A Science-Based Framework for Early Childhood Policy

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The Importance of Early Childhood to Life Development and Success
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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
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

![Graph showing the decrease in ability to change brains over time.](source: Levitt (2009))

- Normal Brain Plasticity Influenced by Experience
- Physiological “Effort” Required to Enhance Neural Connections

Age (Years)

Birth 10 20 30 40 50 60 70

Source: Levitt (2009)
Neural Circuits are Wired in a Bottom-Up Sequence

Sensory Pathways (Vision, Hearing)
Language
Higher Cognitive Function

Experience Shapes Brain Architecture by Over-Production Followed by Pruning

(700 synapses formed per second in the early years)
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 alter performance permanently
Lorenz and imprinted ducklings walking after him
Hubel and Weisel: Classical 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

![Graph showing letter acuity, light sensitivity, global motion, and asymmetry of OKN for large high-contrast patterns over age (years).]

Daphne Maurer

Effects of unilateral and bilateral deprivation of patterned vision (Lewis & Maurer, 2005)
Early experience establishes the neural substrate for capabilities that emerge at a much later point in development.

14 years later children whose cataracts were removed late in infancy were deficient in face processing.
Sensitive Periods for Integration of Auditory and Visual Information

Eric Knudsen studies Barn Owls manipulating their early visual or auditory experience identifying sensitive periods for these inputs.
A sensitive period for language in the visual cortex: Distinct patterns of plasticity in congenitally versus late blind adults

People blind from birth hear language in their visual cortex
And children who go blind before age 5 as well
The timing and nature of experience with language affects perception of different languages

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 only able to discriminate the language(s) they hear in their environment.

Effects of experience on perception of language (Werker & Tees, 2005)
Multiple sensitive periods across development for different domains

Most probably there are different sensitive periods for different skills across the first years of life

FIGURE 4  A cartoon illustrating the cascade of influences involving different components of the overall speech-processing system. Each component has a different optimal period and a different pattern of selectivity. Moreover, experientially induced changes in each component influence both later emerging and previously developed components.

Werker & Tees (2005)
Early windows of experience shape brain function

![Diagram showing the relationship between genes, critical period, environment, and behavior.](image-url)
Interaction Shapes Brain Circuitry

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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

Cumulative Vocabulary (Words)

An “Air Traffic Control System” in the Brain

Executive functioning is a group of skills that help us to 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 Greater Adult Wealth

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.
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.
Significant Adversity Impairs Development in the First Three Years

Number of Risk Factors

Source: Barth, et al. (2008)
Persistent Stress Changes Brain Architecture

Normal

Chronic stress

Prefrontal Cortex and Hippocampus

Typical - neuron with many connections

Neuron damaged by toxic stress - fewer connections

Bock et al Cer Cort 15:802 (2005)
Extreme Neglect Reduces Brain Power

Positive Relationships  Extreme Neglect

Effective Services Improve Relationships and Environments

Rigorous program evaluation research combined with improved scientific understanding of how children develop can help us make better decisions about which programs and policies are smart investments.

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.
Cost/Benefit Analyses Show Positive Returns

Early Childhood Programs Demonstrate Range of Benefits to Society

<table>
<thead>
<tr>
<th>Program</th>
<th>Return per $1 Invested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abecedarian Project (through age 21)</td>
<td>$3.23</td>
</tr>
<tr>
<td>Nurse Family Partnership (High Risk Group)</td>
<td>$5.70</td>
</tr>
<tr>
<td>Perry Preschool (through age 40)</td>
<td>$9.20</td>
</tr>
</tbody>
</table>

Total Return per $1 Invested

Sources:
- Karoly et al. (2005)
- Heckman et al. (2009)
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)
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)
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.