

# The Impact of Early Experiences on Brain and Behavioral Development

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# 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



# Experiences Build Brain Architecture



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# Brain Architecture Supports Lifelong Learning, Behavior, and Health

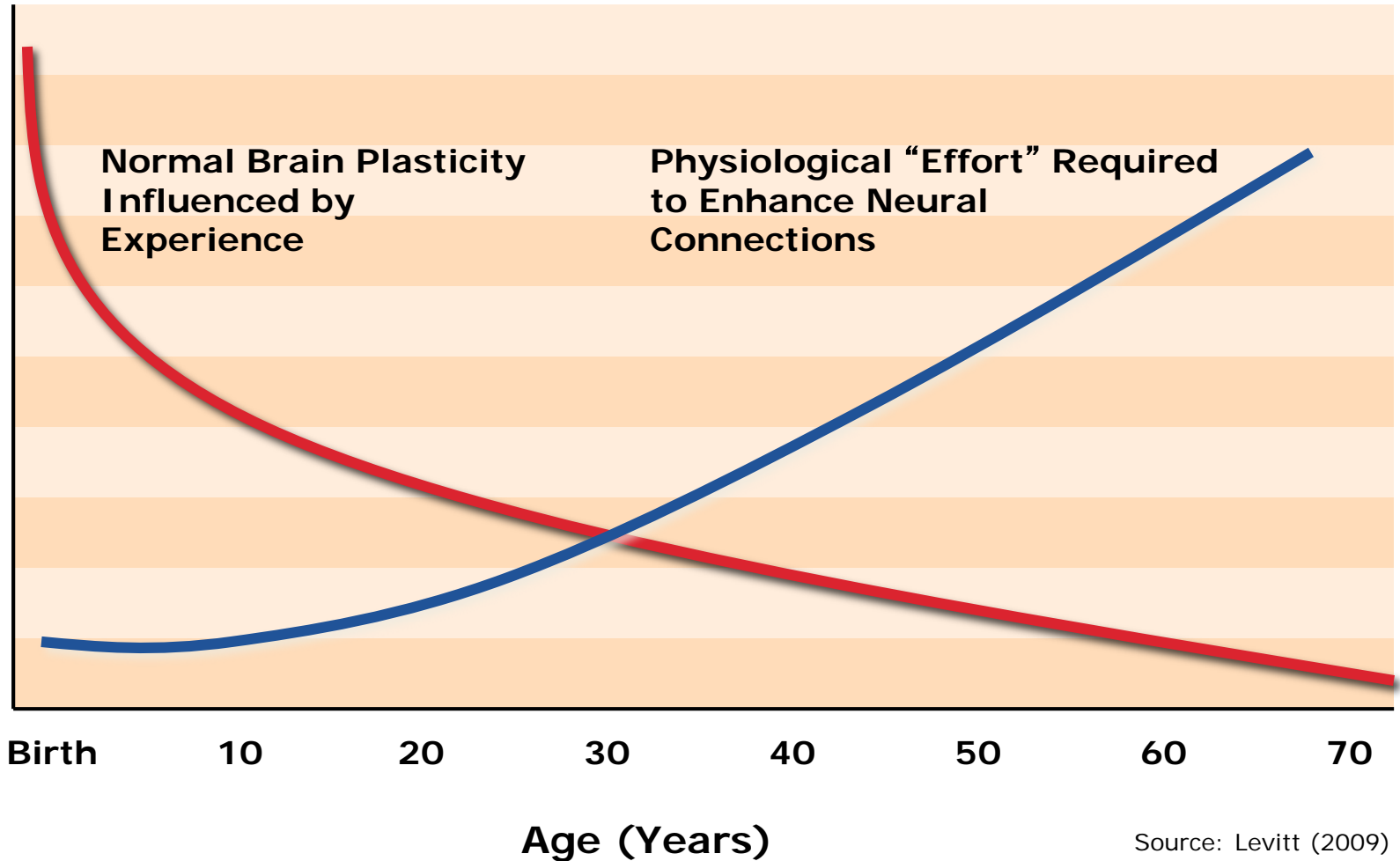
Brains are built over time, starting in the earliest years of life. Simple skills come first; more complex skills build on top of them.

Cognitive, emotional, and social capabilities are inextricably intertwined throughout the life course.

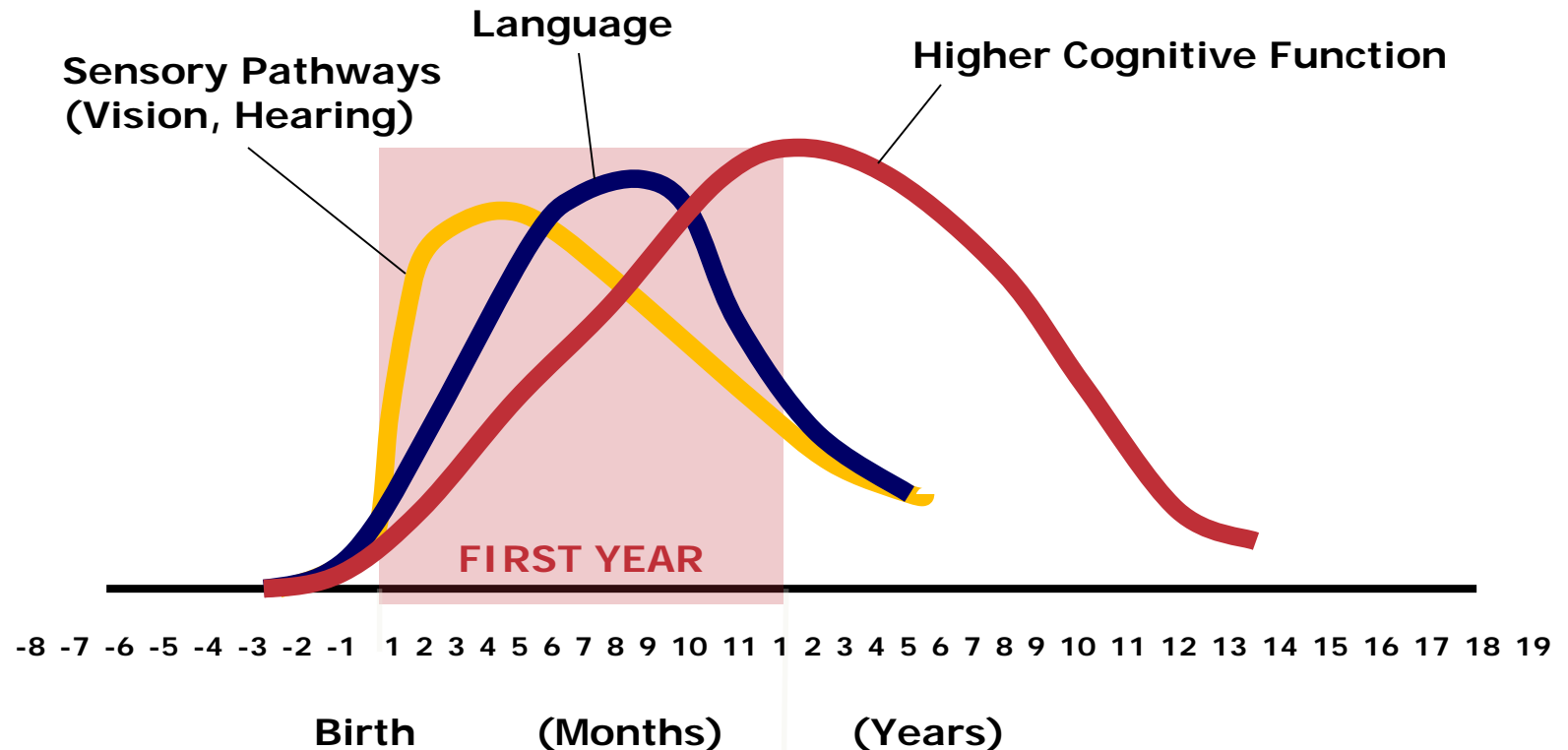
A strong foundation in the early years improves the odds for positive outcomes, and a weak foundation increases the odds of later difficulties.



# The Ability to Change Brains Decreases Over Time



# Neural Circuits are Wired in a Bottom-Up Sequence



Source: C.A. Nelson (2000)

# Experiences Shape Brain Architecture by Over-Production Followed by Pruning

700 synapses are formed per second in the early years



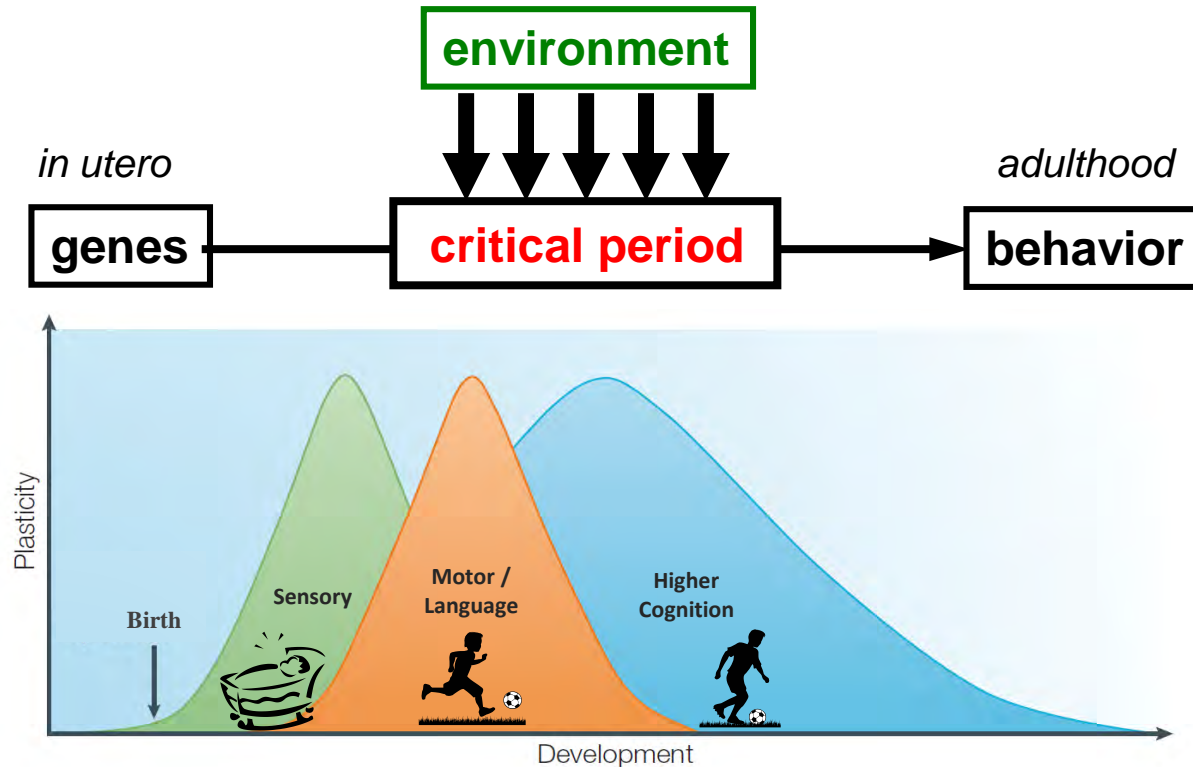
birth

# Sensitive Periods

- Are limited time periods during which the effect of experience on the brain is particularly strong
- Allow experience to instruct neural circuits to process information in an adaptive way
- Provide information that is essential for normal development and may permanently alter performance



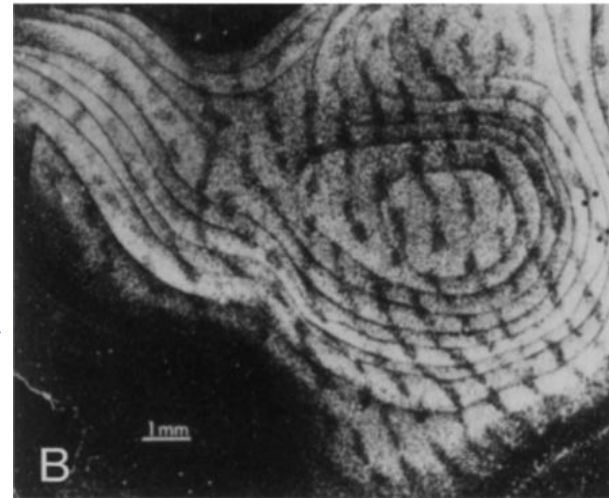
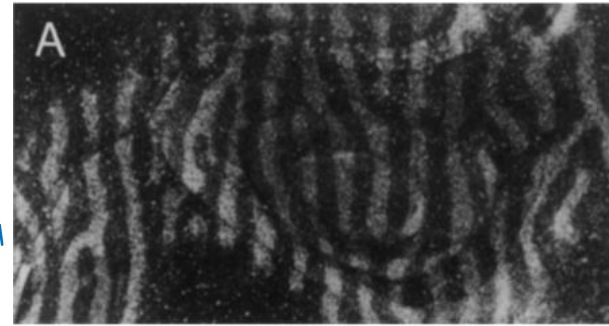
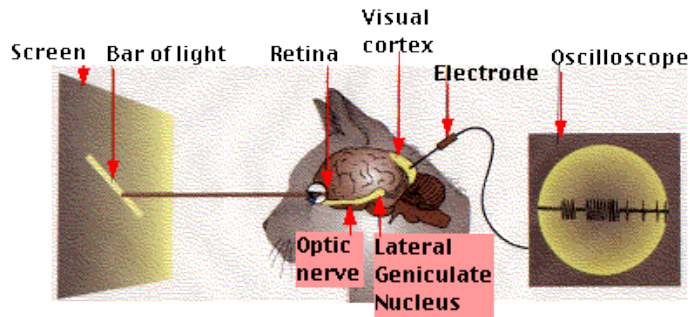
# Early Windows of Experience Shape Brain Function



# Lorenz and Imprinted Ducklings Walking After Him

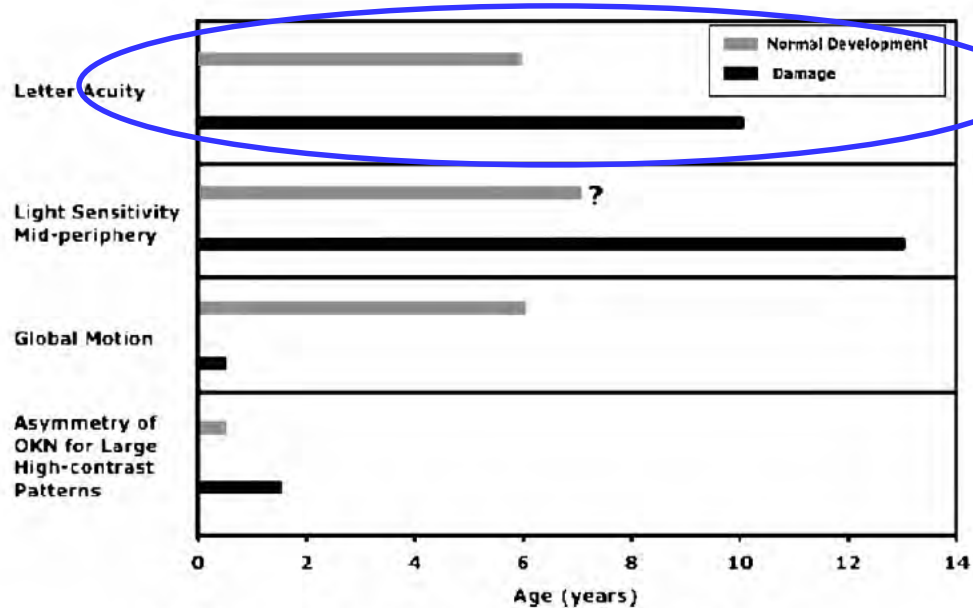


# Hubel and Weisel: Classic Studies on Early Experience and Sensitive Periods



Monocular deprivation in early infancy led to deficits in brain organization in visual cortex

# Studies of Infants Born with Bilateral Cataracts—Timing of Surgical Removal

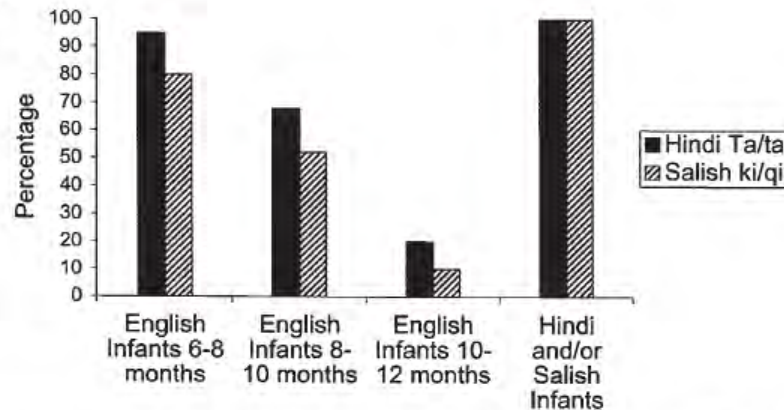


**FIGURE 9** Examples of sensitive periods across four aspects of vision. Gray bars represent periods of normal development, and black bars represent sensitive periods for damage. Ages indicating the end of each period are approximate and apply to the conditions described in the text. For convenience, we chose birth as the beginning of each sensitive period for damage, although the actual ages are unknown. The graph illustrates that the period of normal development ends at ages varying from a few months (asymmetry of OKN for large, high-contrast patterns) to 6 or 7 years of age (letter acuity, global motion, and perhaps light sensitivity in the midperiphery—for which 7 years is the youngest age tested beyond infancy). The sensitive period for damage can be considerably longer or shorter than the period of normal development.

# The Timing and Nature of Experience with Language Affects Perception of Different Languages

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Werker and Tees



**FIGURE 3** The effects of age and experience on infants' ability to discriminate two non-English contrasts. The proportion of infants at each age reaching discrimination criterion on the Hindi and Salish (non-English) contrasts. From "Cross-language speech perception: Evidence for perceptual reorganization during the first year of life," by J. F. Werker & R. C. Tees, 1984a, *Infant Behavior and Development*, 7, 49-63. Adapted with permission of the authors.

Before 9-10 months of age, infants can discriminate the sounds of all languages. By the end of the first year of life, they are able to discriminate only the language(s) they hear in their environment.



# Interaction Shapes Brain Circuitry



# Serve & Return Builds Brains and Skills

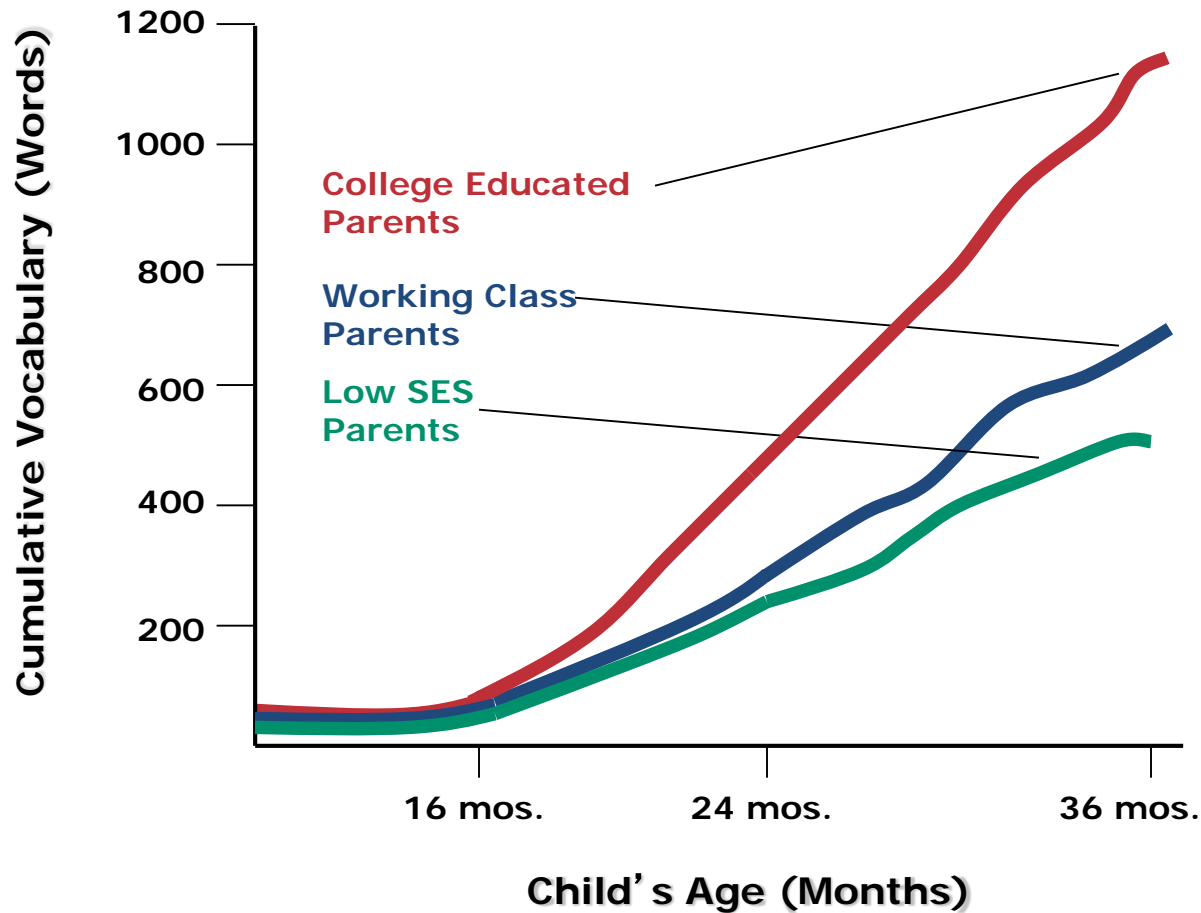
Young children naturally reach out for interaction through babbling, facial expressions, and gestures, and adults respond in kind.

These “serve and return” interactions are essential for the development of healthy brain circuits.

Therefore, systems that support the quality of relationships in early care settings, communities, and homes also support the development of sturdy brain architecture.



# Barriers to Educational Achievement Emerge at a Very Young Age



Source: Hart & Risley (1995)



# An “Air Traffic Control System” in the Brain



Executive functioning is a group of skills that help us focus on multiple streams of information at the same time, set goals and make plans, make decisions in light of available information, revise plans, and resist hasty actions.

- a key biological foundation of school readiness, as well as outcomes in health and employability

# What are Executive Function Skills?

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



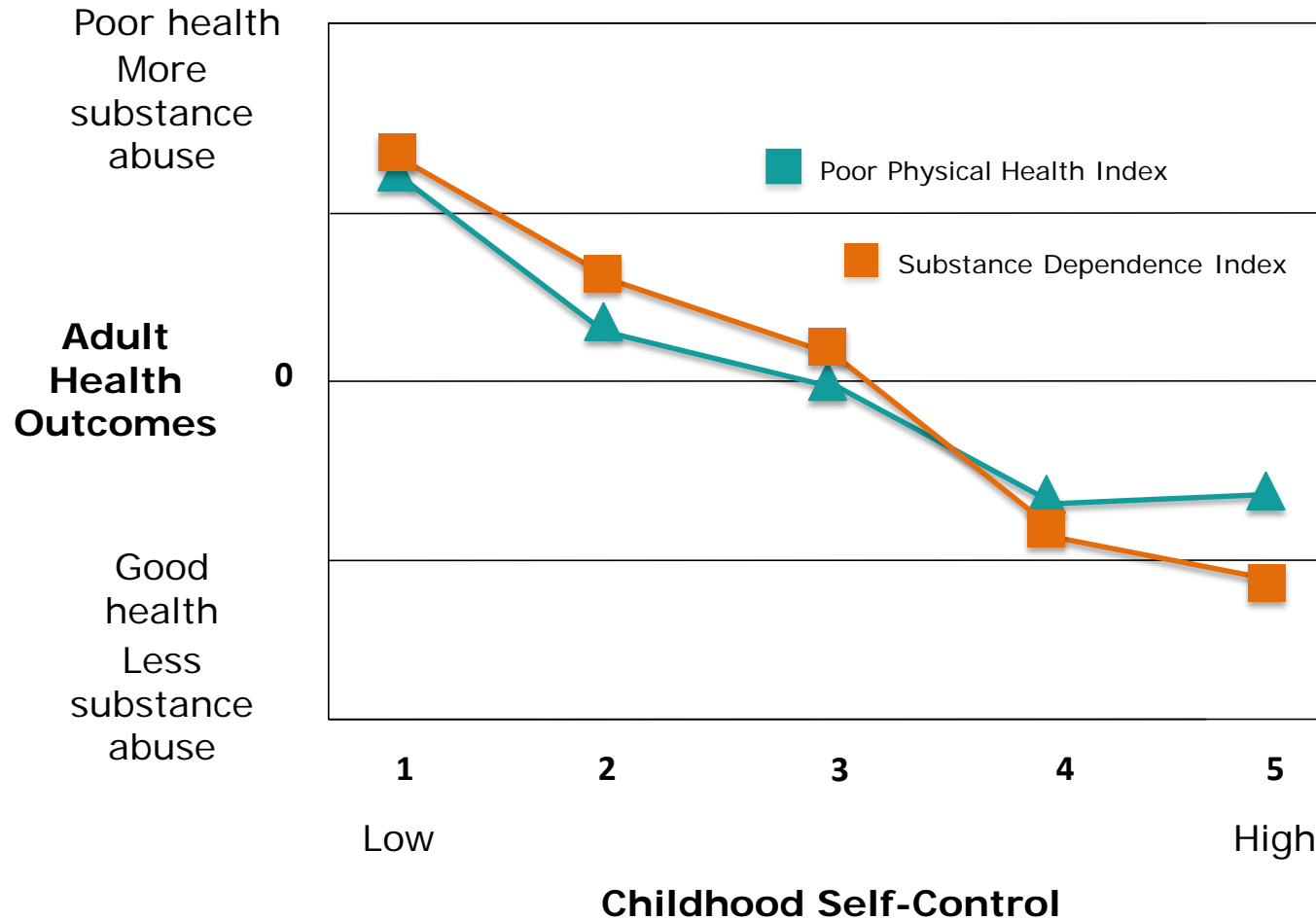
**Working Memory** — hold and manipulate information in our heads over short periods of time



**Cognitive Flexibility** — adjust to changed demands, priorities, or perspectives

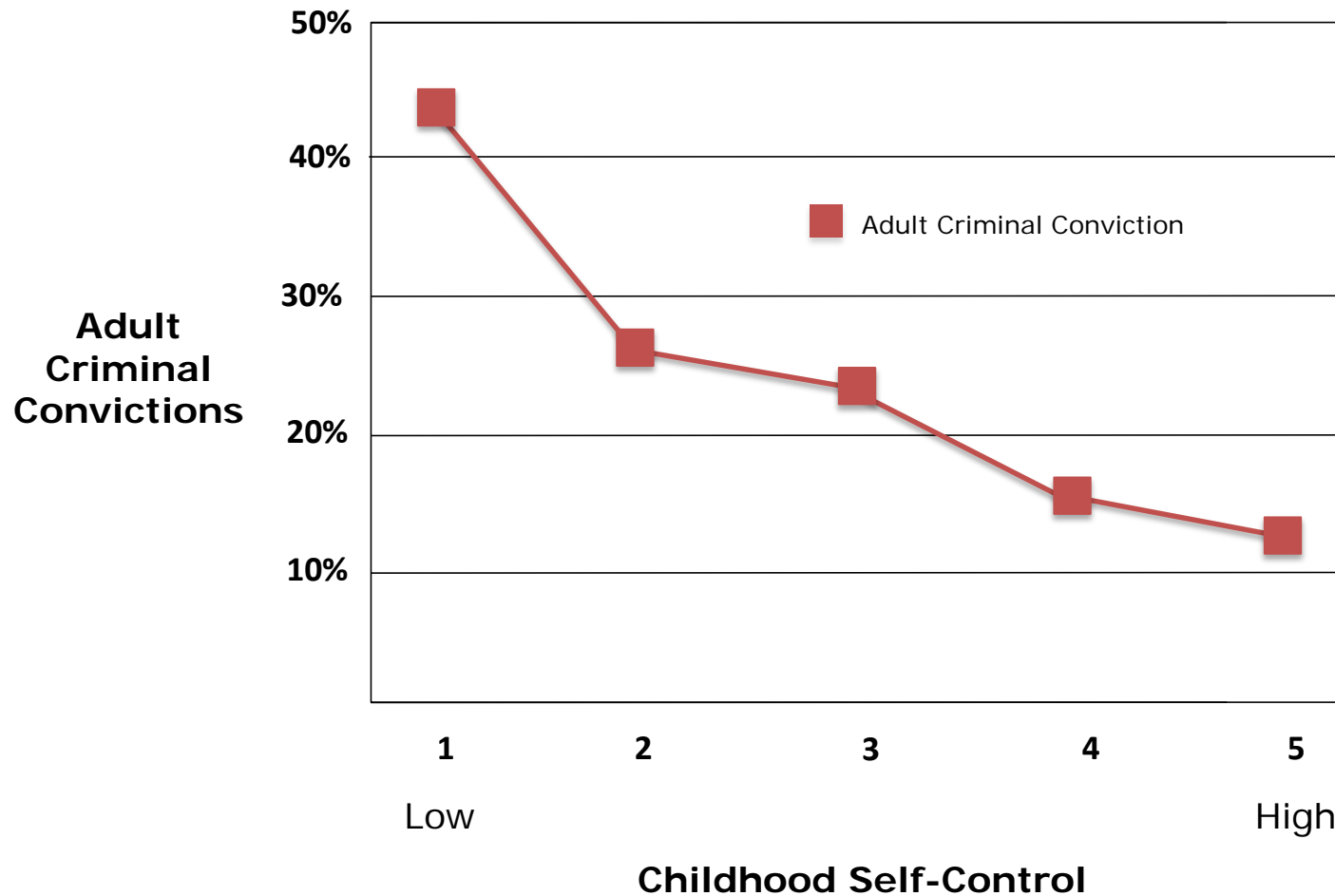


# Higher Childhood Self-Control Predicts Better Adult Health



Source: Moffitt, et al. (2011)

# Higher Childhood Self-Control Predicts Less Adult Crime



Source: Moffitt, et al. (2011)

# Toxic Stress Derails Healthy Development



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# The Biology of Adversity: 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.

# Relationships Buffer the Effects of Stress

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

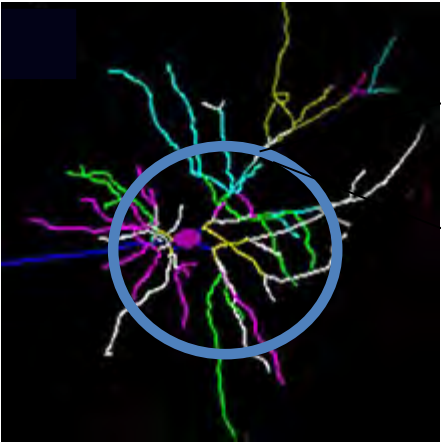
Toxic stress—when the body's stress response system is activated excessively—can weaken developing brain architecture.



Without caring adults to buffer children, toxic stress associated with extreme poverty, neglect, abuse, or severe maternal depression can have long-term consequences for learning, behavior, and both physical and mental health.

# Persistent Stress Changes Brain Architecture

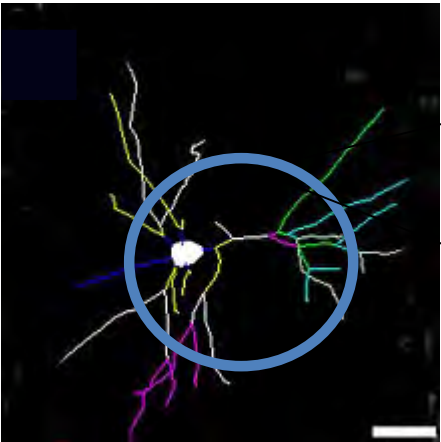
Normal



Typical -  
neuron with many  
connections



Chronic  
stress



Neuron damaged by  
toxic stress –  
fewer connections



Prefrontal Cortex and  
Hippocampus

Source: C. Nelson (2008)  
Bock et al. (2005)



# Adverse Childhood Experiences (ACES) Study

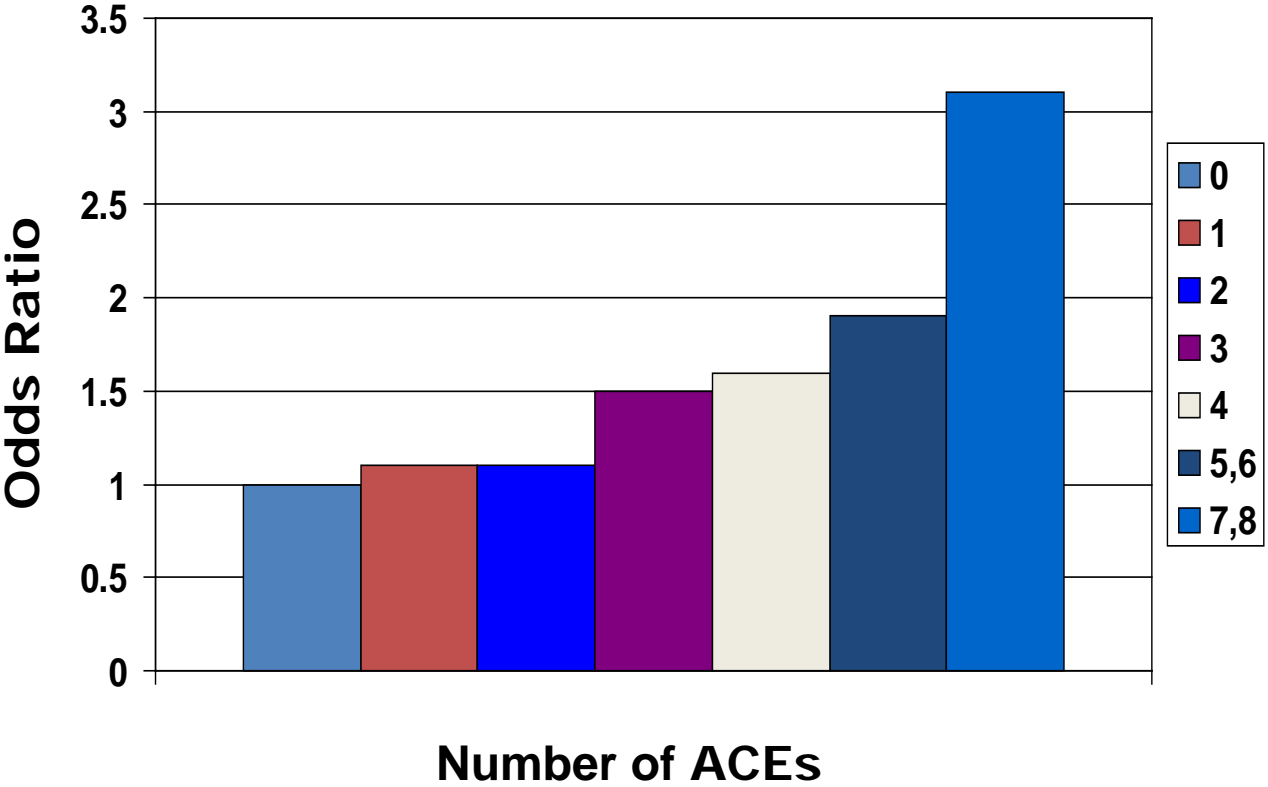
In 1995-1997, Kaiser Permanente in California conducted a survey of adult patients in which they were asked to identify a range of adverse childhood experiences (abuse, neglect, household challenges).

Researchers later found that the cumulative number of these experiences in childhood was related to adult health and disease.



Source: Felitti et al. (1998)

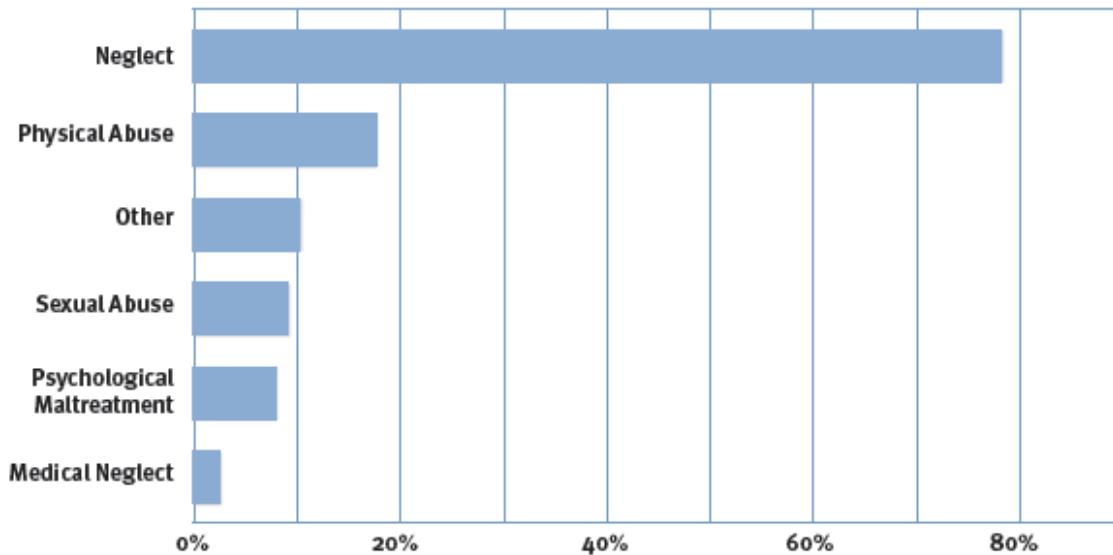
# Adverse Childhood Experiences and Adult Cardiovascular Disease



Source: Dong et al. (2004)

# Neglect is Common

## Neglect is the Most Prevalent Form of Child Maltreatment



Each state defines the types of child abuse and neglect in its own statute and policy, guided by federal standards, and establishes the level of evidence needed to substantiate a report of maltreatment. The data above, from the National Child Abuse and Neglect Data System (NCANDS), reflects the total number of victims (defined as a child for whom the state determined at least one report of maltreatment was found to be substantiated or indicated) as reported by all 50 states, the District of Columbia, and Puerto Rico, between Oct. 1, 2009, and Sept. 30, 2010. "Other" includes abandonment, threats of harm, and drug addiction.

Source: U.S. Department of Health and Human Services (2010b)<sup>23</sup>

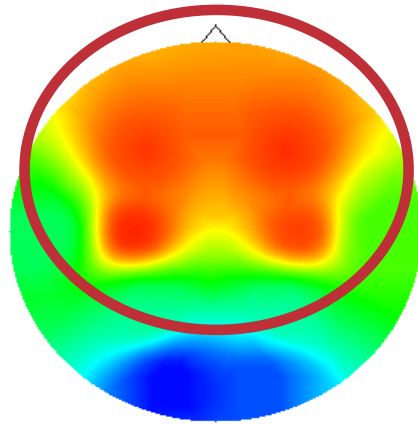


# Effects of Profound Neglect on Brain Development

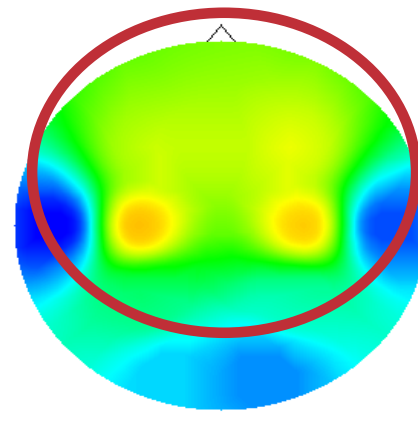
## Why neglect is bad for the brain

- Brain expects input it doesn't receive, so its wiring is altered
- Particularly egregious if experiences expected to occur during a sensitive period fail to occur (e.g., patterned light, sound, caregiving)

# Extreme Neglect Reduces Brain Power



Positive Relationships



Extreme Neglect

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

# There Are No Magic Bullets

Positive relationships and quality learning experiences can be promoted both at home and through a range of **evidence-based** parent education, family support, early care and education, and intervention services.

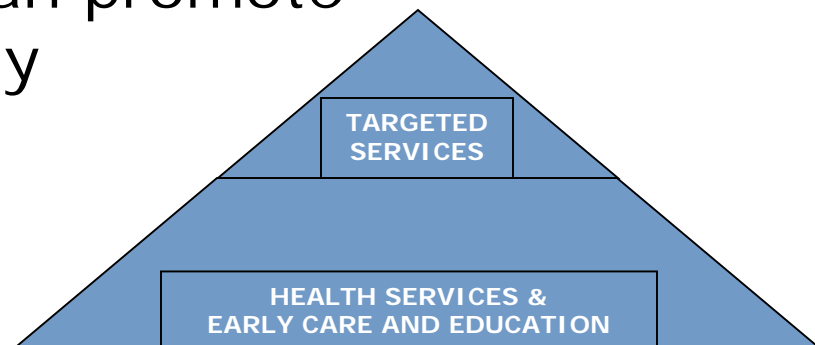
A balanced approach to emotional, social, cognitive, and language development will best prepare children for success in school and later in the workplace.

# Effectiveness Factors for Early Care and Education Programs for Children From Birth to Age 5

- Qualified and well-compensated personnel
- Small group sizes and high adult-child ratios
- Language-rich environment
- Developmentally appropriate “curriculum”
- Safe physical setting
- Warm and responsive adult-child interactions

# Science Points Toward a Two-Tiered Approach to Reducing Disparities

**Basic health services** and good quality **early care and education** can promote healthy development and early detection of problems in all children.



**Targeted services** for children experiencing tolerable or toxic stress can reduce disruptions of the developing nervous and immune systems that lead to later problems in learning, behavior, and health.



# Takeaways

- Significant brain development occurs in the first years of life
- Healthy brain and behavioral development require positive, sensitive, and responsive caregiving
- Toxic stress can derail healthy brain and behavioral development
- Providing support to families, good compensation to early childhood teachers, and good quality and basic health care services can go a long way toward enhancing positive outcomes



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