

# CORE CONCEPTS IN THE SCIENCE OF EARLY CHILDHOOD DEVELOPMENT

Healthy Development Builds a Strong Foundation – For Kids and For Society



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Child development is a critical foundation for community development and economic development, as capable children become the foundation of a prosperous and sustainable society. When we invest wisely in children and families, the next generation will pay that back through a lifetime of productivity and responsible citizenship. When we fail to provide children with what they need to build a strong foundation for healthy and productive lives, we put our future prosperity and security at risk. A rapidly growing body of knowledge from neuroscience, molecular biology, genomics, and child development research can help to inform how we as a community can use our collective resources most effectively and efficiently to build that strong foundation.

# CORE CONCEPTS IN THE SCIENCE OF EARLY CHILDHOOD DEVELOPMENT

Experience Shapes Brain Architecture by Over-Production of Connections Followed by Pruning



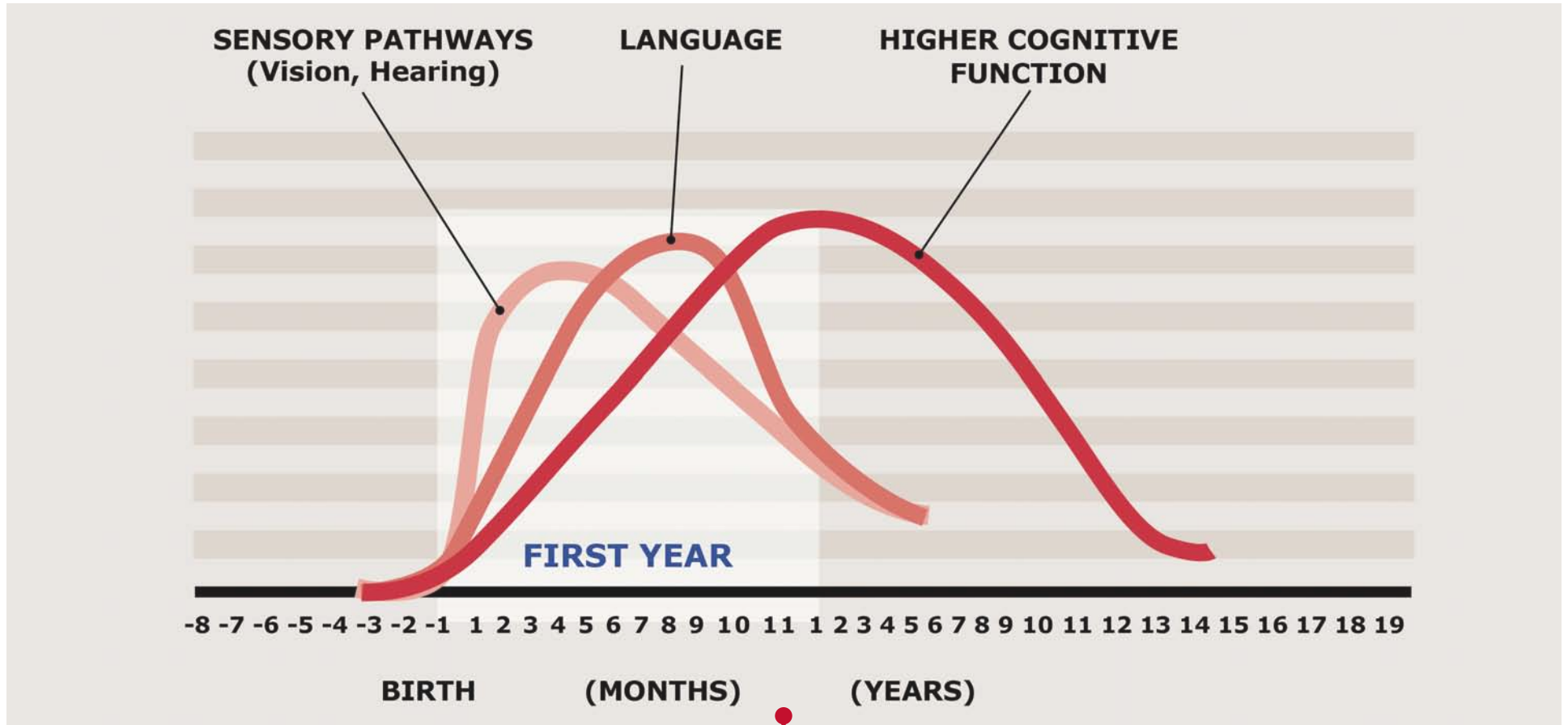
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*Neural proliferation and pruning is a normal, healthy part of brain development: connections that are not used are pruned away.*

The basic architecture of the brain is constructed through an ongoing process that begins before birth and continues into adulthood. During the first few years of life, 700 new synapses (neural connections) are formed every second. After a period of rapid proliferation, connections are reduced through a process called pruning, so that brain circuits can become more efficient. Early experiences affect the nature and quality of the brain's developing architecture by determining which circuits are reinforced and which are pruned through lack of use. Some people refer to this as "use it or lose it." *Graphic Source: Chugani, H.T. Synaptic Density. [Drawing]. In R. Shore, Rethinking the Brain: New Insights into Early Development (p. 20). New York: Families and Work Institute, 1997.*

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Brains Are Built from the Bottom Up: Skills Beget Skills



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Neural connections in different areas of the brain associated with specific functions proliferate rapidly and then begin pruning in the earliest years of life.

Brains are built in a hierarchical fashion, starting with the simplest circuits and then moving up to more complex circuits. Sensory pathways like those for basic vision and hearing are the first to develop, followed by early language skills and higher cognitive functions. Connections proliferate and prune in a prescribed order: the timing is determined genetically but experiences affect whether the circuits are strong or weak. The brain is never a blank slate – every new competency is built upon competencies that came before. *Graph Source: C.A. Nelson (2000)*

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## Serve and Return Interaction Builds Healthy Brain Architecture



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The interactive influences of genes and experience shape the developing brain. Scientists now know a major ingredient in this developmental process is the “serve and return” relationship between children and their parents or other caregivers in the family or community. Young children naturally reach out for interaction through babbling, facial expressions, and gestures, and adults respond with the same kind of vocalizing and gesturing back at them. In the absence of such responses—or if the responses are unreliable or inappropriate—the brain’s architecture does not form as expected, which can lead to disparities in learning and behavior.

## CORE CONCEPTS IN THE SCIENCE OF EARLY CHILDHOOD DEVELOPMENT

Cognitive, Emotional, and Social Development Are Connected: You Can't Do One Without the Other



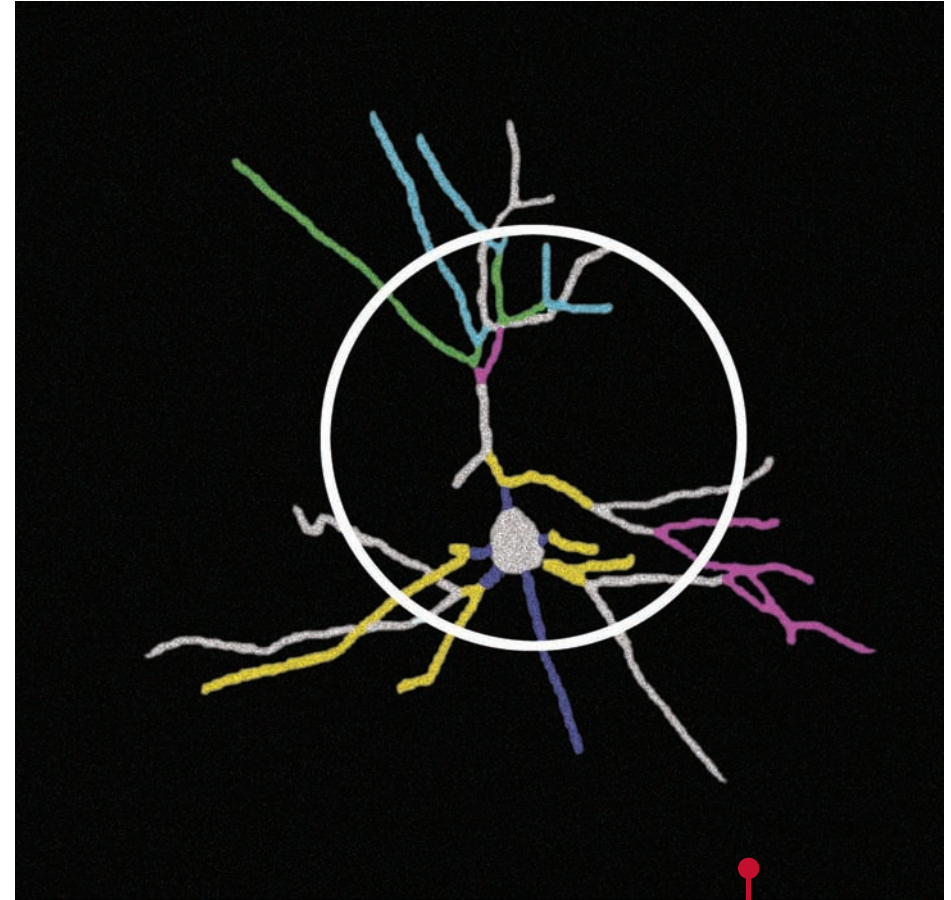
- 5 Cognitive, emotional, and social capacities are inextricably intertwined in the brain, and, in like fashion, learning, behavior, and both physical and mental health are highly interrelated throughout the life course. One domain cannot be targeted without affecting the others. The brain's multiple functions operate in a richly coordinated fashion: Emotional well-being and social competence provide a strong foundation for emerging cognitive abilities, and together they are the bricks and mortar that comprise the foundation of human development. The emotional and physical health, social skills, and cognitive-linguistic capacities that emerge in the early years are all important prerequisites for success in school and later in the workplace and community.

# CORE CONCEPTS IN THE SCIENCE OF EARLY CHILDHOOD DEVELOPMENT

## Toxic Stress Damages Developing Brain Architecture



*Typical neuron: many connections*

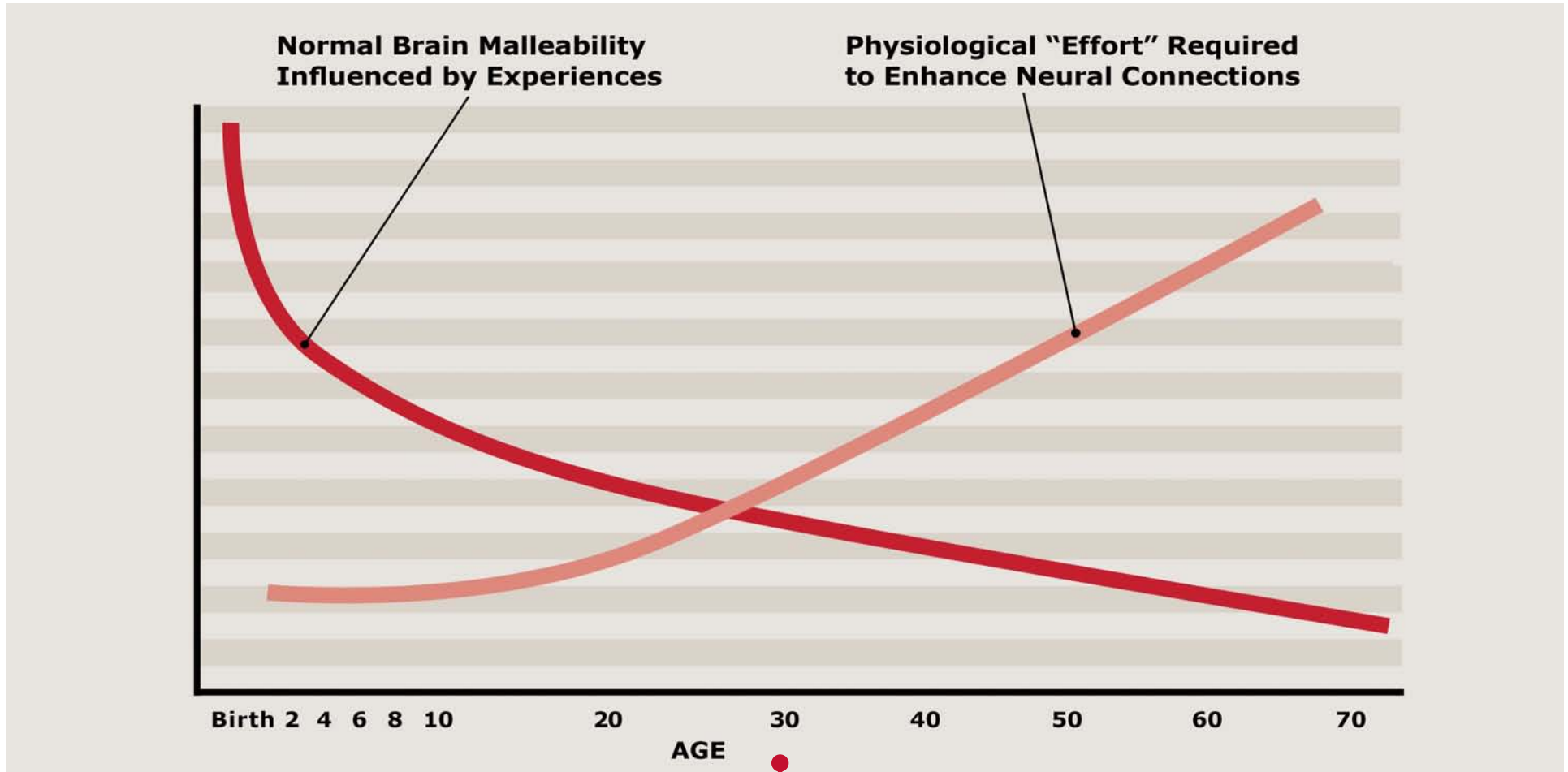


*Neuron damaged by toxic stress: fewer connections*

6 Scientists now know that chronic, unrelenting stress in early childhood, perhaps caused by extreme poverty, neglect, repeated abuse, or severe maternal depression, for example, can be toxic to the developing brain. While positive stress (moderate, short-lived physiological responses to uncomfortable experiences) is an important and necessary aspect of healthy development, toxic stress is the strong, unrelieved activation of the body's stress management system in the absence of the buffering protection of adult support. This image depicts the structure of neurons in the areas of the brain that are most important for successful learning and behavior in school and the workplace—the hippocampus and prefrontal cortex. The neuron on the right, which has been subjected to toxic stress, clearly displays underdeveloped neural connections, or weaker brain architecture.

# CORE CONCEPTS IN THE SCIENCE OF EARLY CHILDHOOD DEVELOPMENT

The Ability to Change Brains and Behavior Decreases Over Time



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As the maturing brain becomes more specialized to assume more complex functions, it is less capable of reorganizing and adapting. For example, by the first year, the parts of the brain that differentiate vocal sounds are becoming specialized to the language the baby has been exposed to and are already starting to lose the ability to recognize important sound distinctions found in other languages. As the brain prunes away the circuits that are not used, those that are used become stronger and increasingly difficult to alter over time. Declining plasticity means it's easier and more effective to influence a baby's developing brain architecture than it is to rewire parts of its circuitry in the adult years. In other words, we can "pay now" by ensuring positive conditions for healthy development, or "pay more later" in the form of costly remediation, health care, mental health services, and increased rates of incarceration. *Graph Source: P. Levitt (2009)*