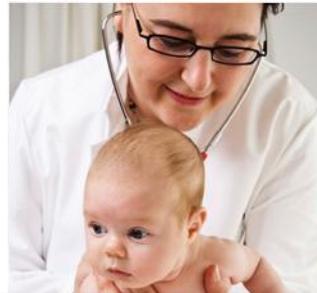


**EARLY** BRAIN &  
BIOLOGICAL  
DEVELOPMENT:  
A SCIENCE IN  
SOCIETY SYMPOSIUM

# The Interplay between Early Brain and Behavior Development

Judy Cameron, Ph. D.

*May 30, 2011*

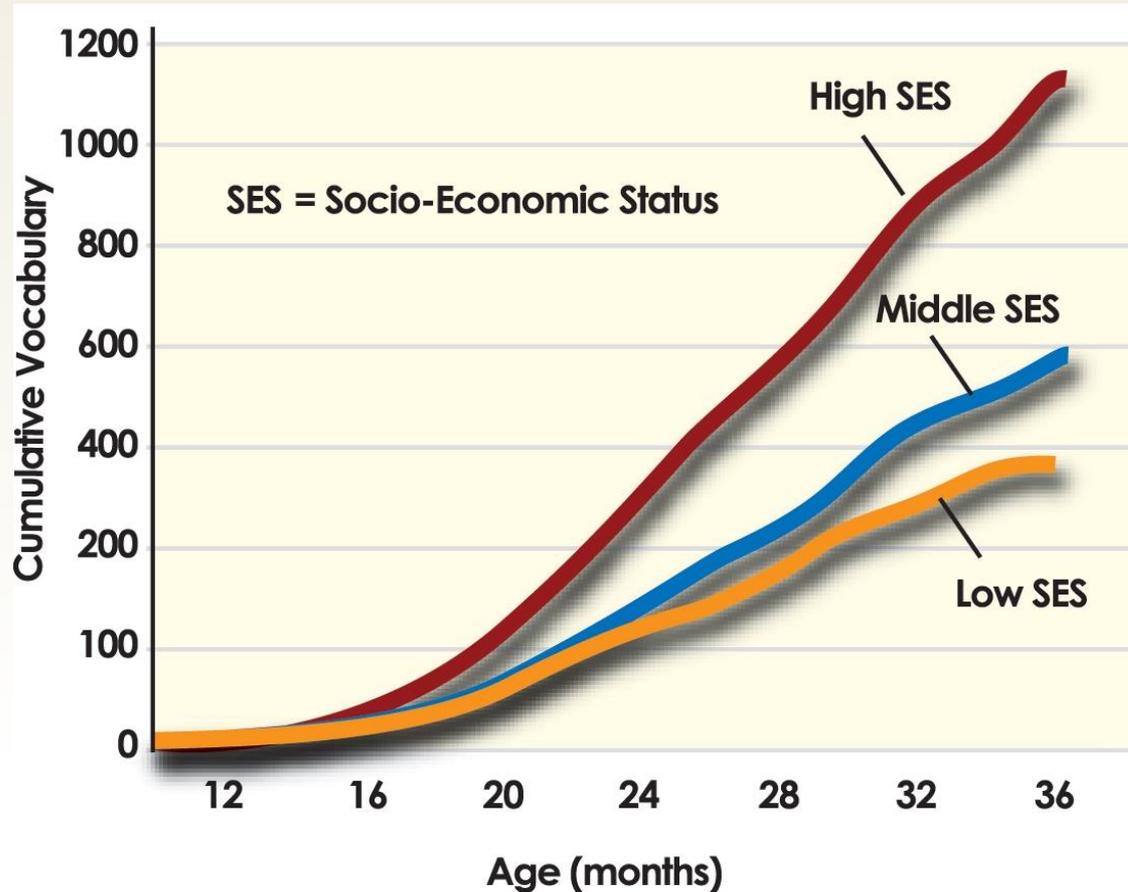


# The Importance of Viewing the Needs of Children in a Broad Context

The healthy development of all children benefits all of society by providing a solid foundation for economic productivity, responsible citizenship, strong communities, and a secure nation.



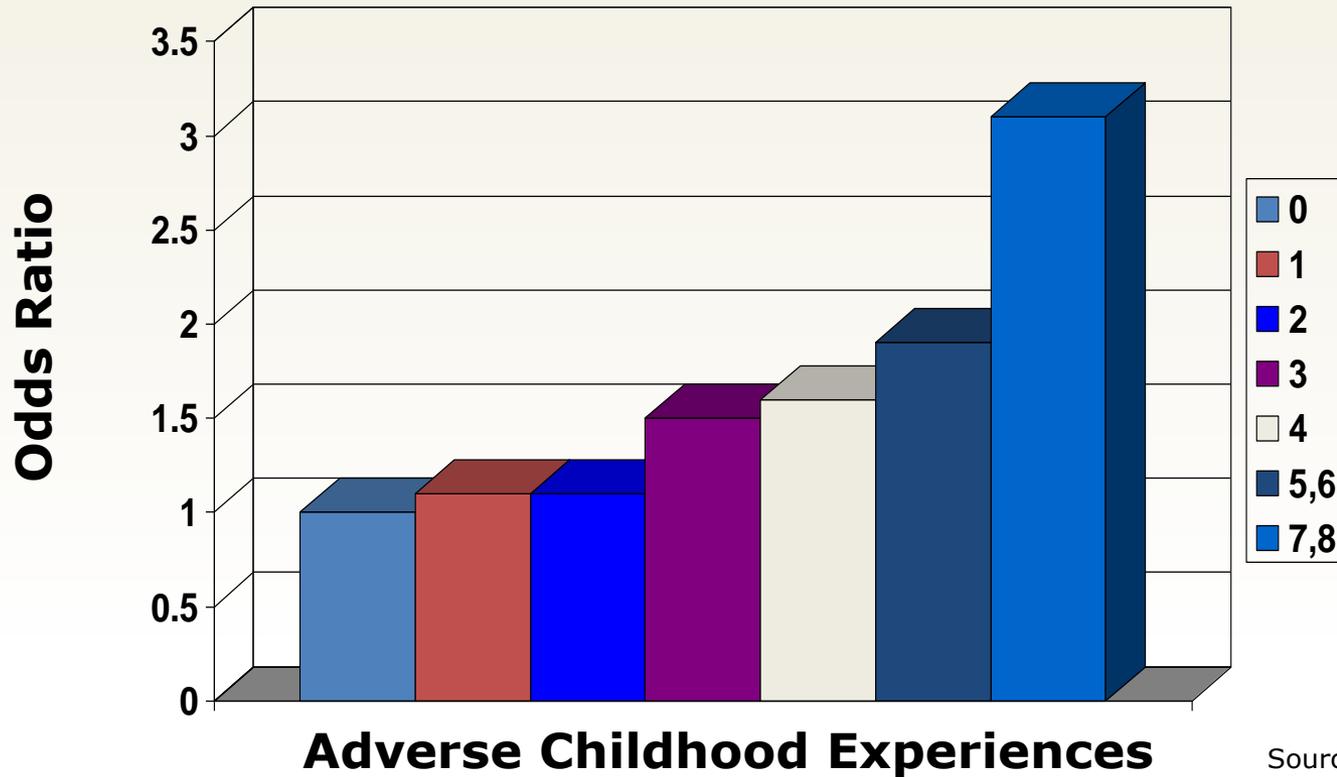
# Disparities in Early Vocabulary Growth



Source: Hart & Risley (1995)



# Adverse Childhood Experiences and Adult Cardiovascular Disease



Source: Dong et al, 2004

# Building an Integrated Science of Early Childhood Development

**Convergence of findings from neuroscience, developmental psychology, molecular biology, economics, and program evaluation research.**



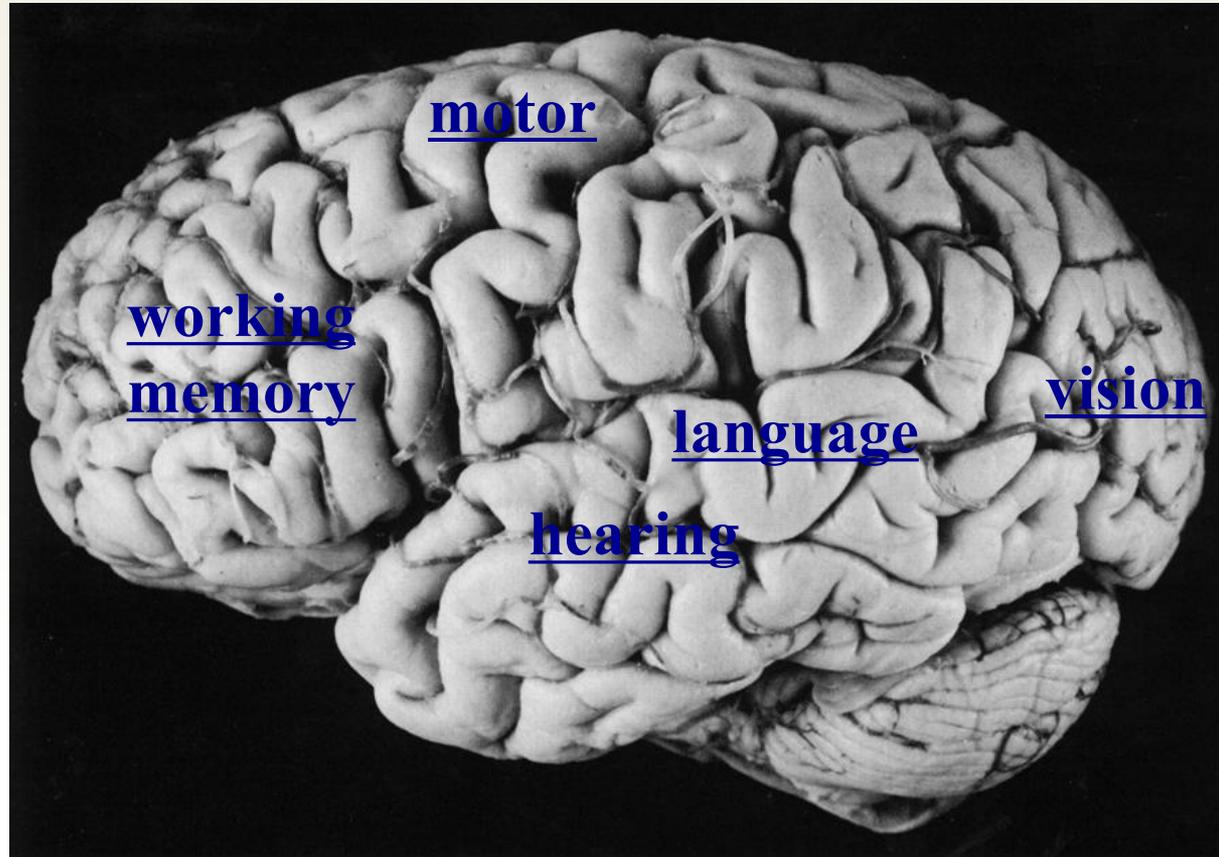
# Concept #1:

## Brains and Skills Are Built Over Time

- **The early years of life matter because both early experience and genes affect the architecture of the maturing brain.**
- **As it emerges, the quality of that architecture establishes either a sturdy or weak foundation for all the learning and behavior that follow.**



# Brain Architecture is Organized into Specialized Functional Areas



# Experience Shapes Brain Architecture by Over-Production Followed by Pruning



**birth**

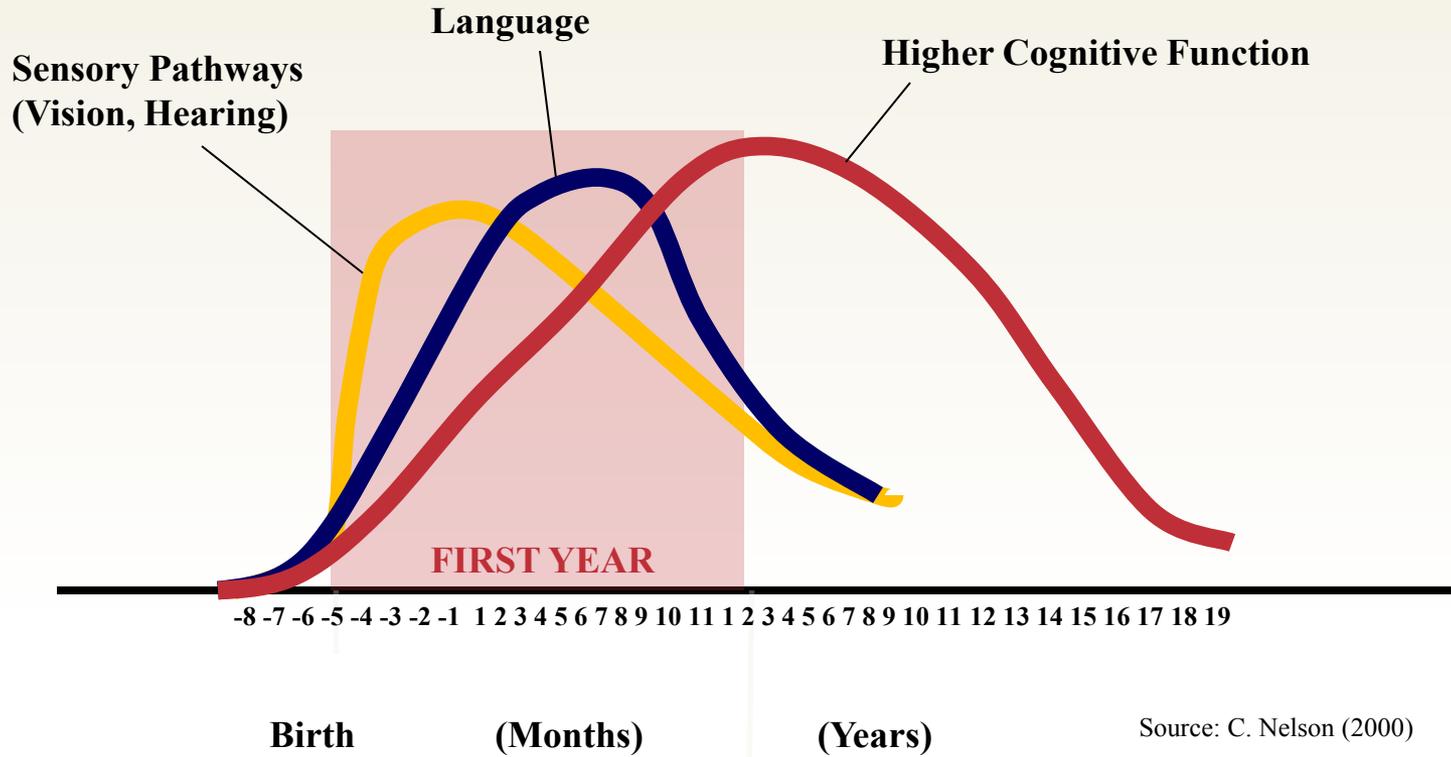
**3 years**

**14 years**



# Neural Circuits are Wired in a Bottom-Up Sequence

(700 synapses formed per second in the early years)



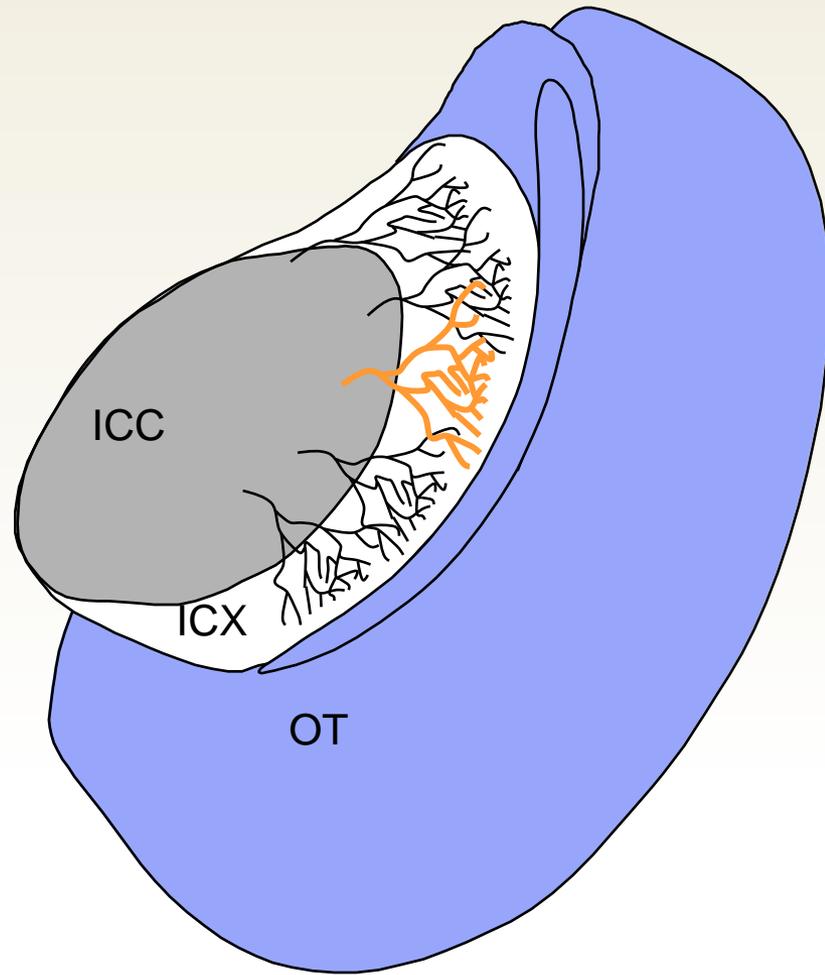
## Concept #2:

# Brain Architecture and Skills Are Built in a “Bottom-Up” Sequence

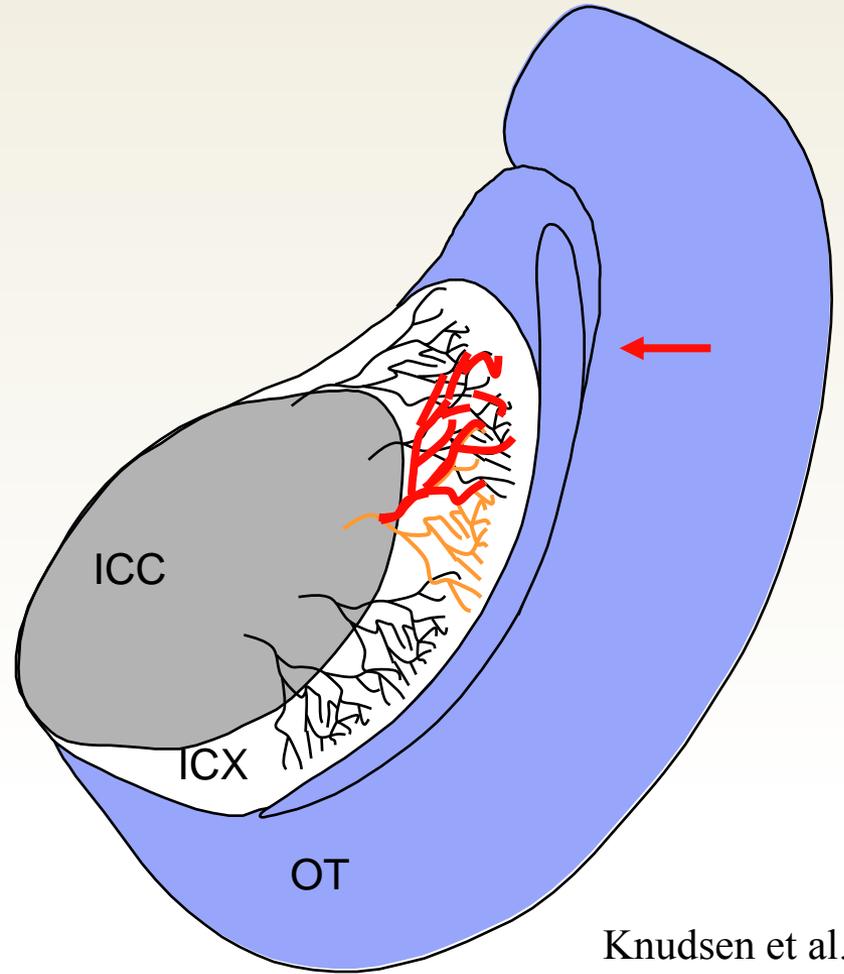
- **Neural circuits that process basic information are wired earlier than those that process more complex information.**
- **Higher circuits build on lower circuits. Adaptation at higher skill levels is more difficult if lower level circuits are not wired properly.**
- **Advanced skills build on basic skills in all aspects of development.**



# Normal



# After Prism Experience



Knudsen et al. 2007

## Concept #3:

# “Serve and Return” is a key ingredient in the learning process

- **Social interactions are important. Children learn best when an attentive adult is engaged with them in the learning process.**



# Brains and Skills are Built Over Time



# There Are No Magic Bullets

## *Relationships Matter*

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.



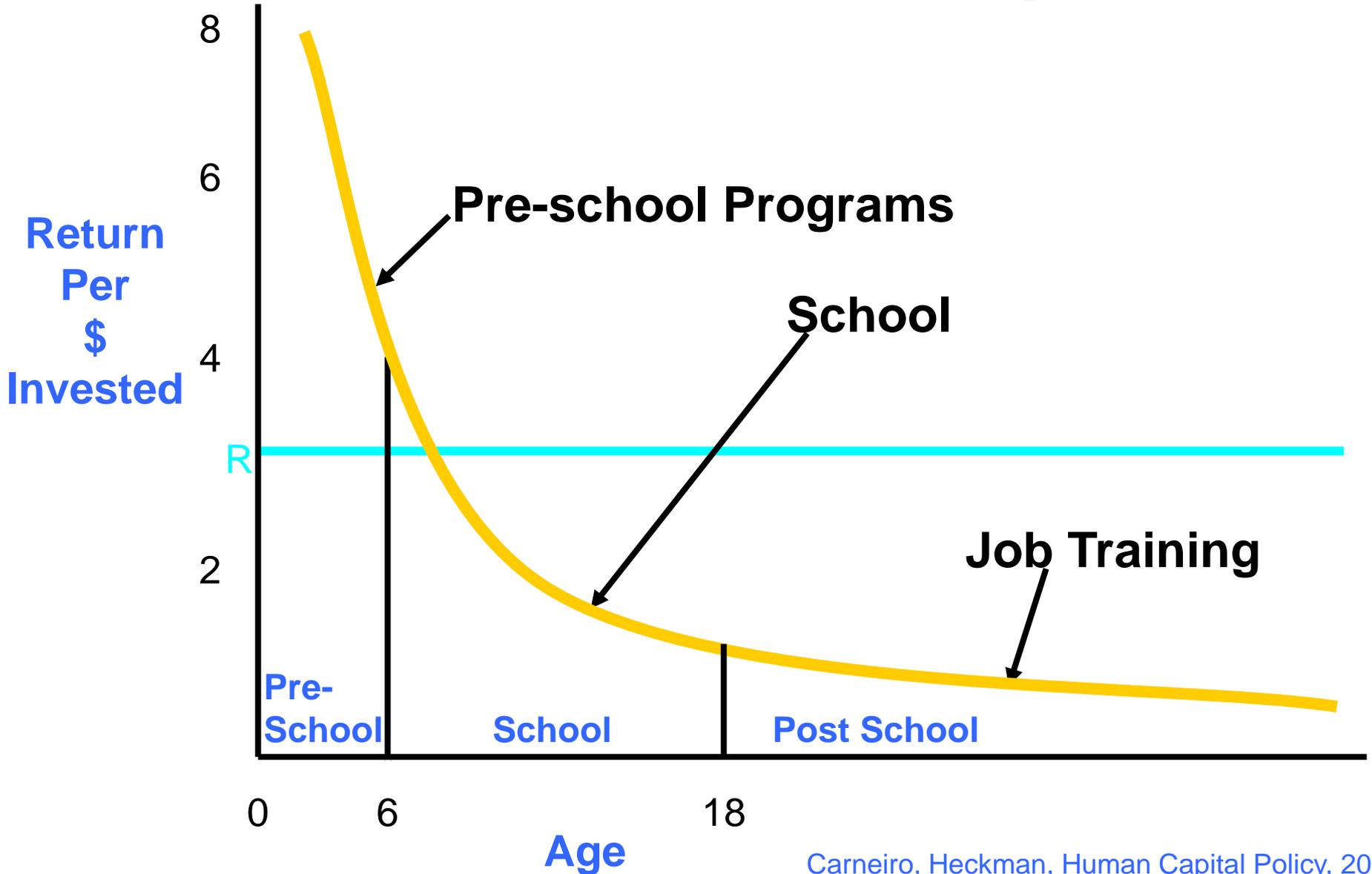
# Concept #4:

## Brain Plasticity - The Ability to Change Behavior Decreases Over Time

- **Brain circuits stabilize with age, making them increasingly more difficult to alter.**
- **The window of opportunity for development remains open for many years, but the costs of remediation grow with increasing age.**
- **It is more efficient, both biologically and economically, to get things right the first time than to try to fix them later.**

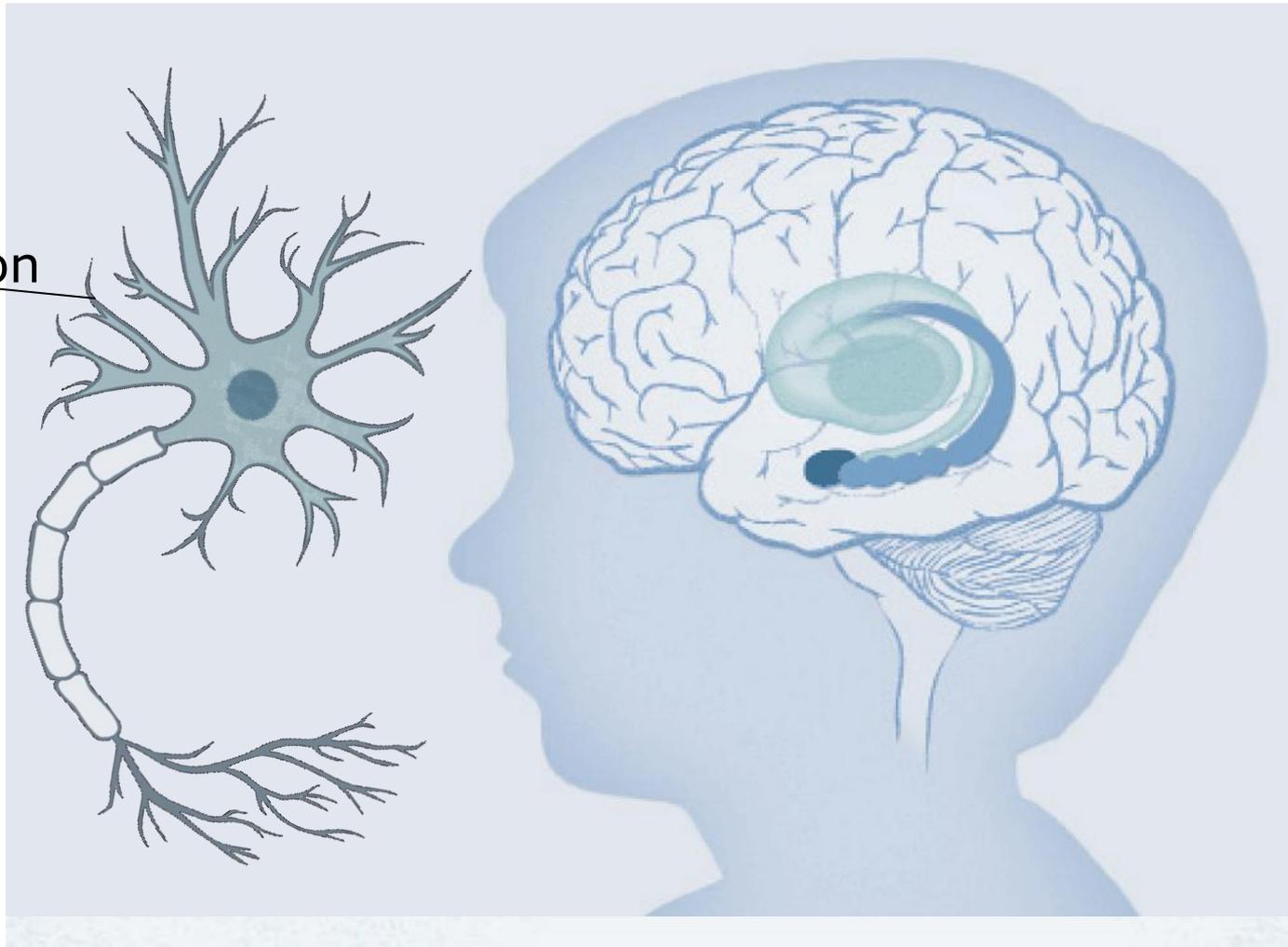


# Rates of Return to Human Development Investment Across all Ages

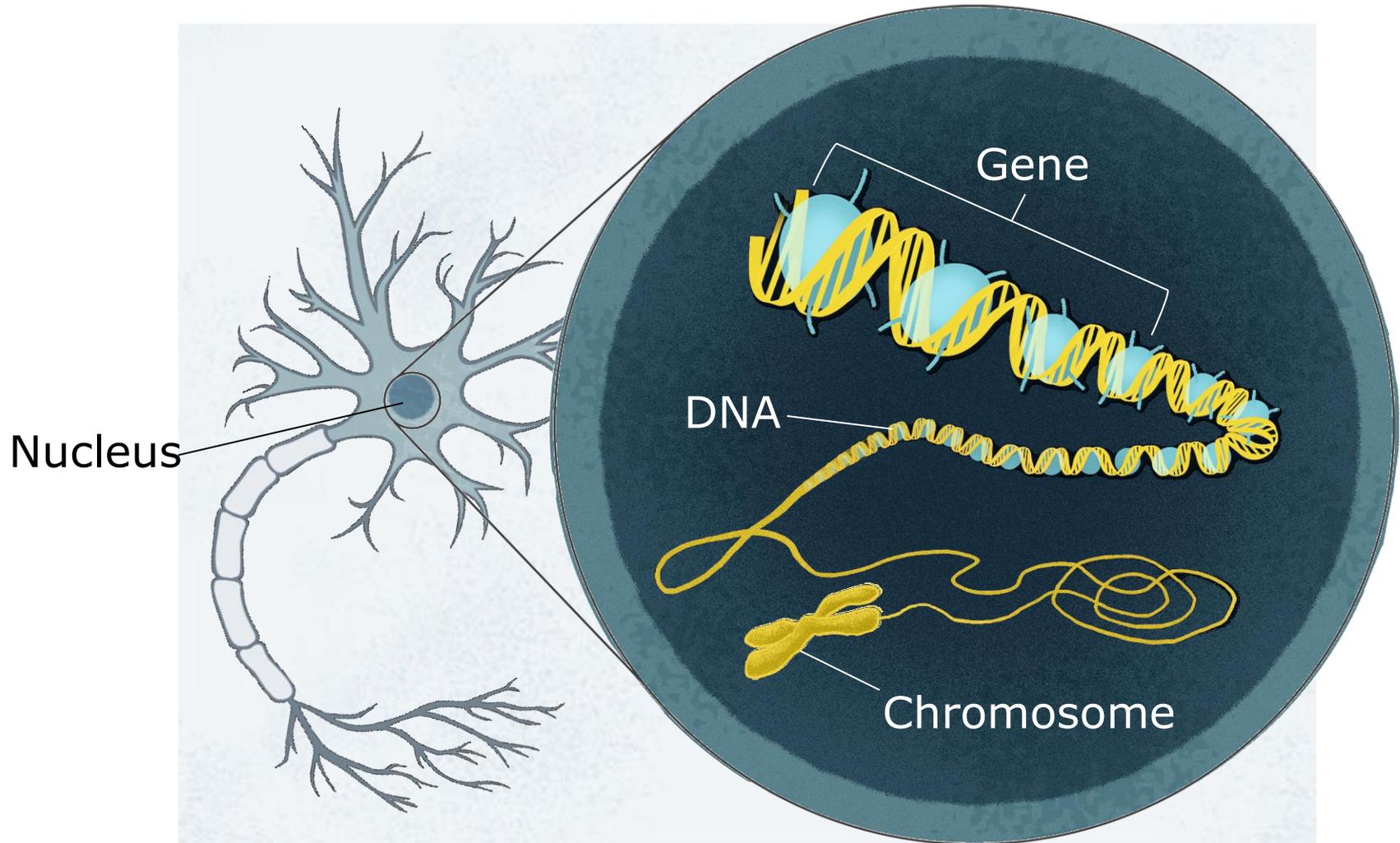


# How Early Experiences Alter Gene Expression and Shape Development

Neuron



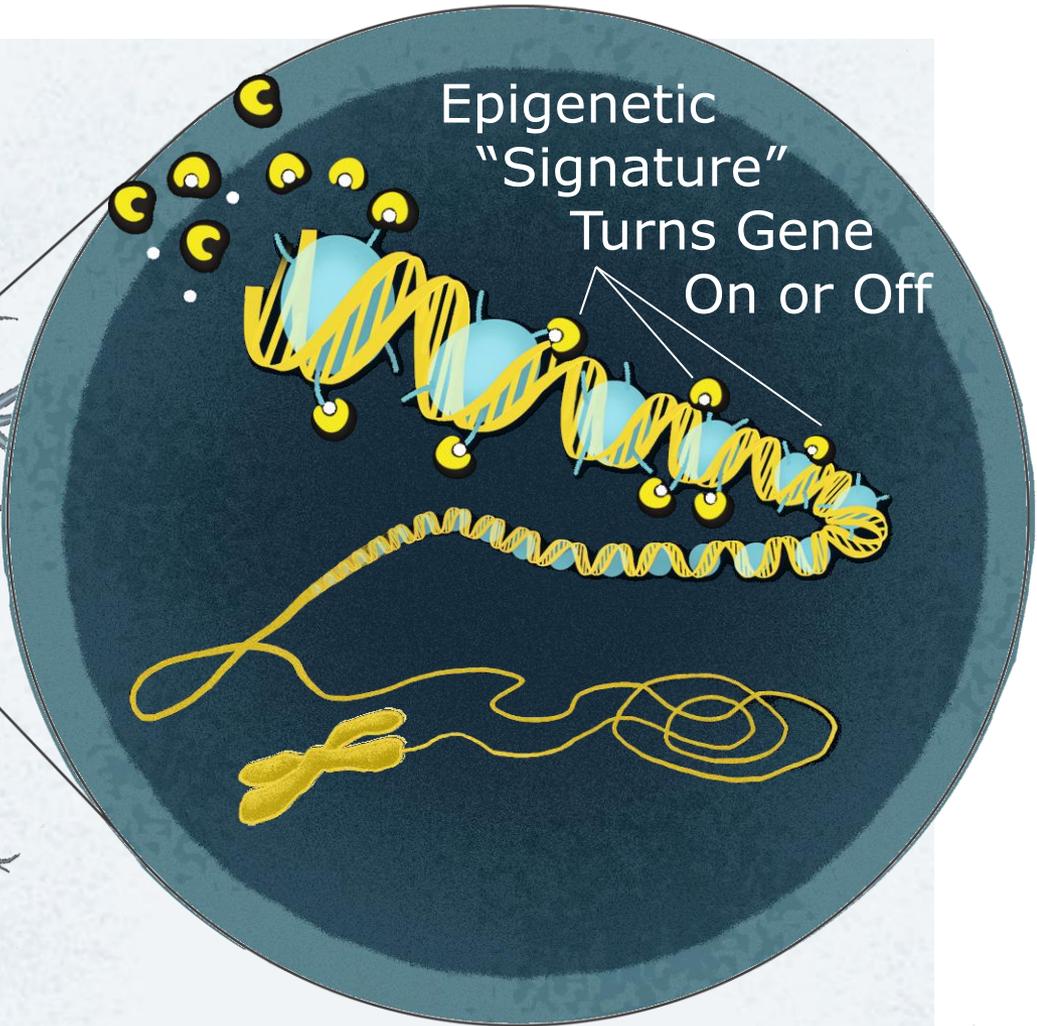
# Genes Carry Instructions that Tell Our Bodies How to Work



# Early Experiences Leave Lasting Chemical "Signatures" on Genes

External Experience

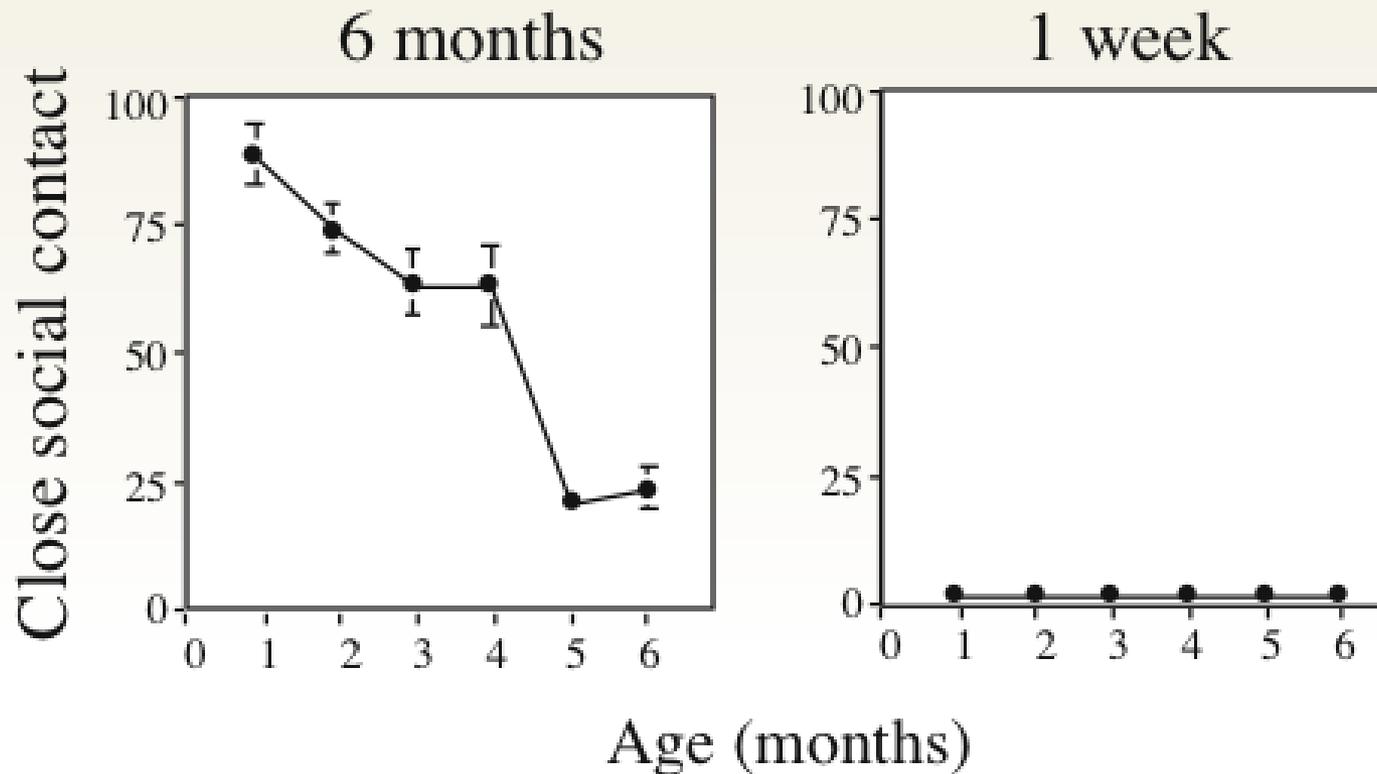
Gene Regulatory Proteins



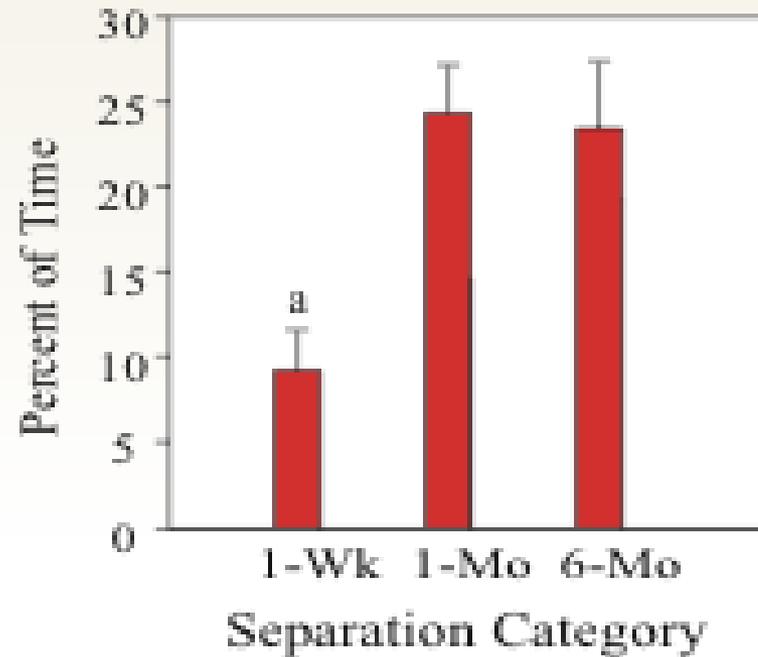
# Studies in monkeys show that early life experiences have lasting effects on brain development



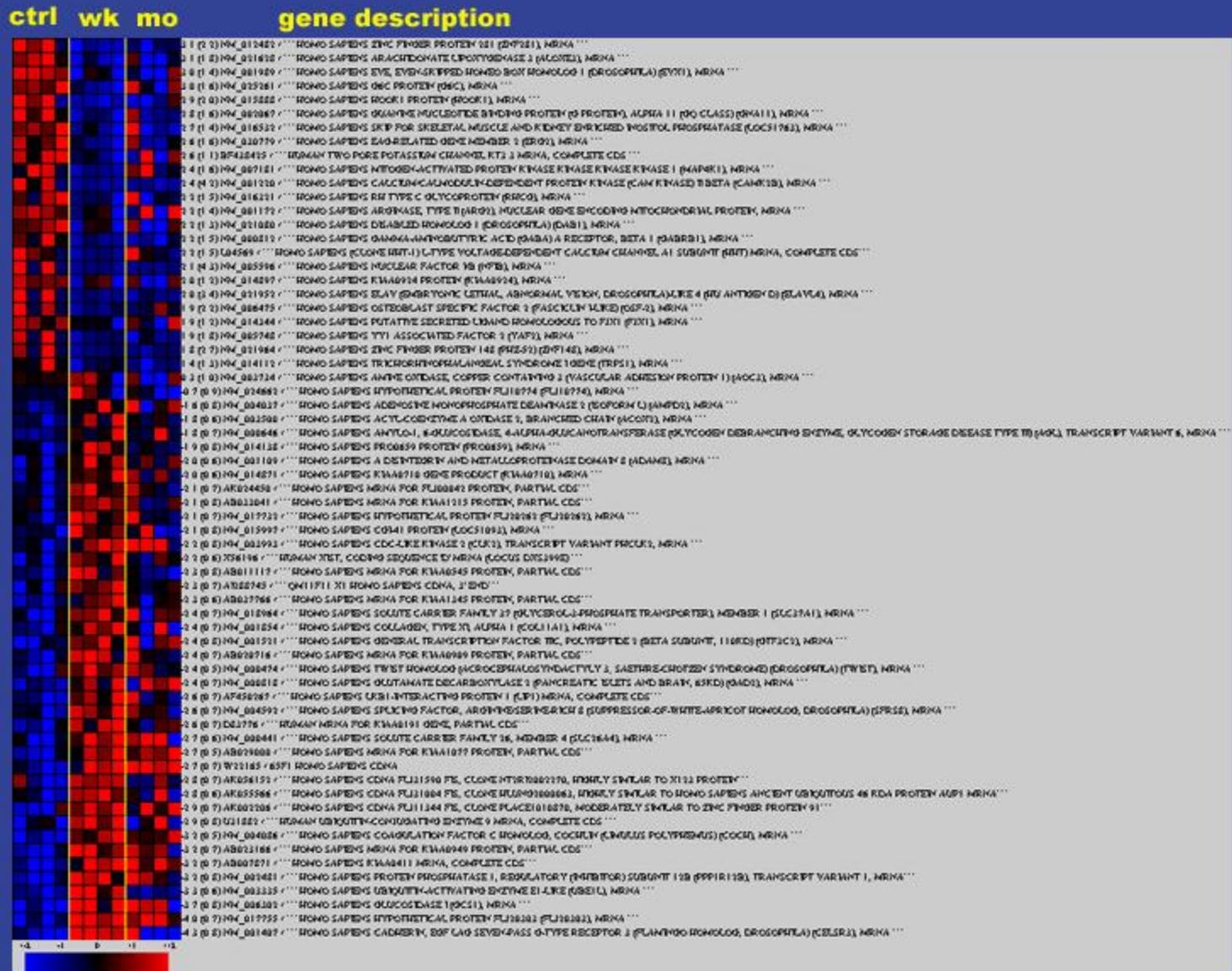
# Mother removed from social group when young monkey was:



# Social Behavior Remains Decreased in Adulthood



# Amygdala Microarray Studies



# *Intervention*

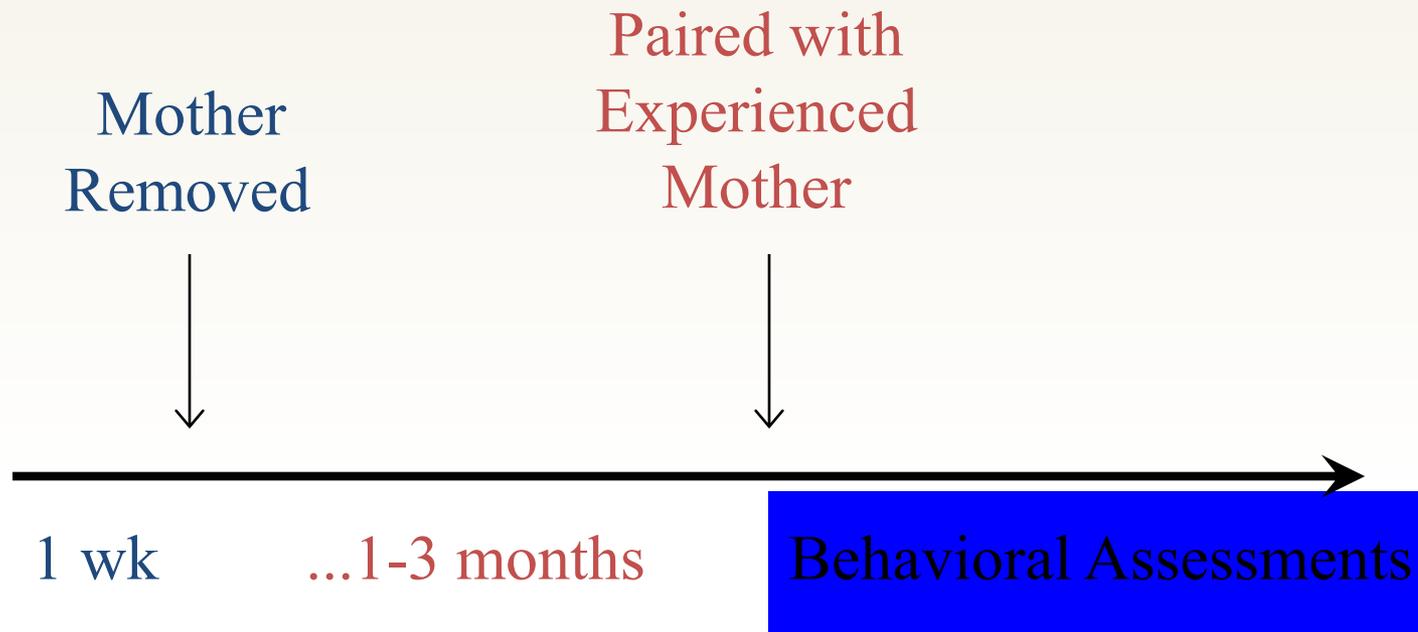
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*Can pairing a separated infant with a very attentive mother reverse the effects of early social bond disruption?*

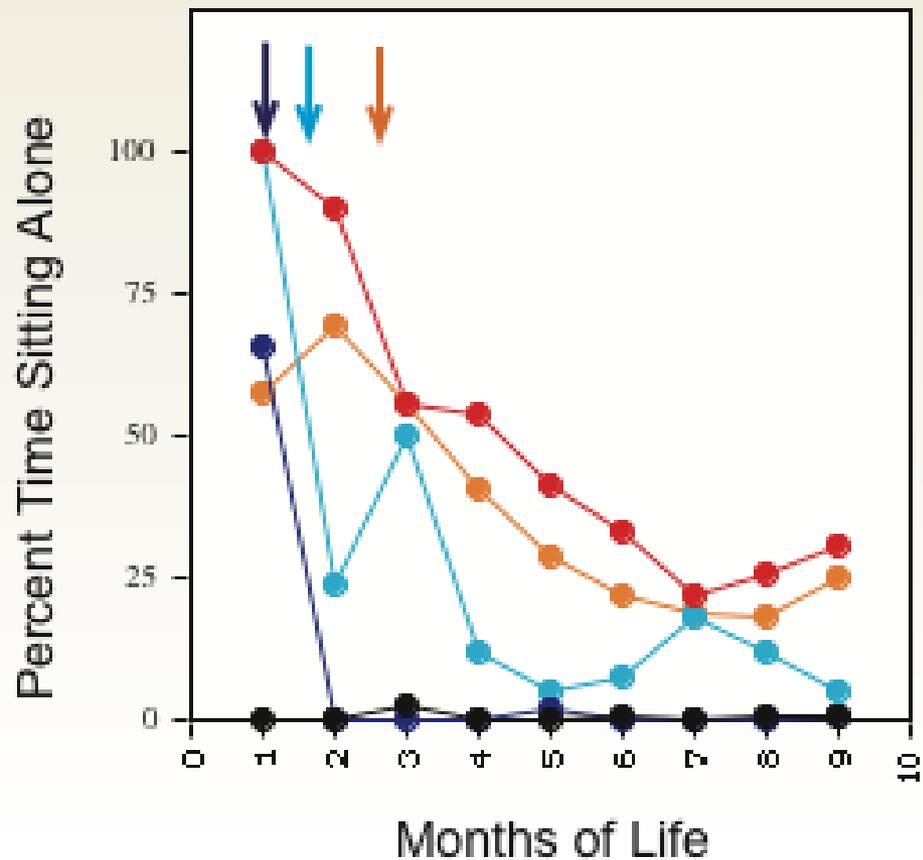
*Does the **timing** of therapy matter?*



# *Intervention Design*



(arrows show introduction of experienced mother)



*Pairing with an experienced mother is effective when initiated early.*



# The role of early experience in shaping social-emotional development:

## Conclusions

The *timing* of early stressful life experience plays a critical role in determining the outcome of stress exposure on behavior.

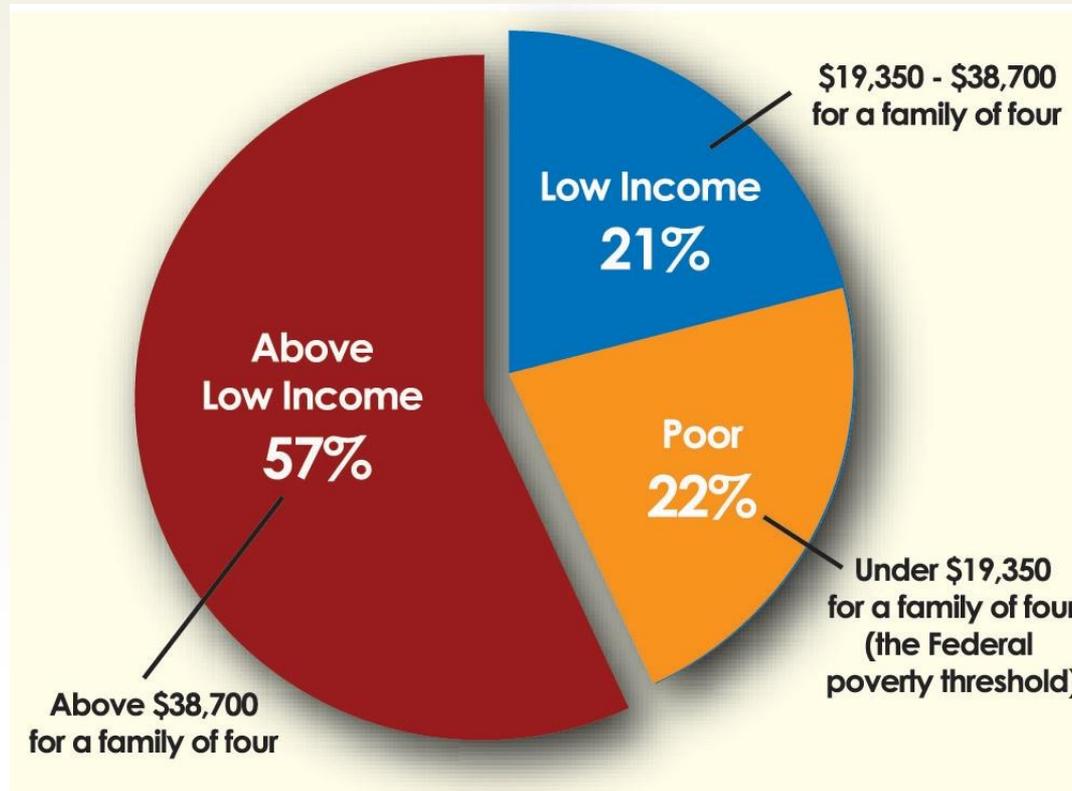
Early social bond disruption can lead to changes in *brain anatomy* and *gene expression* in the brain.

*Early intervention can prevent long-term consequences* of social bond disruption, but the timing of intervention is important.



# Children in Poverty

## U.S. Families with Toddlers and Infants

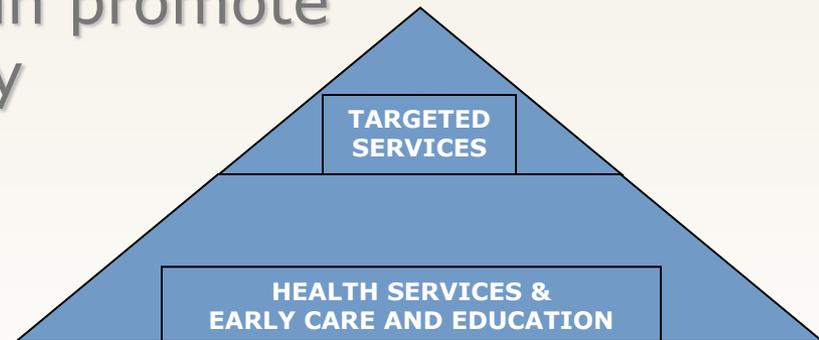


Source: National Center for Children in Poverty (2006)



# 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 substantial stresses early in life can reduce disruptions of the developing nervous and immune systems that lead to later problems in learning, behavior, and health.



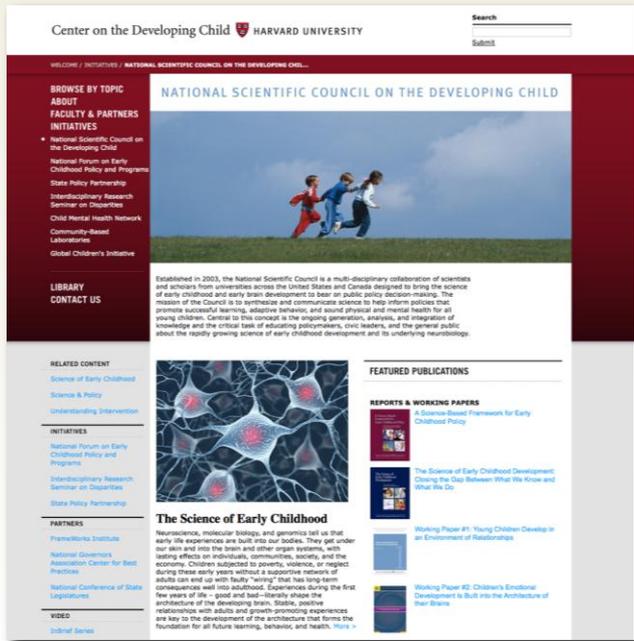
# Maximizing Return on Investment

The basic principles of neuroscience and human capital formation indicate that later remediation will produce less favorable outcomes than preventive intervention.

Low cost services that have little impact are a waste of money. Responsible investments focus on effective programs that are staffed appropriately, implemented well, and improved continuously.



# Further Information:



<http://www.developingchild.net>

Center on the Developing Child  HARVARD UNIVERSITY

NATIONAL SCIENTIFIC COUNCIL ON THE DEVELOPING CHILD  
NATIONAL FORUM ON EARLY CHILDHOOD PROGRAM EVALUATION

Knudsen EI, Heckman JJ,  
Cameron JL, Shonkoff JP.

Economic, neurobiological  
and behavioral perspectives  
on building America's future  
workforce.

*World Economics* 7: 17-41, 2006

Judy Cameron, Ph.D.  
[jcameron@pitt.edu](mailto:jcameron@pitt.edu)

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