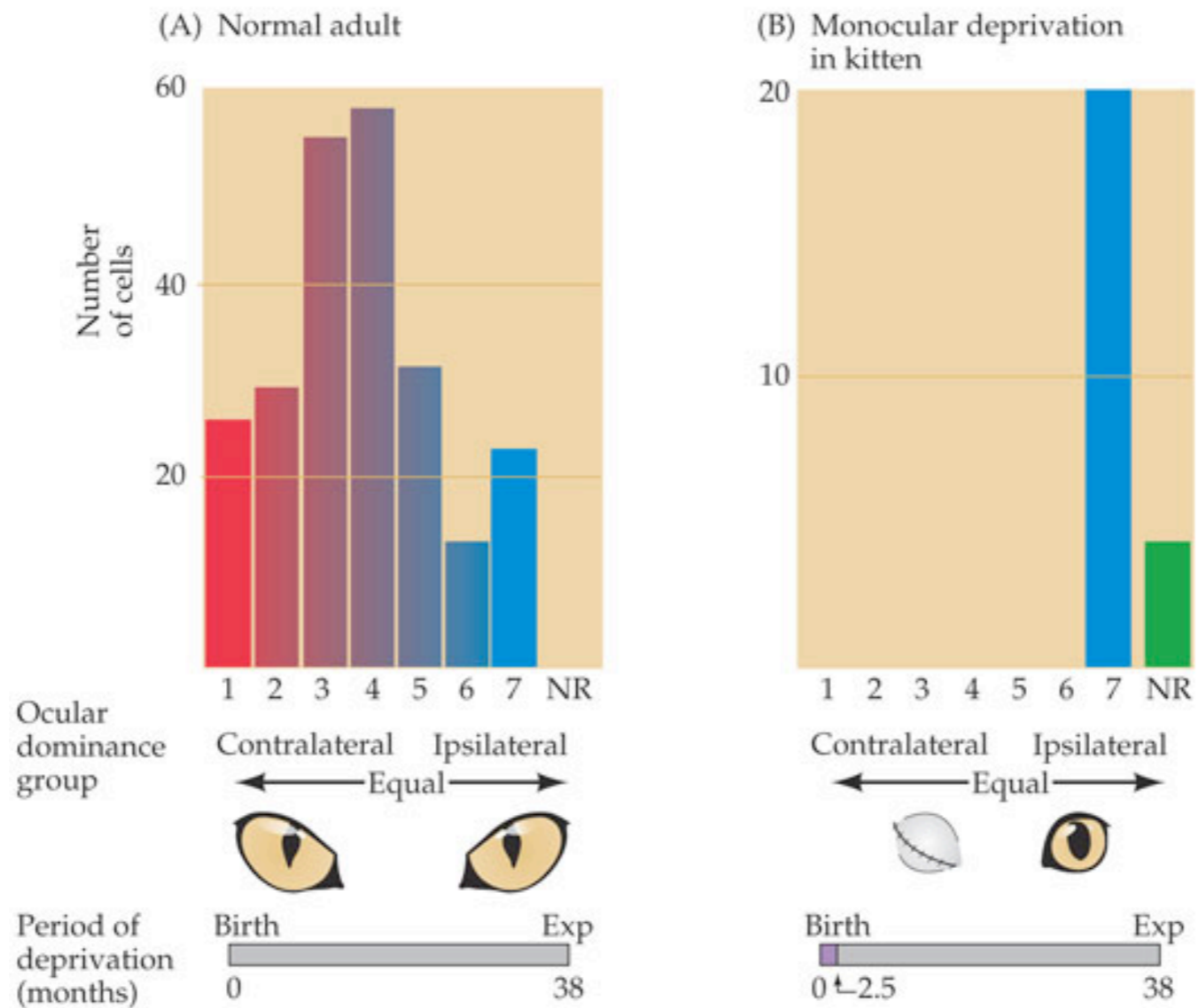
6 mos

14 yrs



Source: H.T. Chugani  
Wayne State University

# Critical Period for Visual Development in Kittens: The Influence of Visual Stimulus



Normal response properties of brain cells.

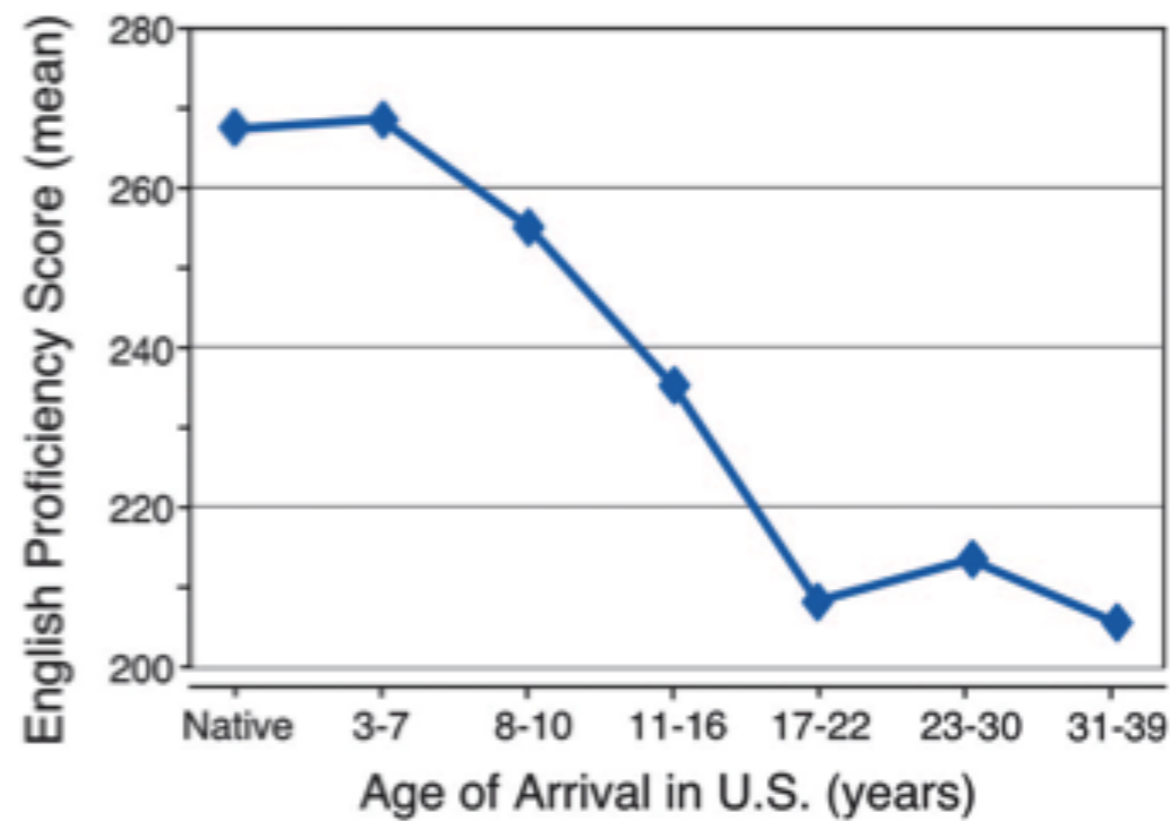
After visual deprivation of one eye: Majority of brain cells are driven by the non-deprived eye (shift in ocular dominance).

Source: NEUROSCIENCE, Third Edition, Figure 23.4 (Part 1) © 2004 Sereauer Associates, Inc.

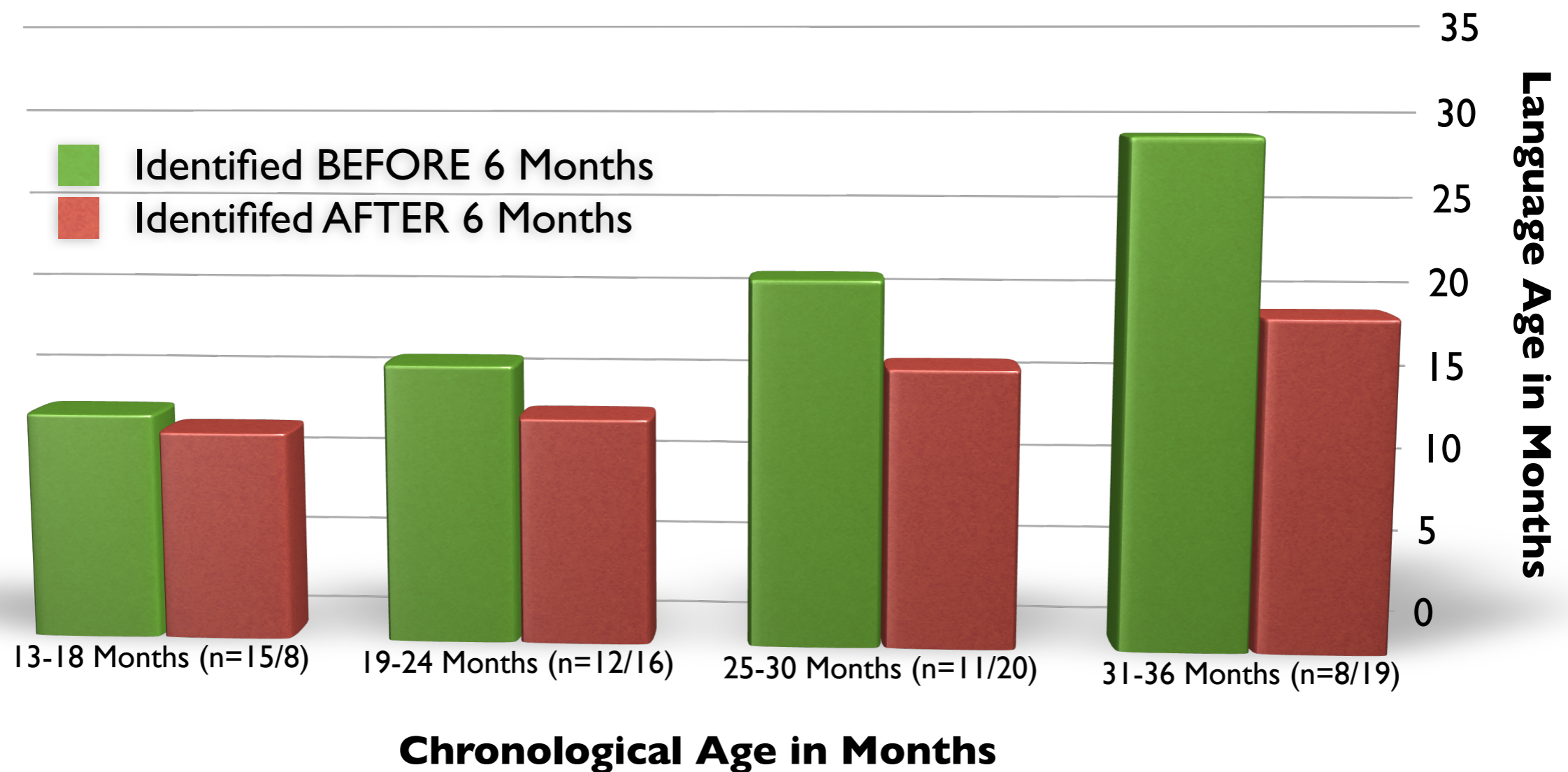


# Critical Periods for Language Development

Sensitive Periods in Language Acquisition  
Age of Arrival in U.S. of Chinese and Korean Adults



# Expressive Language Scores for Hearing Impaired Children Identified Before and After 6 Months of Age



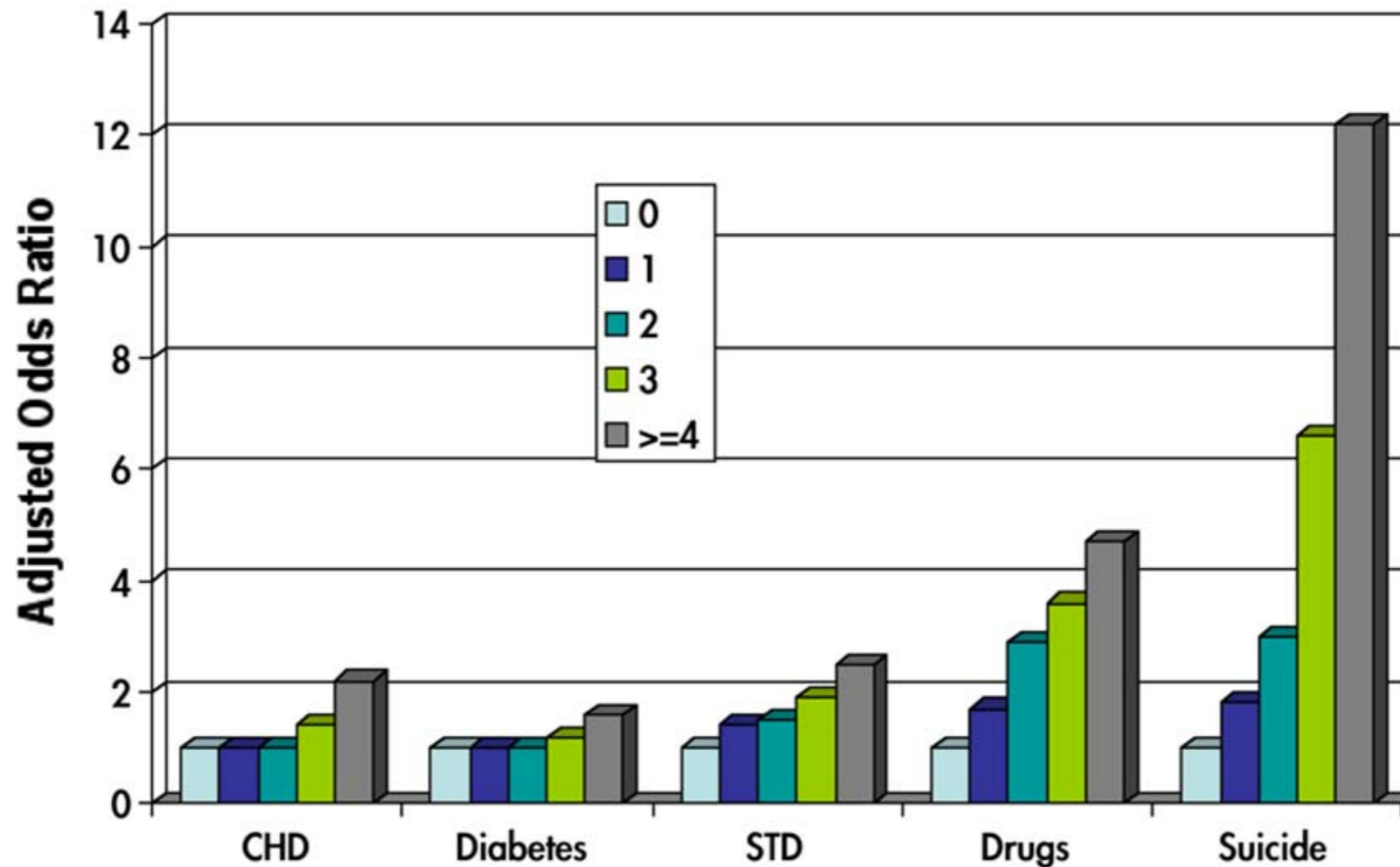
# The ACE Study

- The Adverse Childhood Experience (ACE) Study-A CDC, Kaiser Permanente Collaborative
- 17,000 Middle Class Enrollees average age 57 years
- 10 ACE: Abuse, Neglect, Household Dysfunction

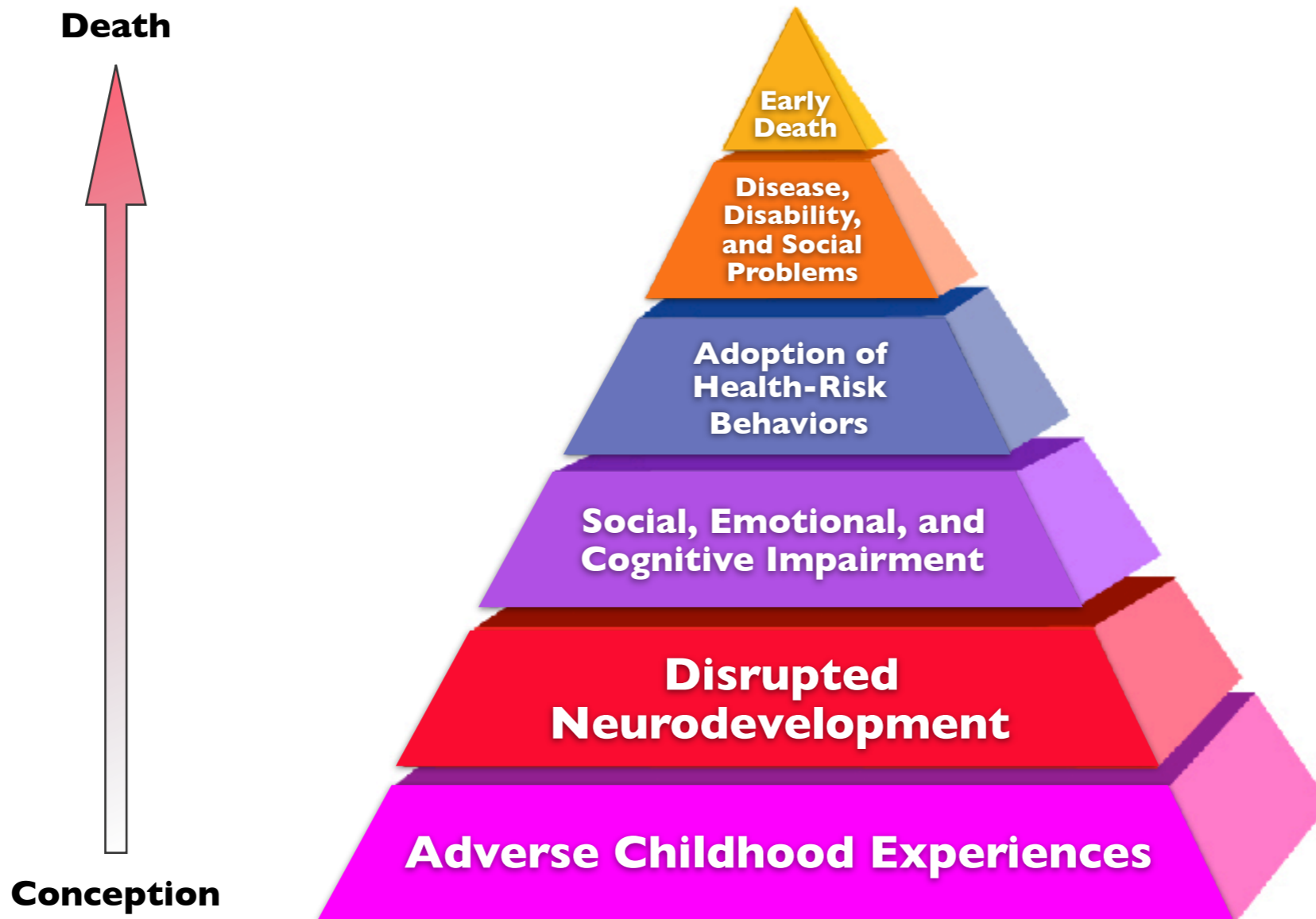
# Adverse Childhood Experiences (ACE Study)

- Three types of abuse
  - Sexual
  - Physical
  - Emotional
- Two types of neglect
  - Physical
  - Emotional
- Five types of family dysfunction
  - Having a mother who was treated violently
  - Household member who's an alcoholic or drug user
  - Household member who's been imprisoned
  - Household member who's diagnosed with mental illness
  - Parents are separated or divorced

# Negative Childhood Experiences Can Affect Adult Behavior



# Adverse Childhood Experiences Can Last a Lifetime



**Mechanisms by Which Adverse Childhood Experiences  
Influence health and Well-Being Throughout the Lifespan**

# Three Levels of Stress

## **Positive**

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

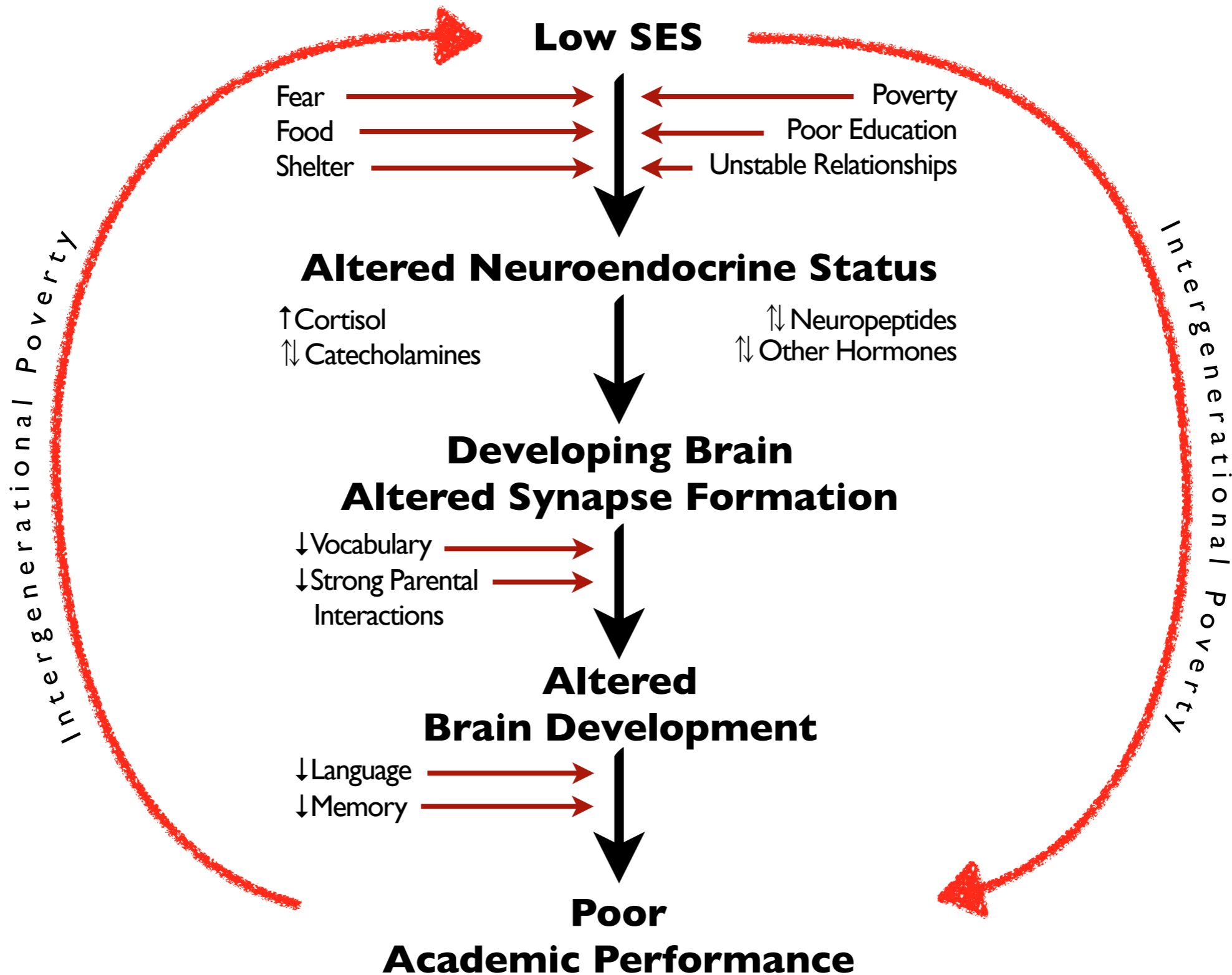
## **Tolerable**

Serious, temporary stress responses,  
buffered by supportive relationships.

## **Toxic**

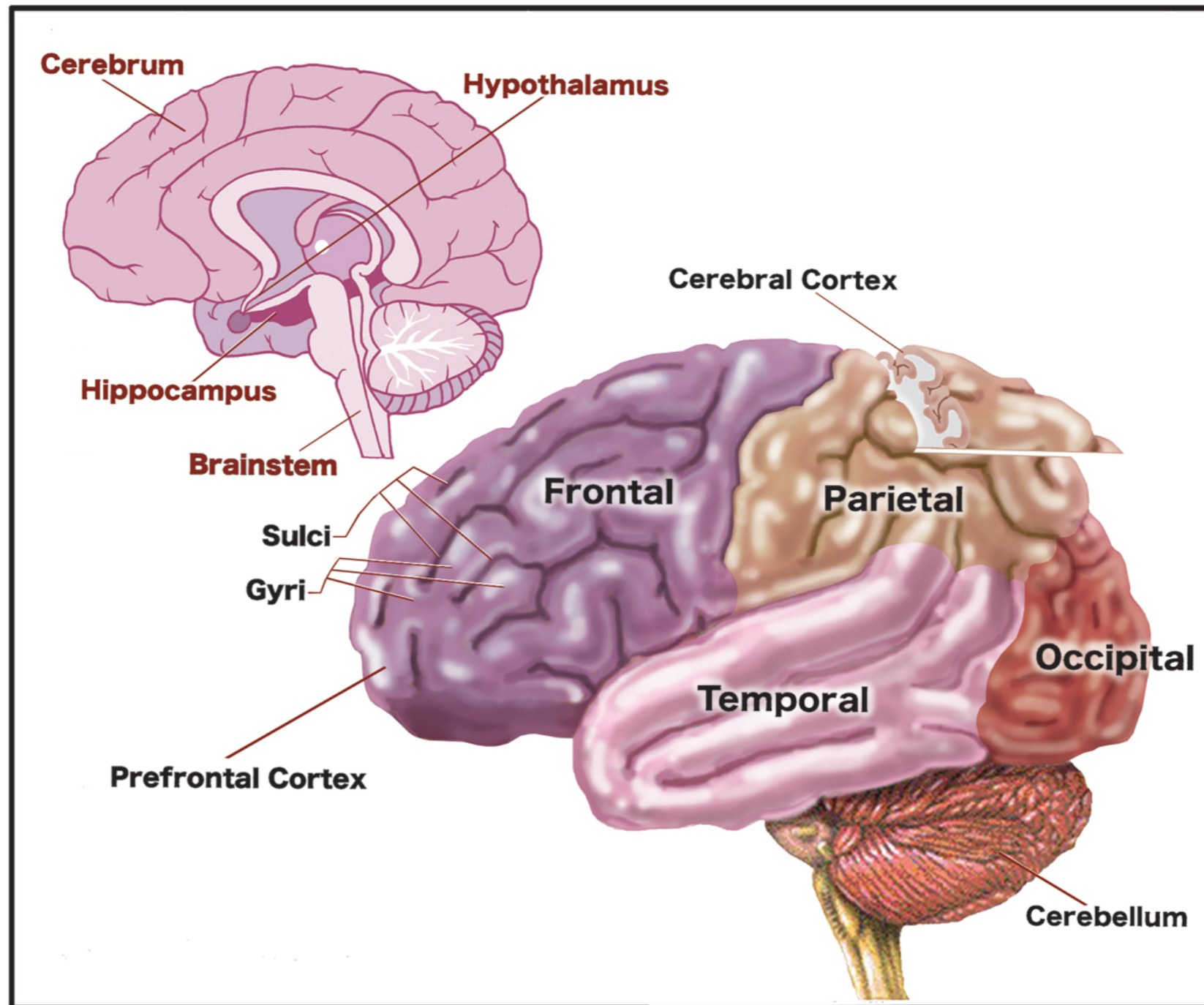
Prolonged activation of stress response systems  
in the absence of protective relationships.

# Hypothesis: SES-Associated Stresses Influence Brain Development





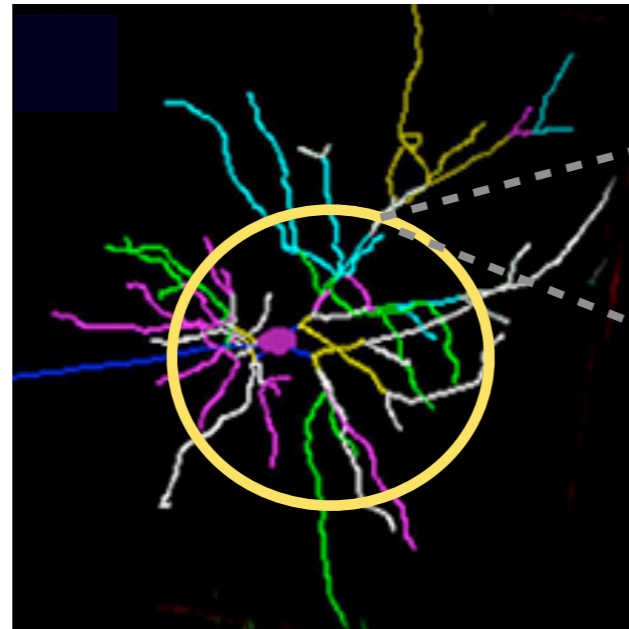
# Medial View of the Human Brain



# The Neuroscience of Stress

## Toxic Stress Changes Brain Architecture

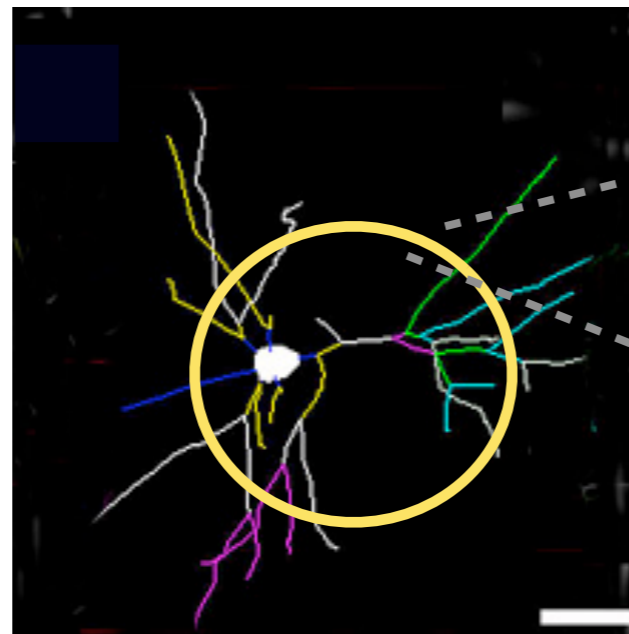
Normal



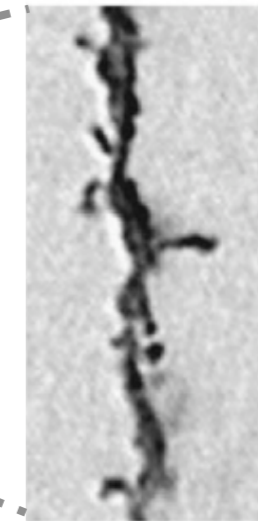
Typical neuron –  
many connections



Toxic  
Stress



Damaged neuron –  
fewer connections



Prefrontal Cortex and  
Hippocampus

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



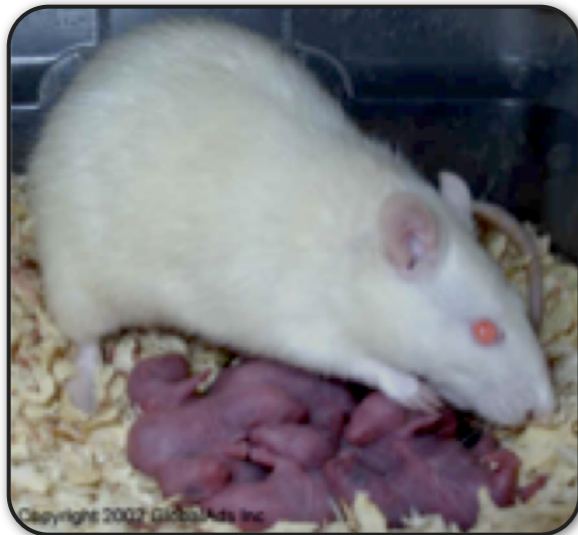
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# Tying It All Together

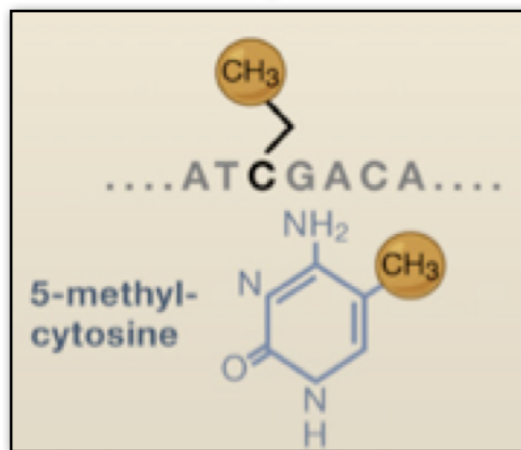
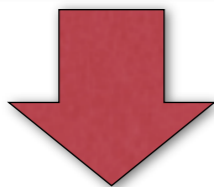
- Epigenetics- Describes changes in gene function that are not the result of changes in the underlying DNA sequences
  - E.g.All cells in the human body have the same DNA but different cells do different things: neurons vs muscle
  - Nature + Nurture can result in modification of gene expression such that your DNA genome is not necessarily your destiny
  - In some situations changes in gene expression can be passed down at least one generation
- Cloud, J. Why Genes Aren't Destiny, Time Magazine Jan 18 2010, p 48-53.

# Effect of Maternal Care (Nurturing, Environment) on Gene Expression (Nature) in the Rat

**Bad Mom**



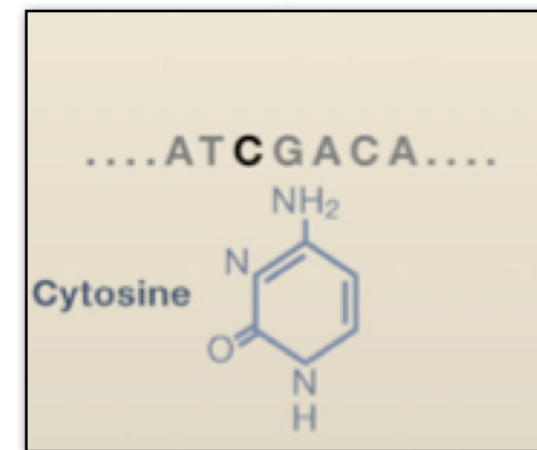
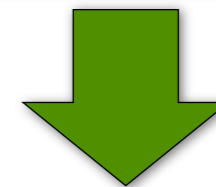
On the left, a mother nurses her offspring without arching her back, which may lead to increased cytosine methylation (diagrammed on bottom left) in a glucocorticoid receptor gene promoter, which will decrease glucocorticoid receptor gene expression.



**Good Mom**



On right, a mother engages in arched-back nursing, which allows for greater movement and access to nipples and is associated with more demethylated cytosine (diagrammed on bottom right) and more glucocorticoid gene expression.



*Maternal behavior changes expression of an important stress response gene through methylating a gene promoter.*

# Environmental Signals Can Remodel Epigenetic Marks that Regulate Gene Expression

(MJ Meaney, Child Psych, 2010)

- Low LG pups have enhanced HPA responsiveness when faced with stress
- Low LG pups have decreased hippocampal glucocorticoid receptors
- Effects of maternal care on hippocampal GCR expression are associated with an epigenetic modification of a neuron specific GCR promoter
- High LG pups have increased GCR expression in hippocampal tissue and a muted HPA response to stress



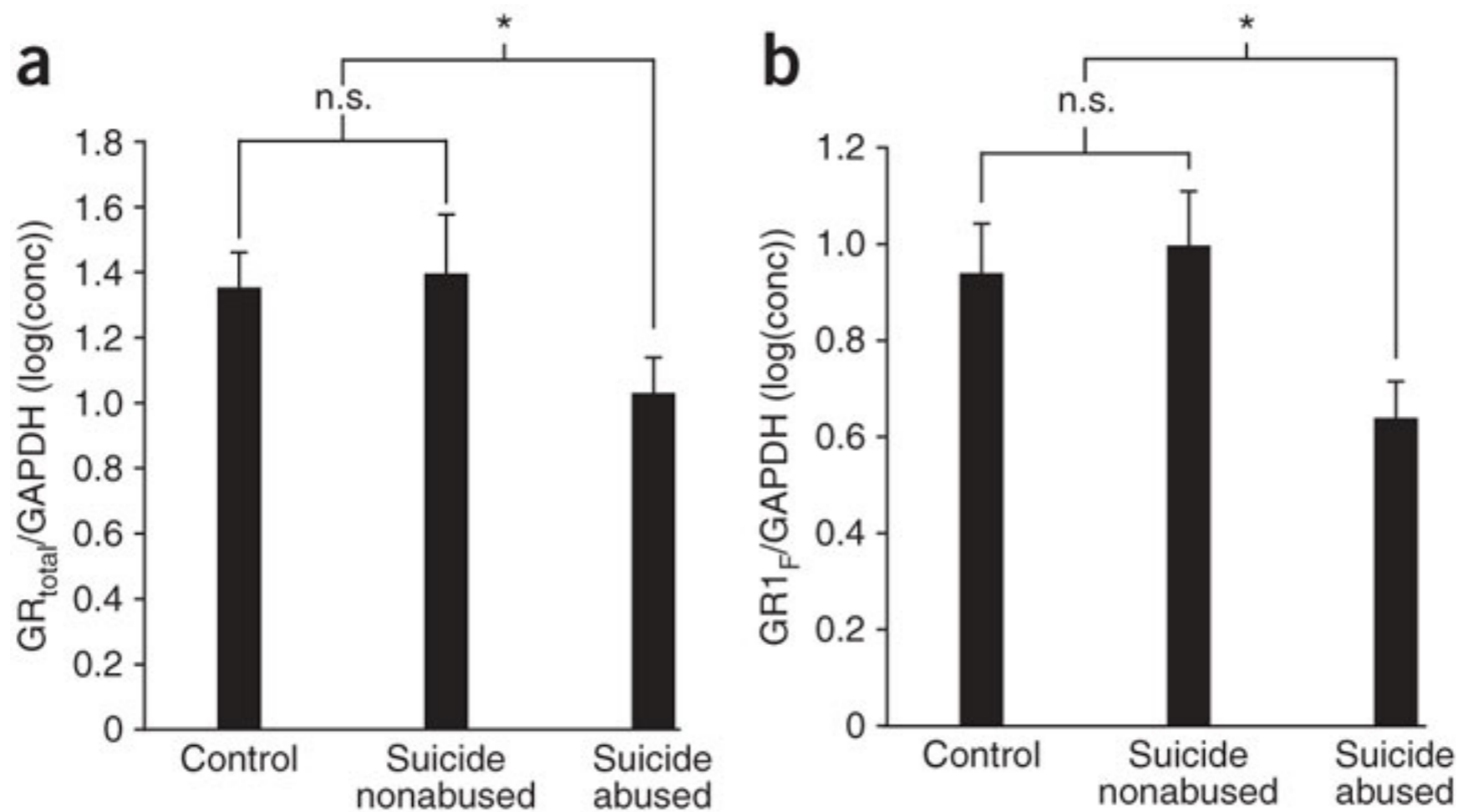
# Epigenetic Regulation of GCR and Child Abuse

(McGowen et al. Nature Neuroscience 2009)

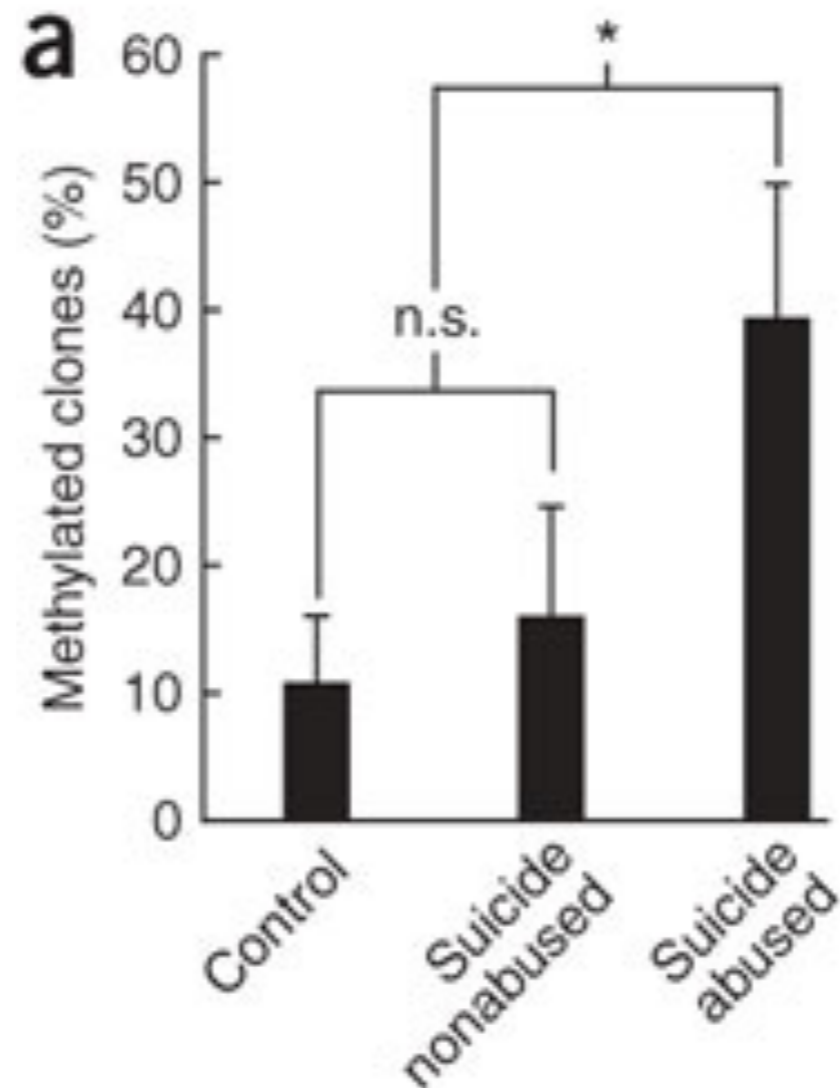
- 12 Accidental death controls
- 12 suicide victims who had a history of child abuse: decreased GCR in hippocampus, increased methylation of NR3C1 promoter
- 12 suicide victims without a history of child abuse: no significant difference from 12 acute accidental death controls.

# Hippocampal GCR expression in humans

a) GR mRNA b) GR receptor



# Methylation of the NR3C1 Promoter in the Human Hippocampus





# Toxic Stress.

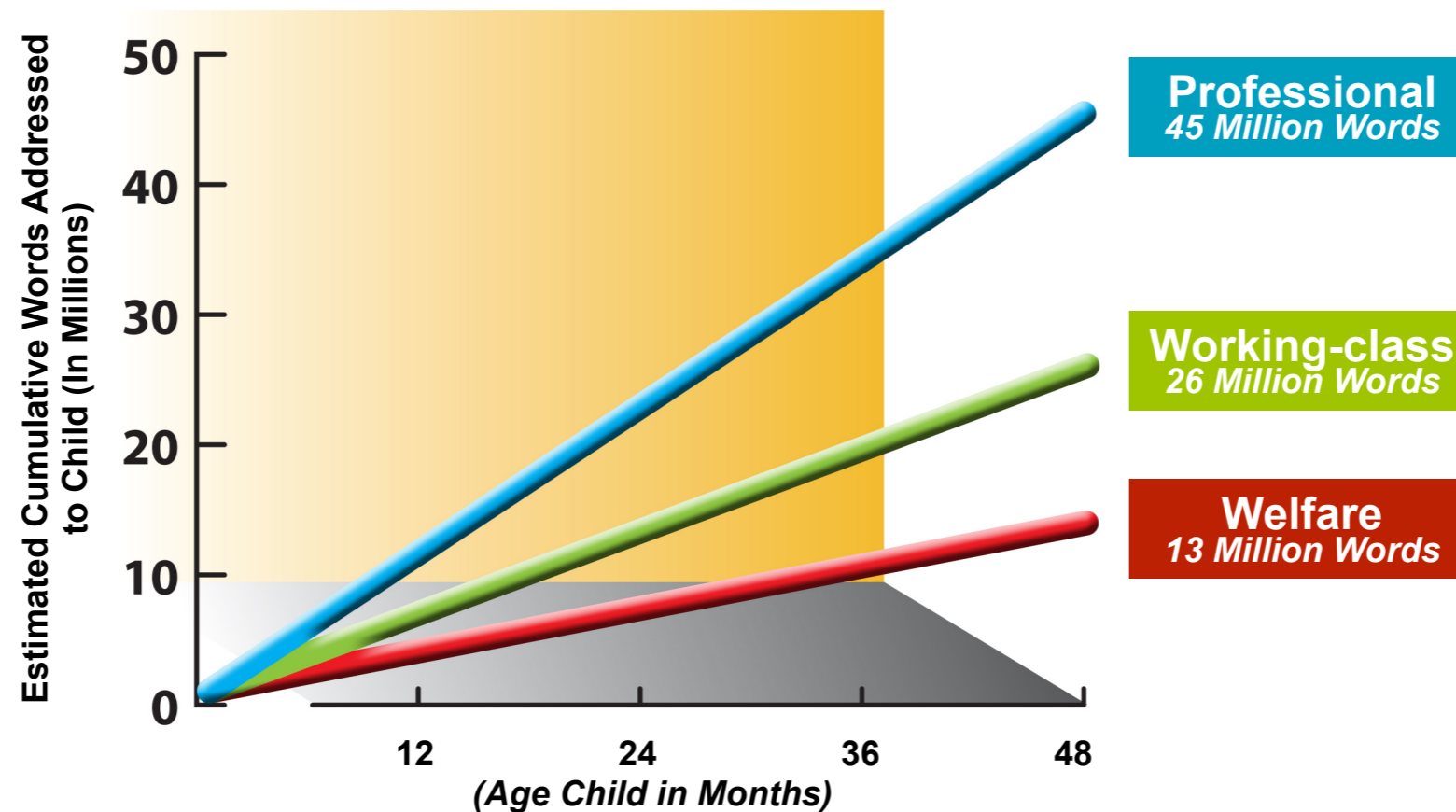


Source: Bill Day, The Urban Child Institute, 2009

# Optimizing a Baby's Brain Development

- Family and friends
- Structured Interventions
  - Home Visitation
  - Center Based Care

# Language Experiences by SES Group



Source: *Meaningful Differences in the Everyday Experience of Young American Children* by Betty Hart & Todd R. Risley. Paul H. Brookes Publishing Co. (1995).



Source: Bill Day, The Urban Child Institute, 2009

# “Motherese”

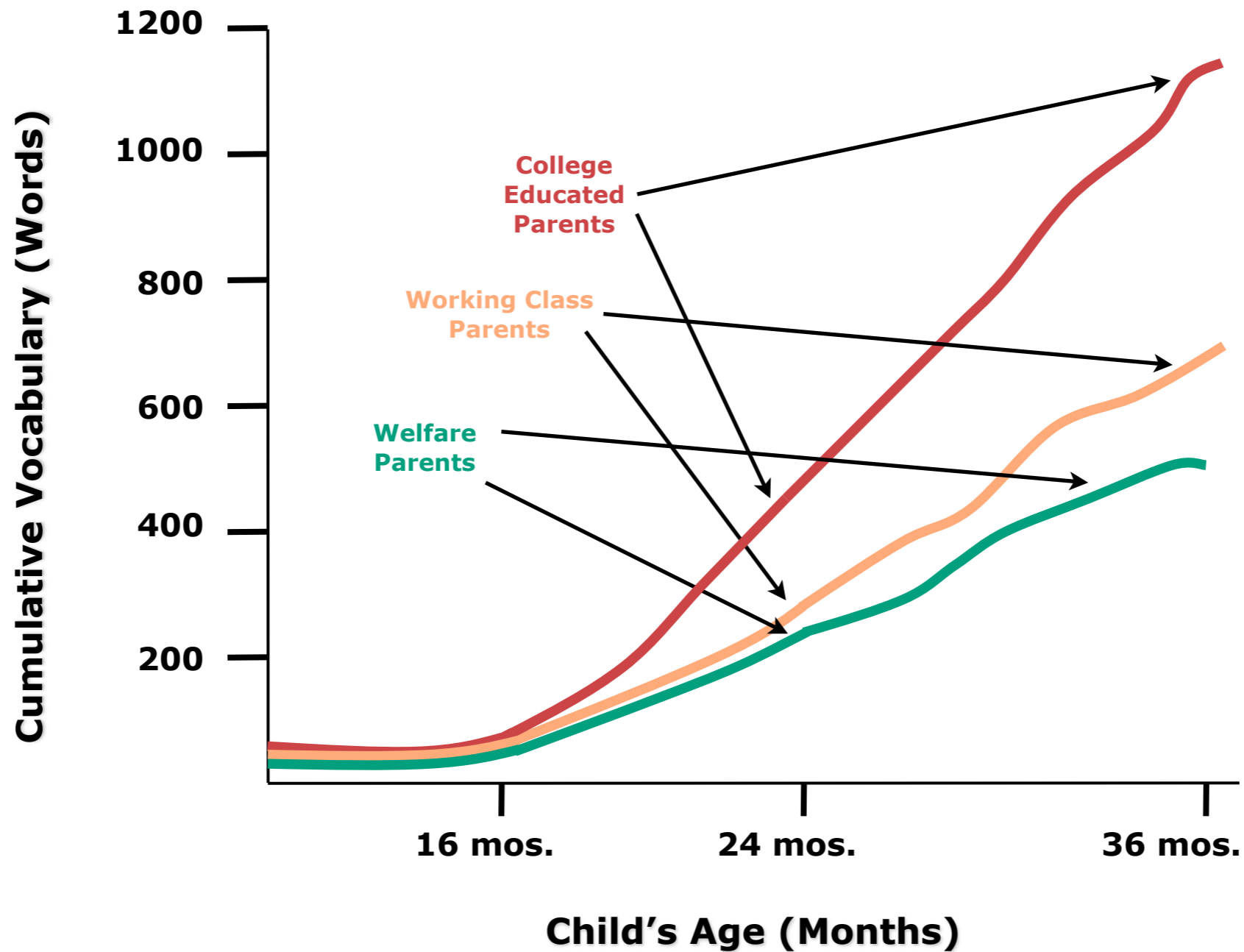


Yeah.

Do I have to  
eat these?



# Barriers to Educational Achievement Emerge at a Very Young Age



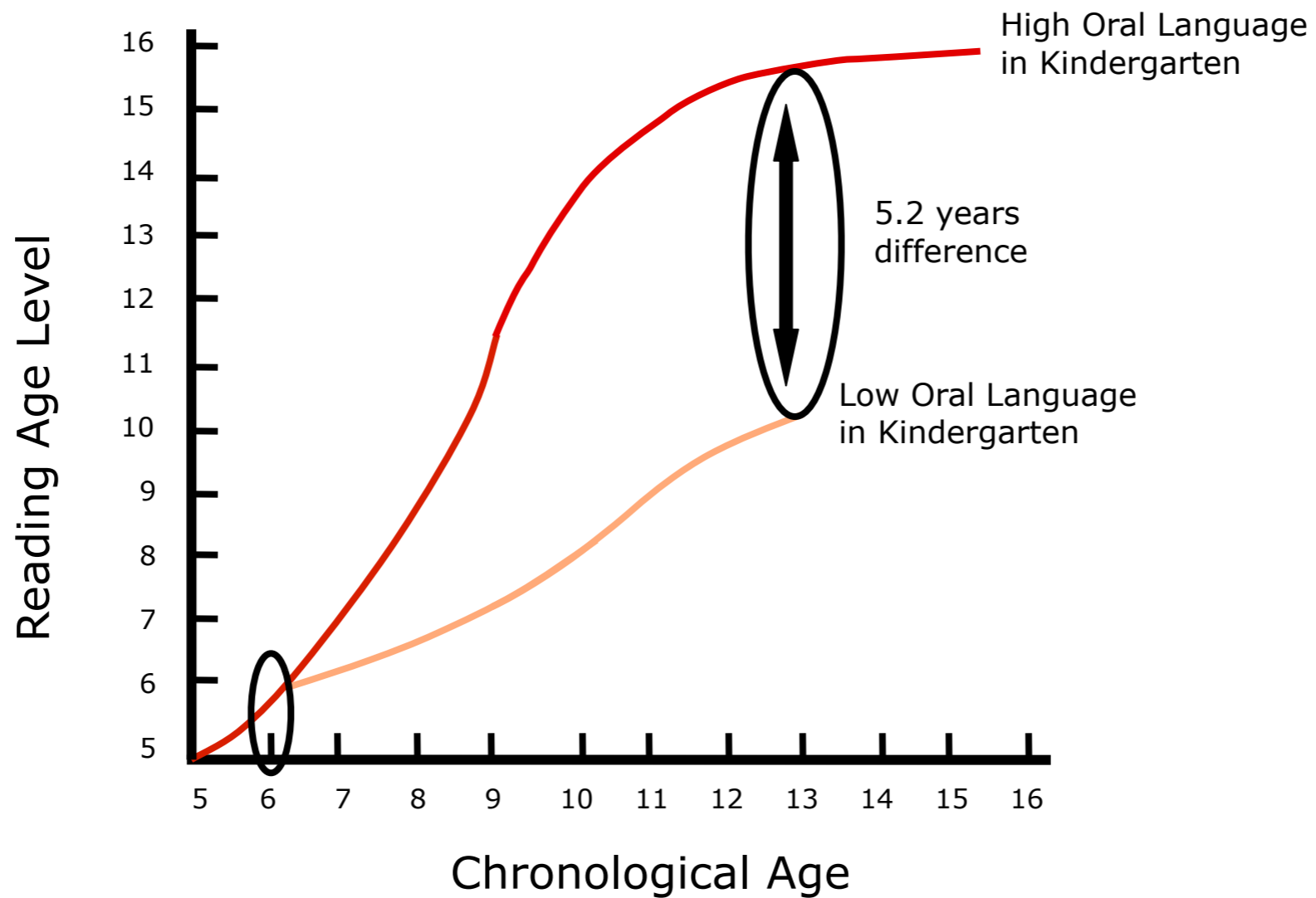
Source: Hart & Risley (1995)



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# Effect of Oral Language on Reading Levels



# The Memphis Nurse Family Partnership Program

(Olds et al Peds 2007 e 832-e845.)

- Enrollment Characteristics-AA, unmarried, low income, <12 grade education, unemployed
- Control Group-515 enrollees. Prenatal visits and developmental screenings at 6, 12, 18 mos.
- Intervention Group-228 enrollees. As above plus home visits while pregnant and for first two years of child's life

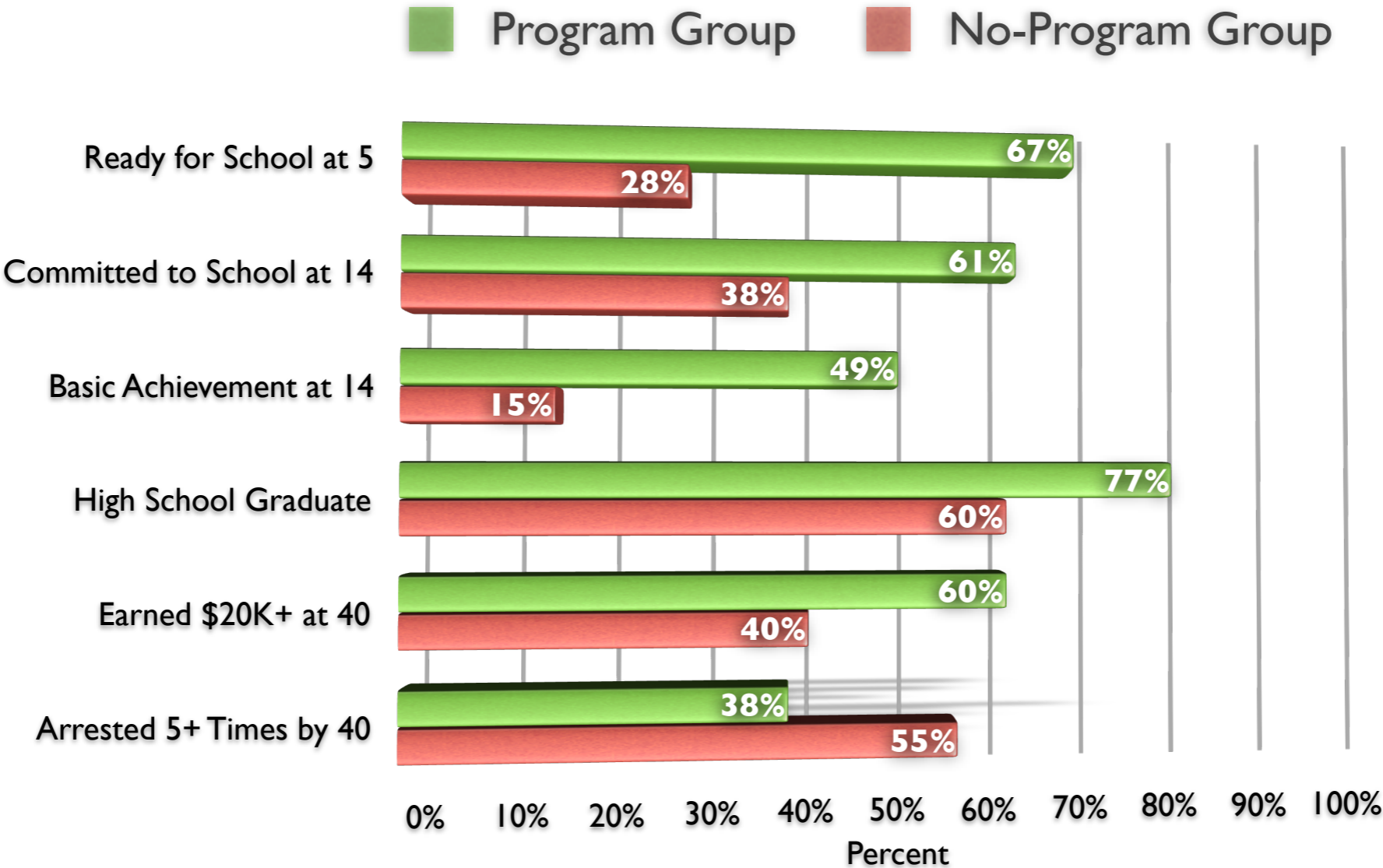
# Effect of Memphis NFP on Mothers

- Increased interval between births of first and second children
- Longer period with same partner
- Decrease in number of months on food stamps and other welfare programs
- Fewer subsequent low birth weight babies
- Less substance use

# Effect of Memphis NFP Program on Children Through First Nine Years

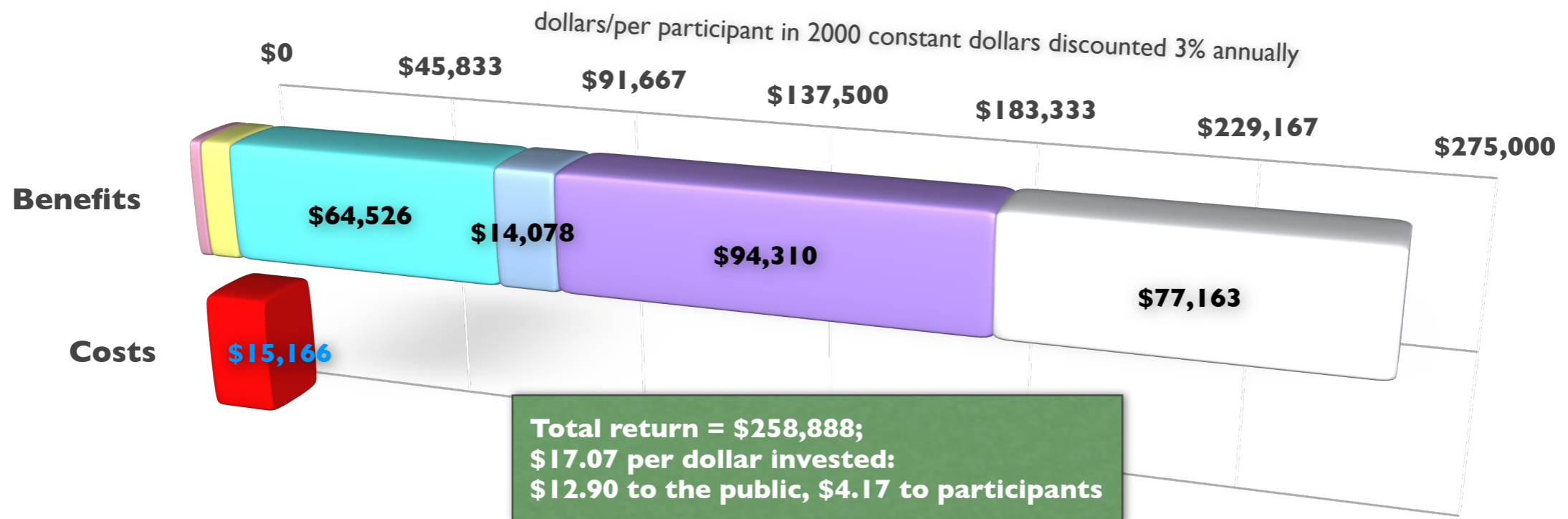
- During the first 2 years of life fewer hospitalizations for accidents and injuries
- By 9 years of age improved grade point averages-lowest resource children (LRC)
- Improved achievement test scores-LRC
- Deaths: Control group 10 deaths (4 SIDS, 2 firearm deaths) Intervention group 1 death (chromosomal abnormality)

# Model Preschool Programs May Have Lifetime Effects



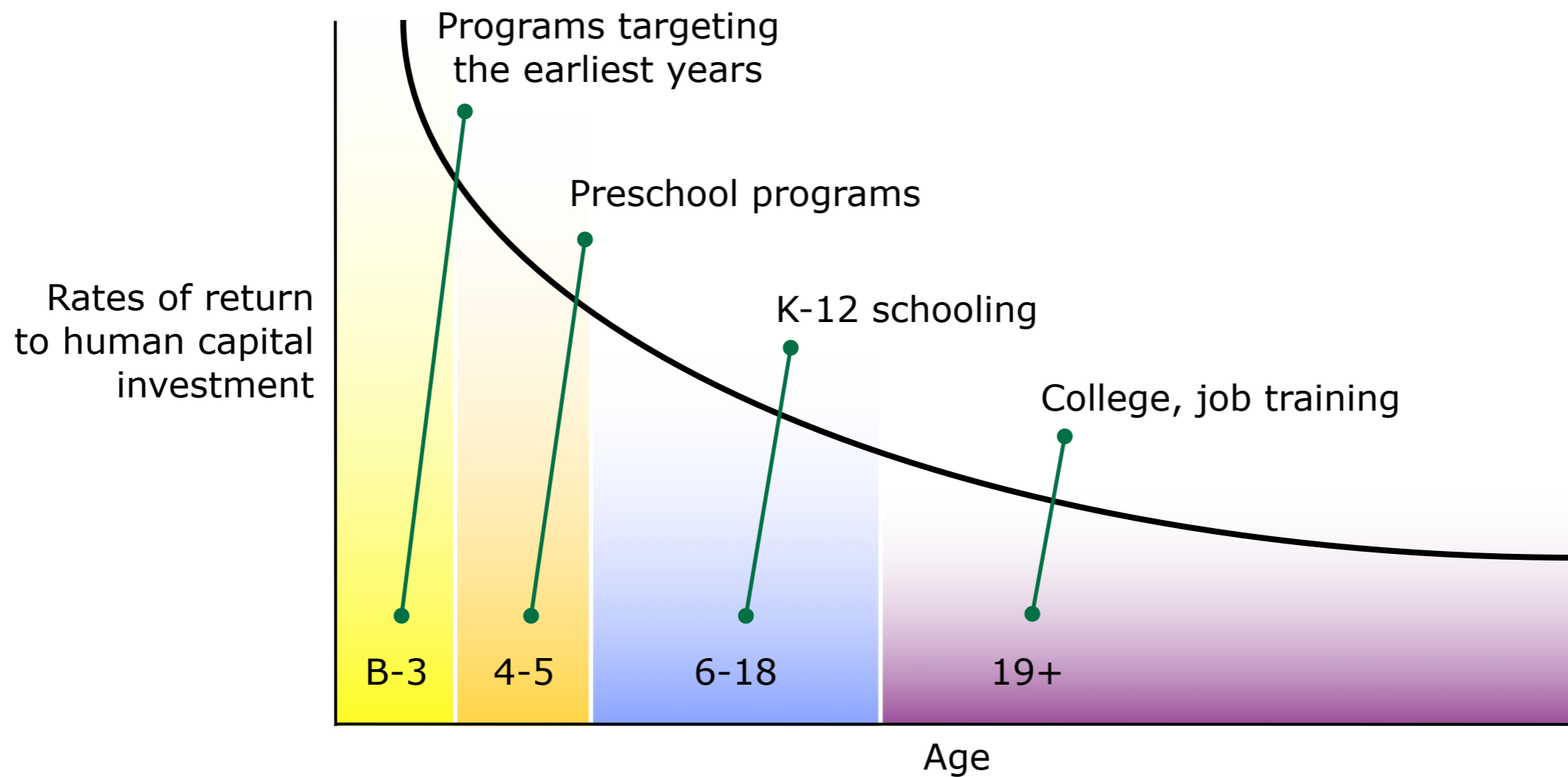
Source: High/Scope Perry Preschool Study

# Model Preschool Programs Have Large Return on Investment





# Preventive Intervention is More Efficient and Produces More Favorable Outcomes Than Later Remediation



Source: Heckman, J. (2007)



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