Lucile Packard Children's Hospital AT STANFORD

A Primer on Brain Development

or/and

Why First 5 is Very Important to the Children of Northern California

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FIRST 5 SAN MATEO COUNTY

Learning Objectives: By the conclusion, participants should be able to explain the following:

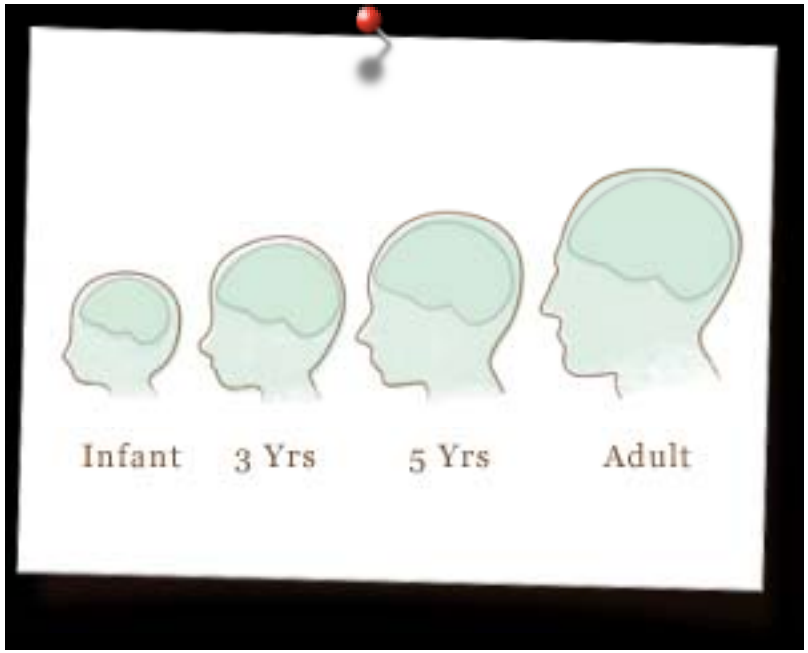
1. Human brain is a dynamically developing organ
   -Changes in brain structure and function
   -Greatest changes occur in the first 5 years of life.
2. The brain develops through learning.
3. Many biological and social threats can alter or limit brain development, especially at young ages.
4. First 5 is positioned to maximize positive changes and limit negative forces

1. Human Brains Develop Dramatically

- The brain is structurally immature at birth
- Major changes dramatic in first 5 years
  a) Size increases
  b) Cortical surface folds
  c) Number of synapses increases and then regress
  d) White matter volume increases

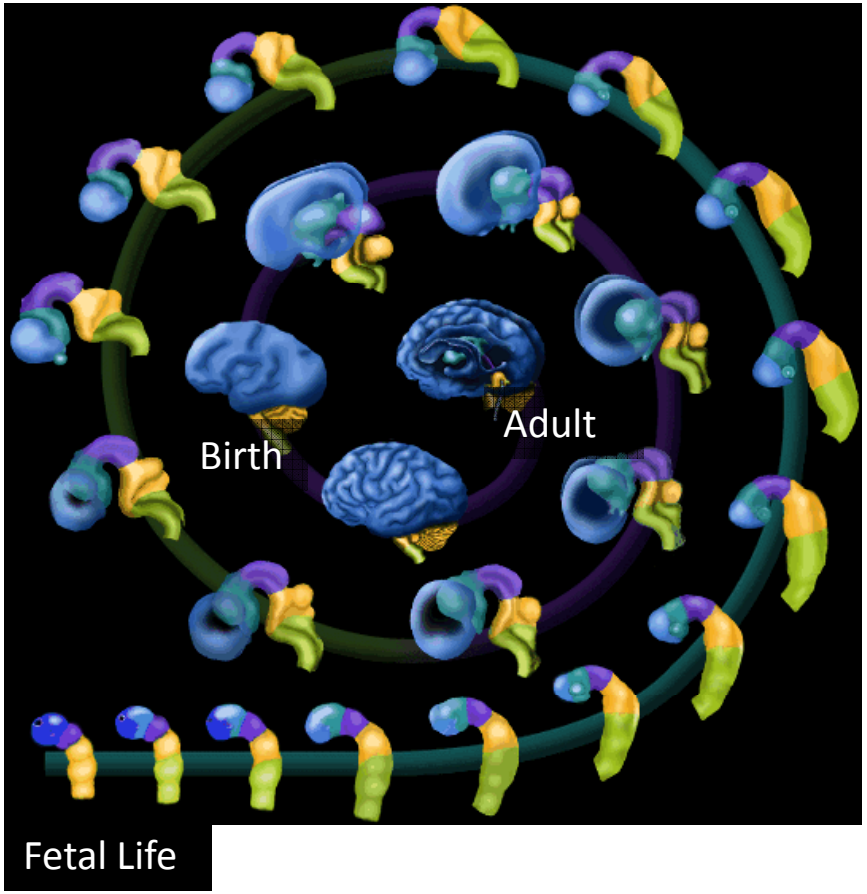
1a. Size increases

- In the first 3 years of life, child's brain volume grows to approximately 80% of adult size
- By age five, it grows to about 90% of adult size

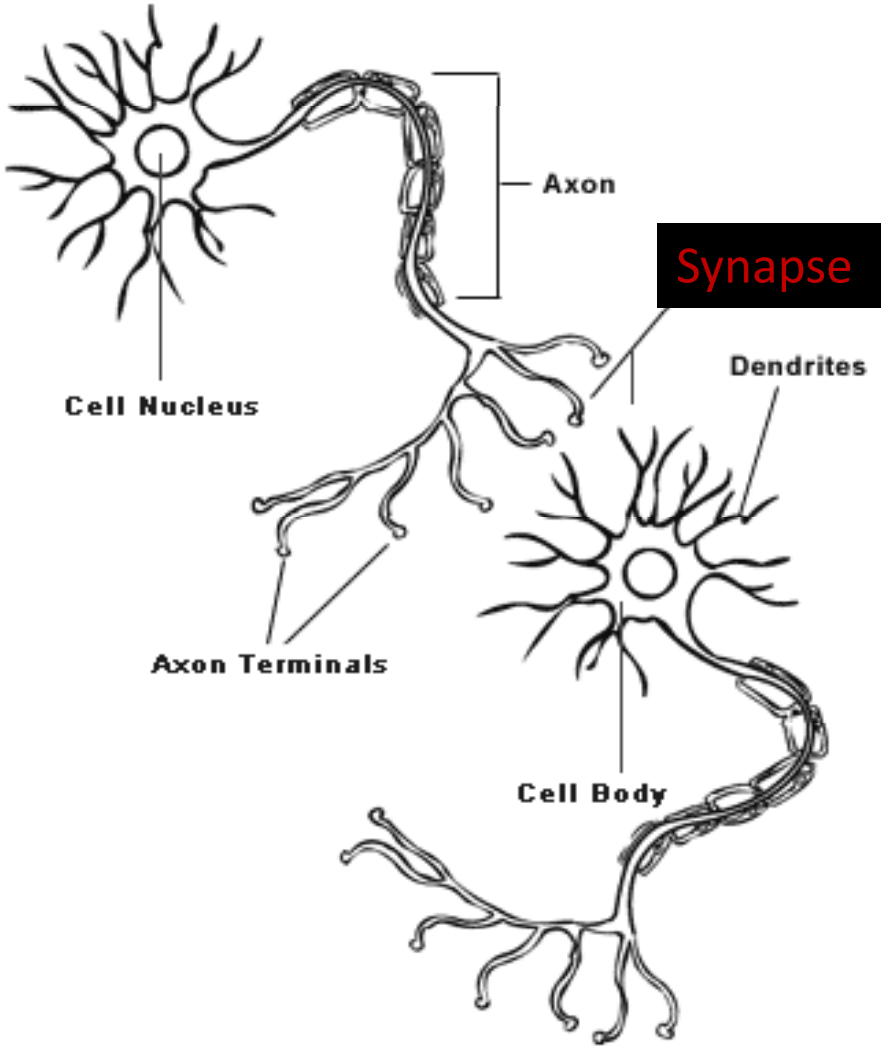


1b. Cortical Surface Folds

- The brain begins as a simple tube and folds into a complex structure
- Folding of the cortex provides increased surface area that leads to increased intellectual capacity
- Folding continues after birth

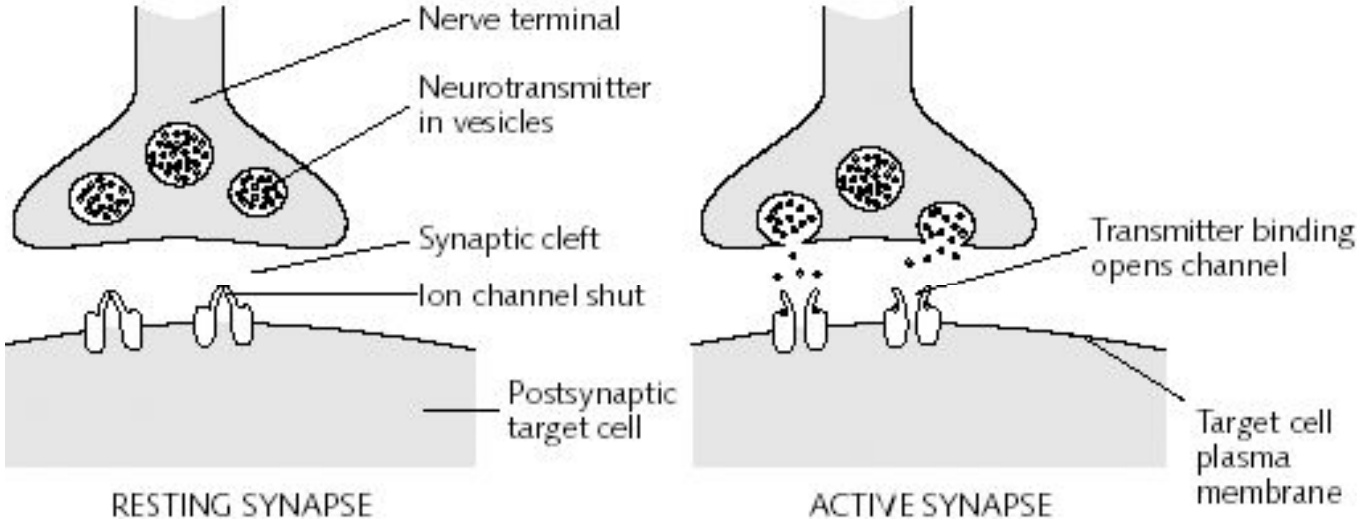


1c. Synapses Proliferate in Early Life

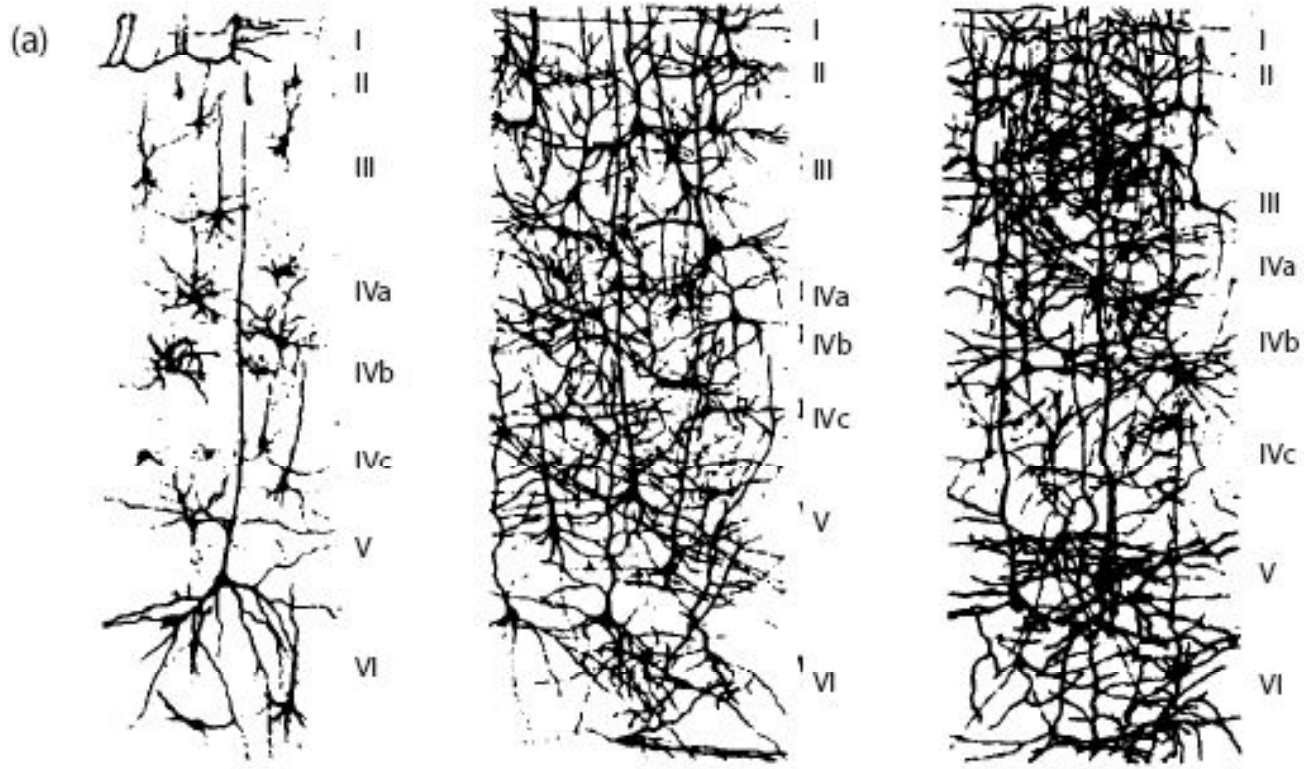


1c. Synapses

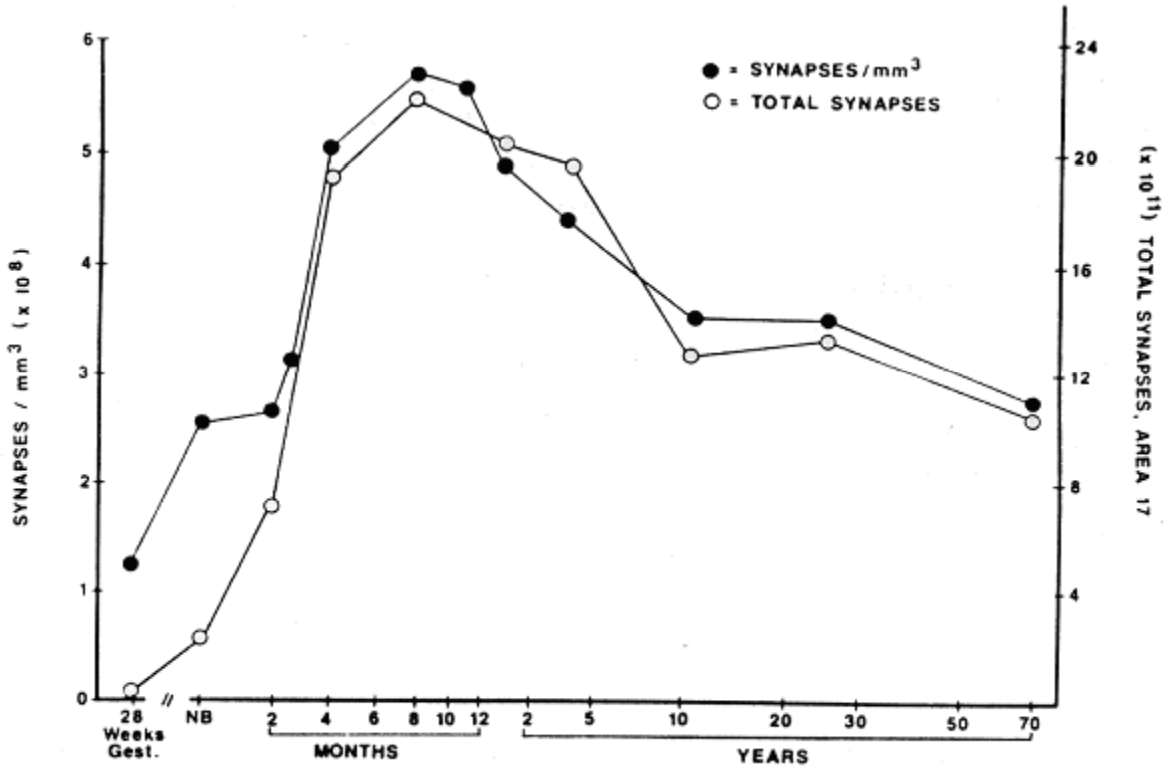
Synapse



1c. Early Growth of Synapses

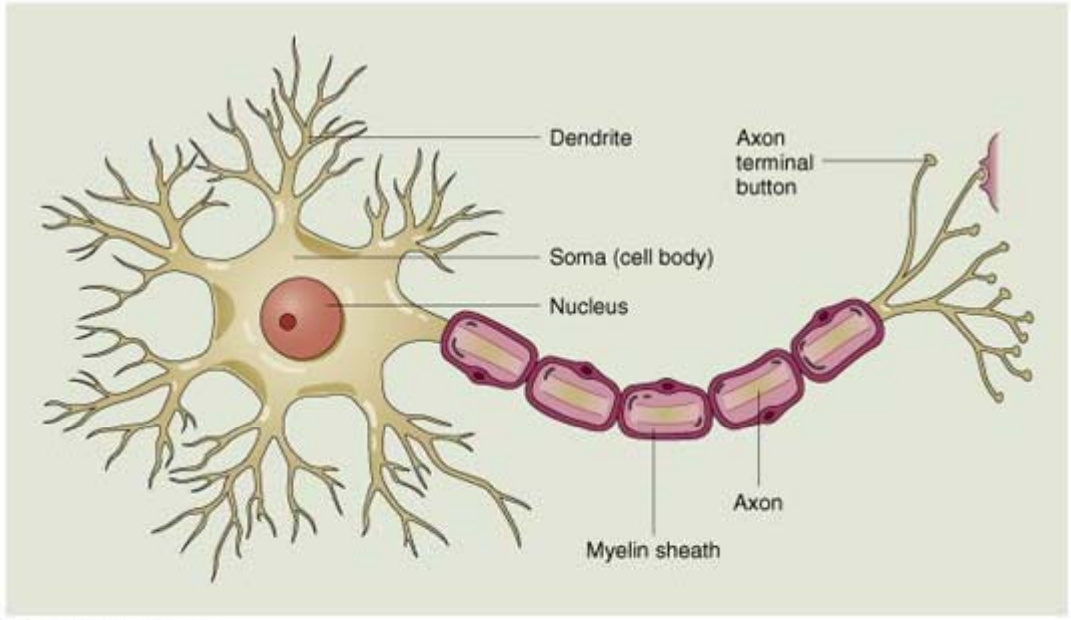


1c. Synapses Increase then Decrease

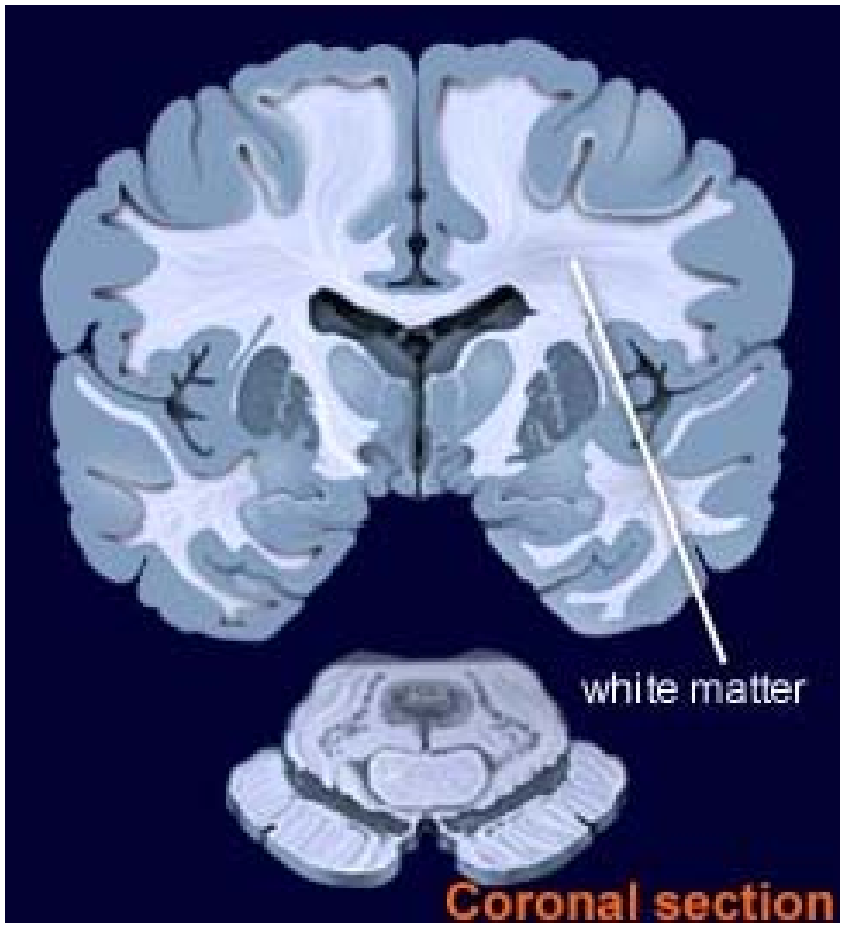


Proliferation "Pruning" Improves Efficiency

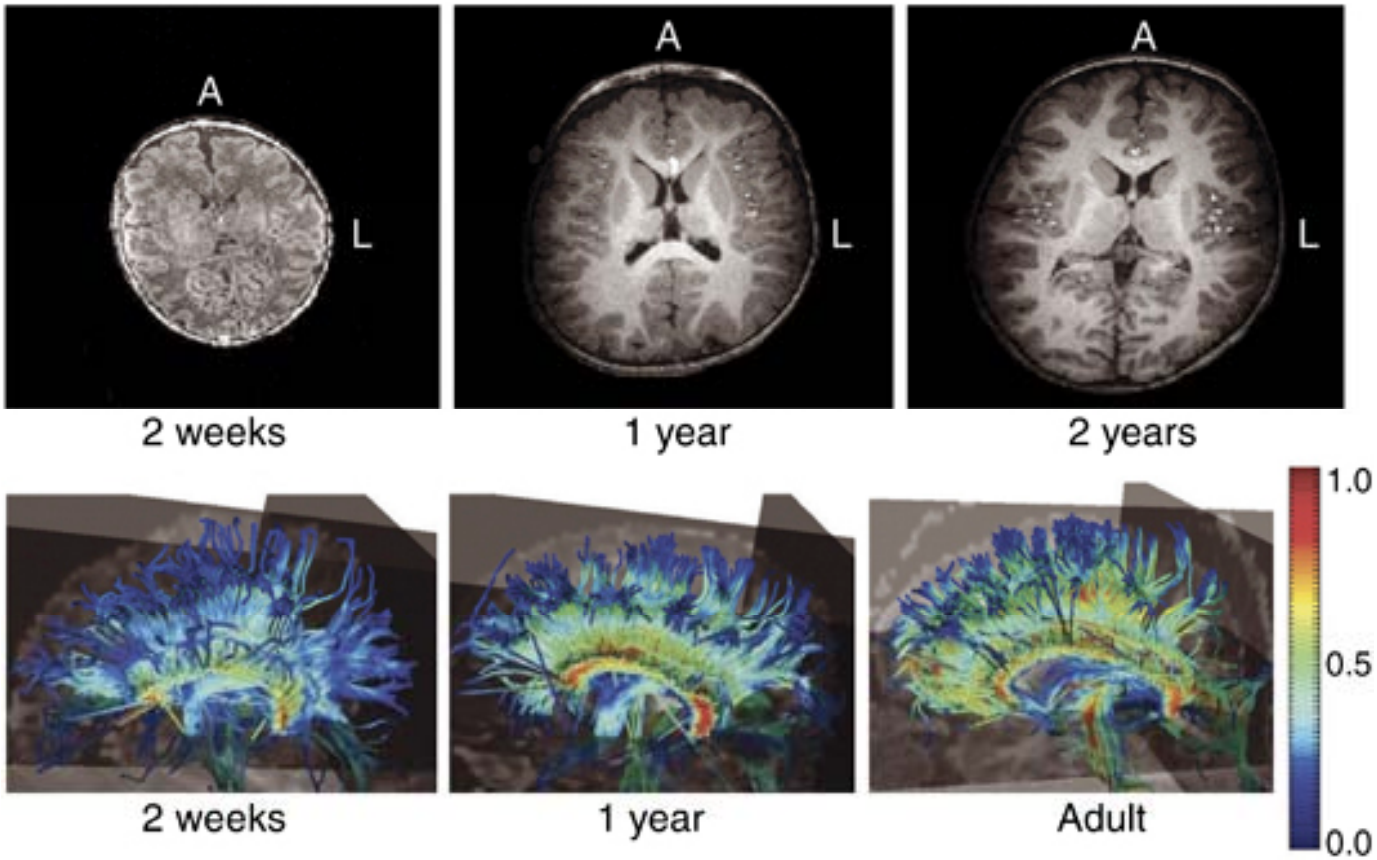
1d. White Matter is Myelinated Axons



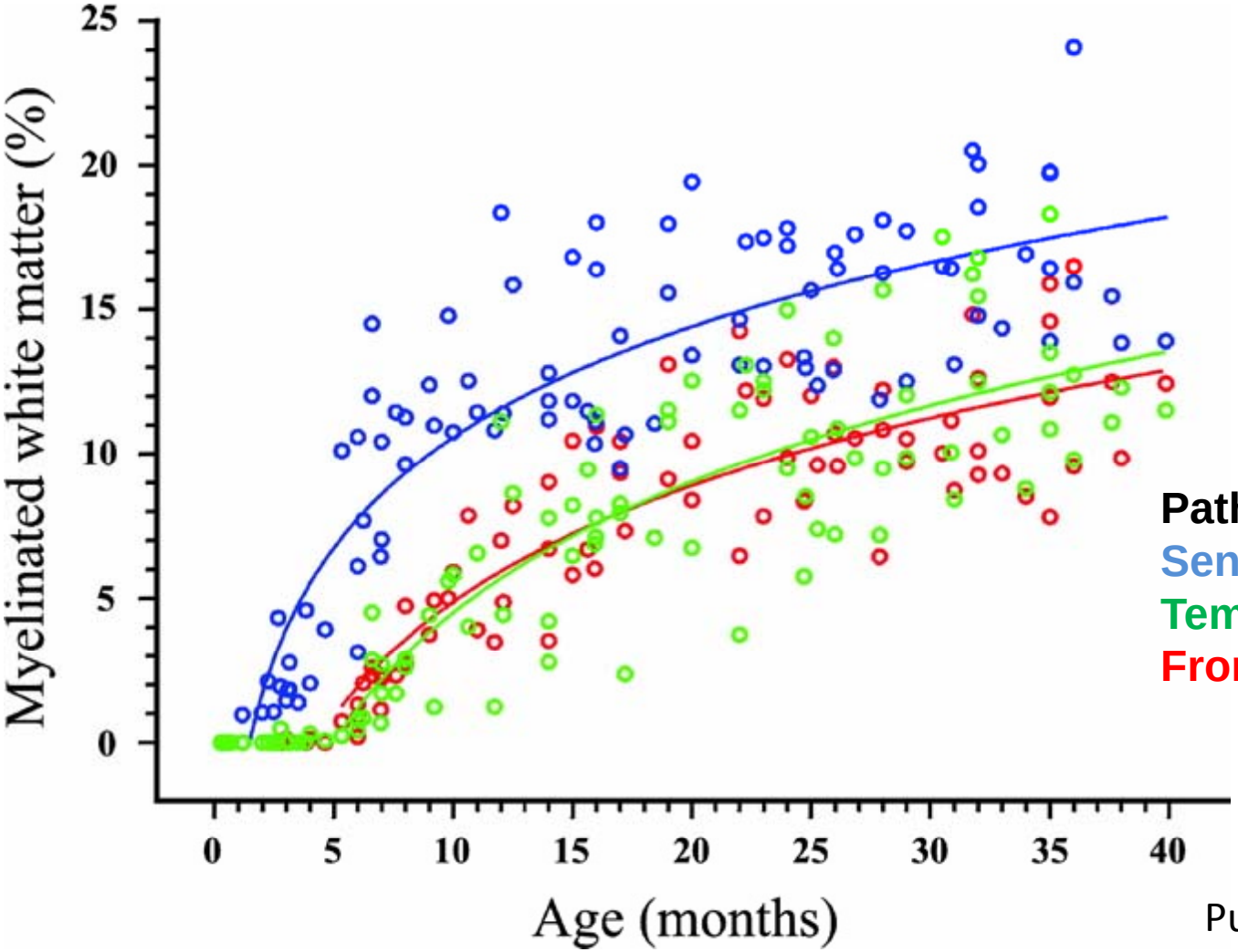
1d. White Matter Connects Brain Regions



1d. White Matter Increases with Age



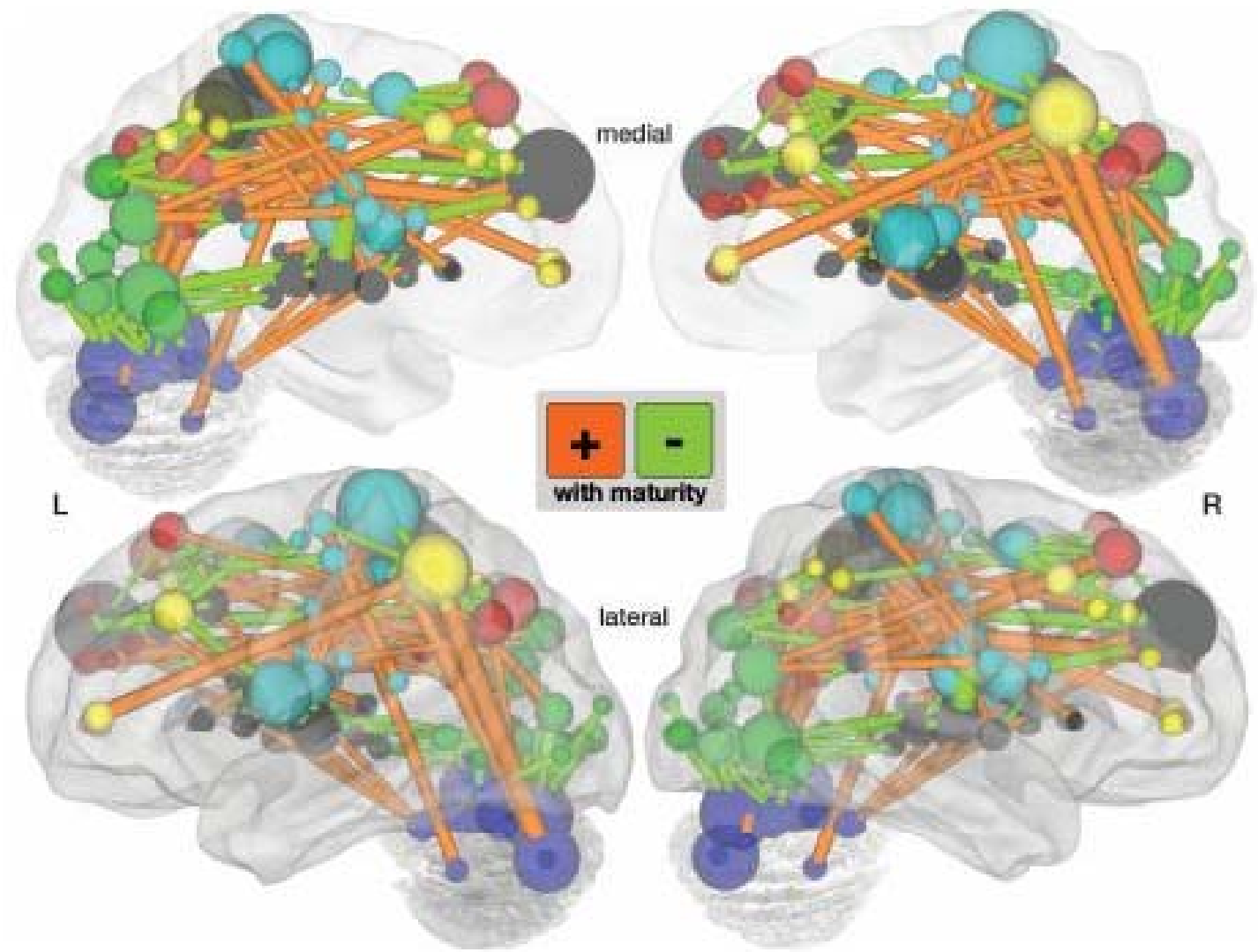
1d. Myelination in First 5 years



Pathways:
Sensori-motor
Temporal language
Frontal language

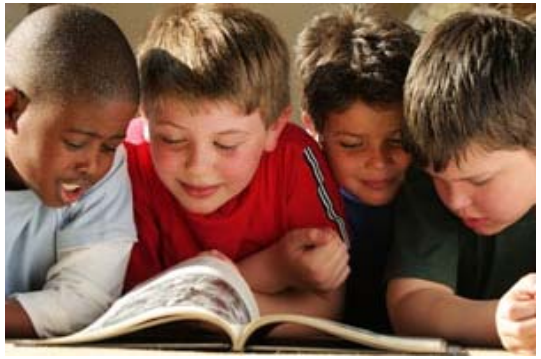
Pujol, et a., 2006

1d. White Matter Strengths Connections

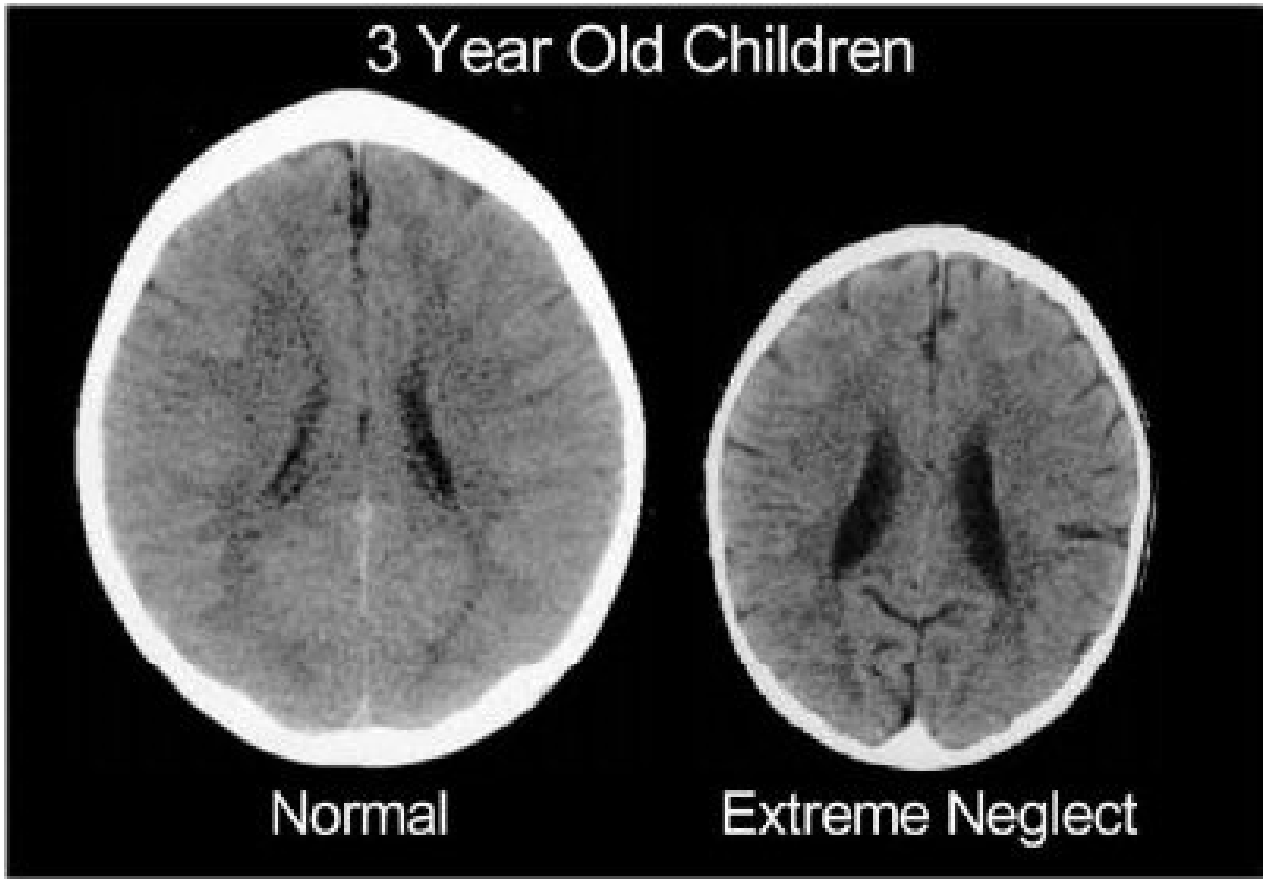


2. Brain Develops through Learning

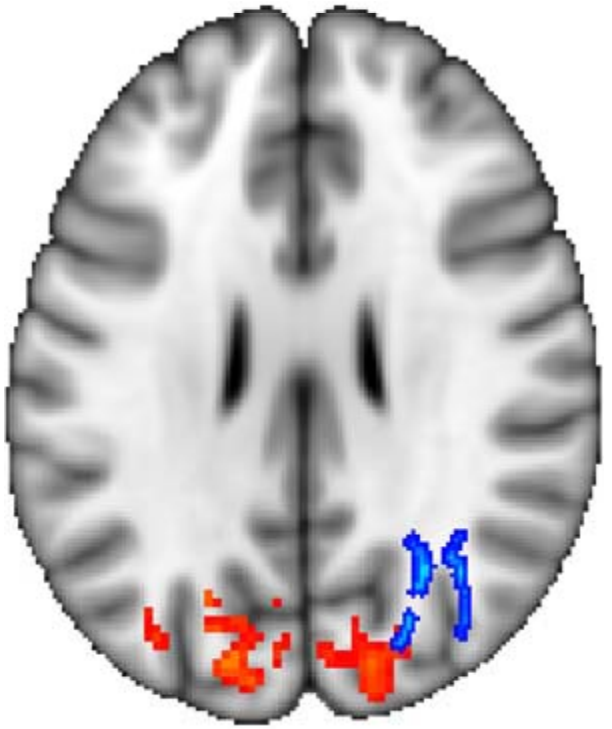
- The brain is a self-organizing system
- Different from a computer that comes loaded with software
- Brain software develops through use
- Learning facilitated by warm social relationships



2. Poor Brain Growth after Neglect



2. Enhanced Brain Growth Through Experience



3. Threats to Healthy Brain Development

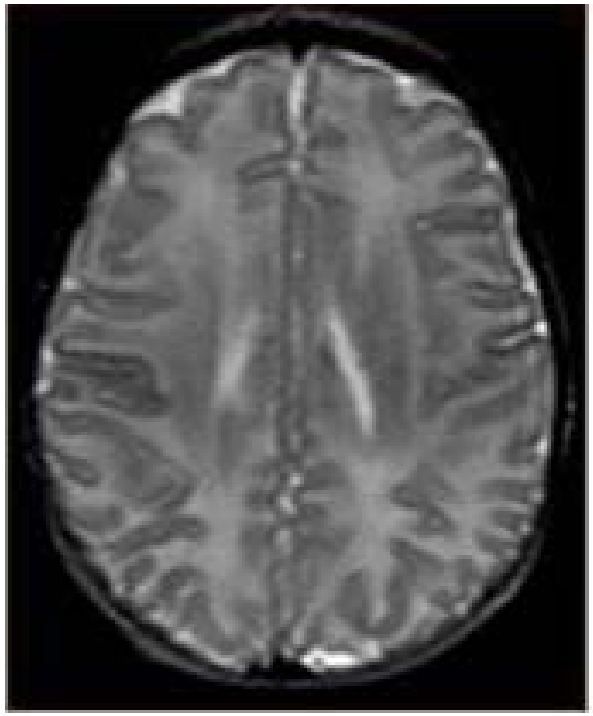
- Biological Factors
  a) Prematurity
  b) Fetal exposure to alcohol
- Psychosocial Factors
  c) Toxic stress
  d) Poverty

3a. Prematurity as Biological Risk

32-week Preemie

25-week Preemie

3a. Neurological Consequences

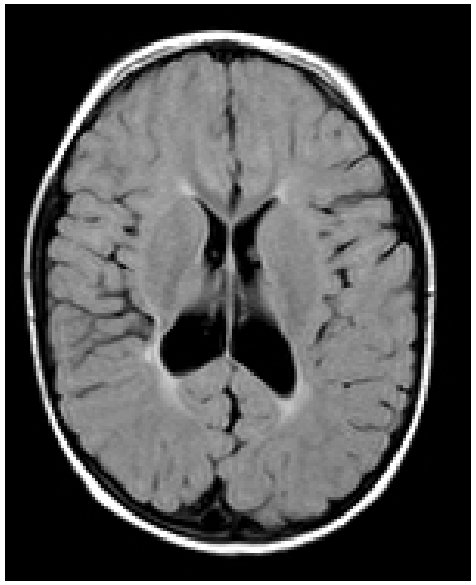
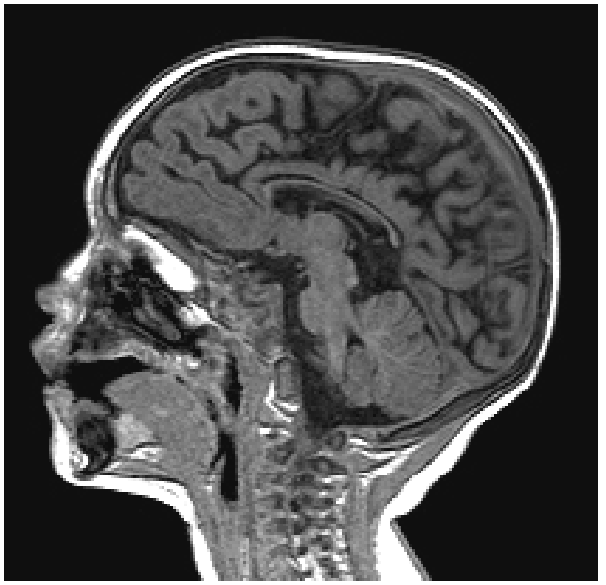


Brain of a Term Infant at Term

Brain of a 30-week Preemie at Term

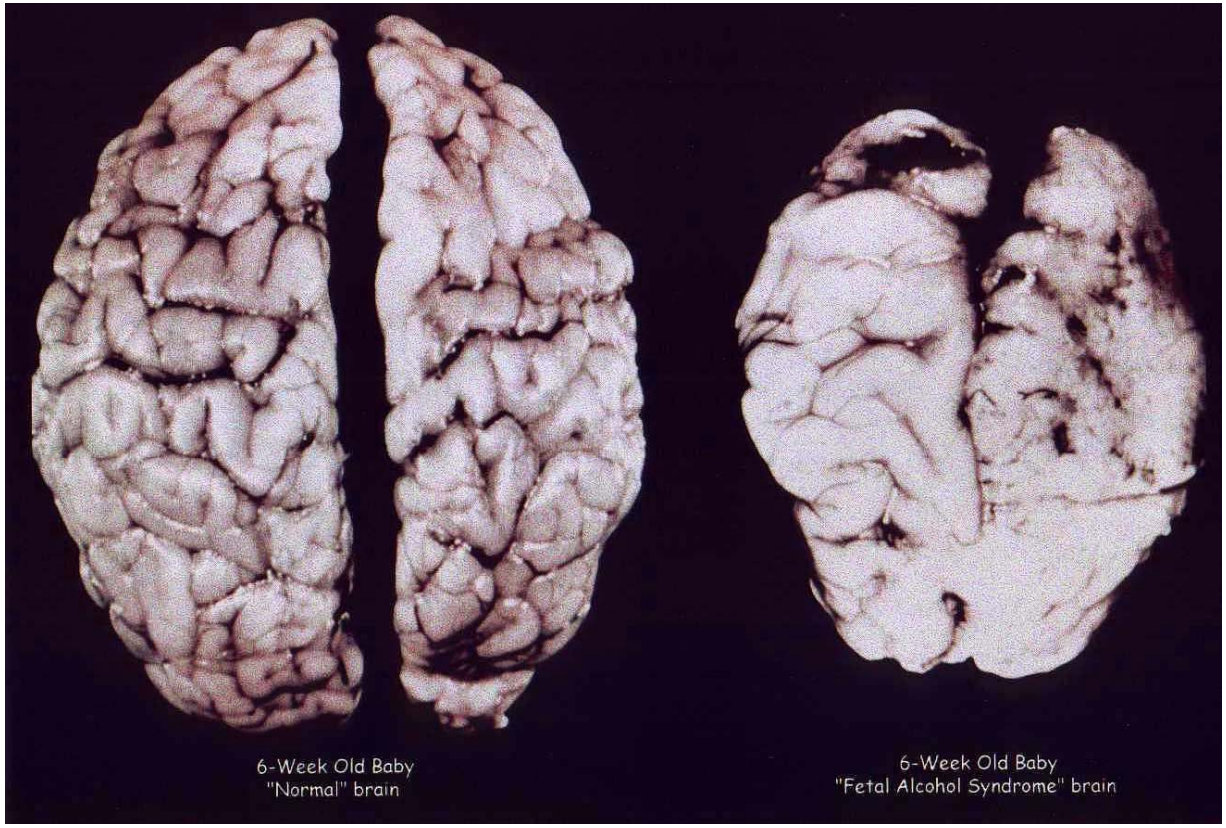
- Reduced brain size
- Abnormal cortical folding
- Diffuse, excessive high signal intensity consistent with white matter abnormality.

3a. Injuries Associated with Prematurity

- Enlargement of the ventricles
- Irregular angular (scalloped) appearance of ventricular contours
- Loss of white matter with atrophy, notable present in the corpus callosum

3b. *In Utero* Alcohol Exposure

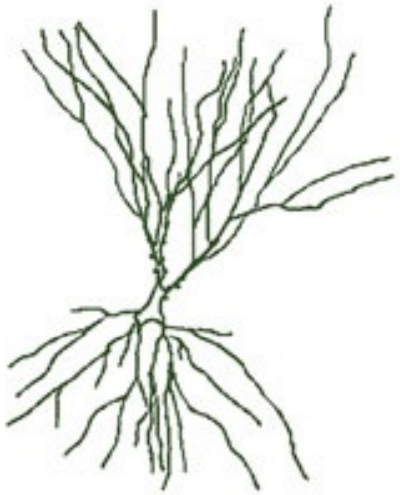


3c. High Levels of Stress/Distress

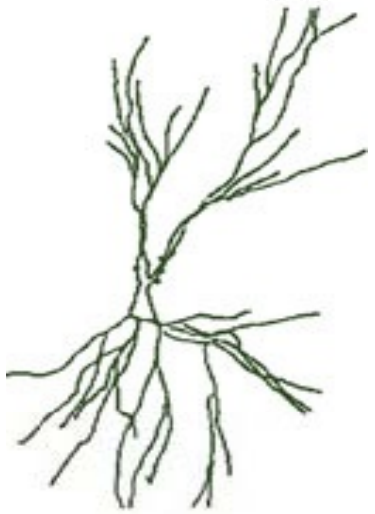
Positive
Brief increases in heart rate,
mild elevations in stress hormone levels.

Tolerable
Serious, temporary stress responses,
buffered by supportive relationships.

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



Brain Cell of
Healthy Mouse

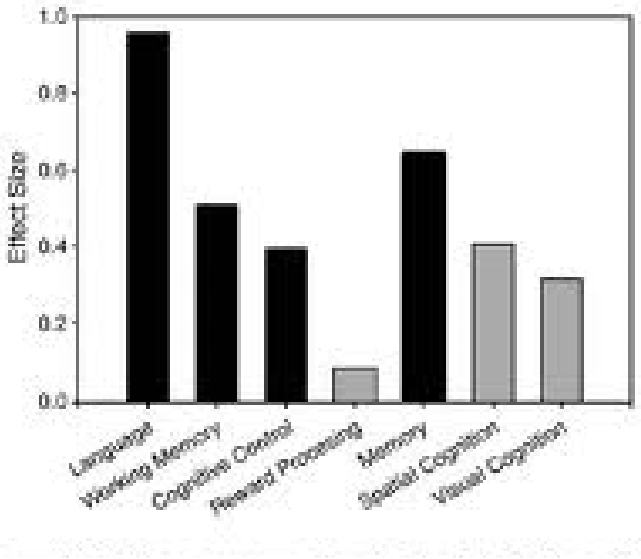


Brain Cell of
Stressed Mouse

3d. Poverty and Brain Development

- Poverty includes
  - Inadequate and variable nutrition
  - Poor health care
  - Reduced exposure to learning opportunities
  - Increased risk of toxic stress
- Poverty robs children of learning potential

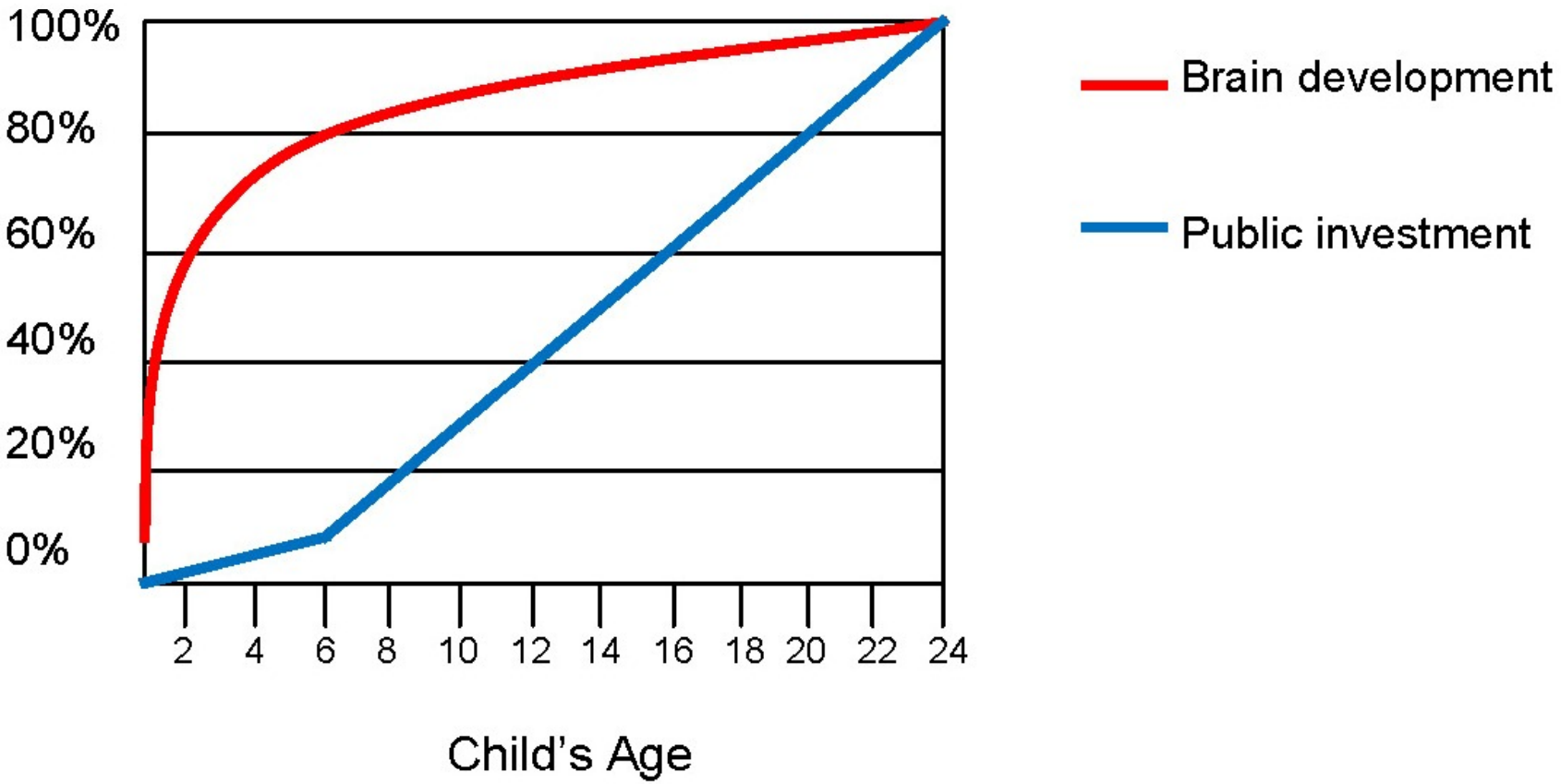
3d. Poverty and Brain Development



Degree of advantage to middle income children by neurocognitive domain

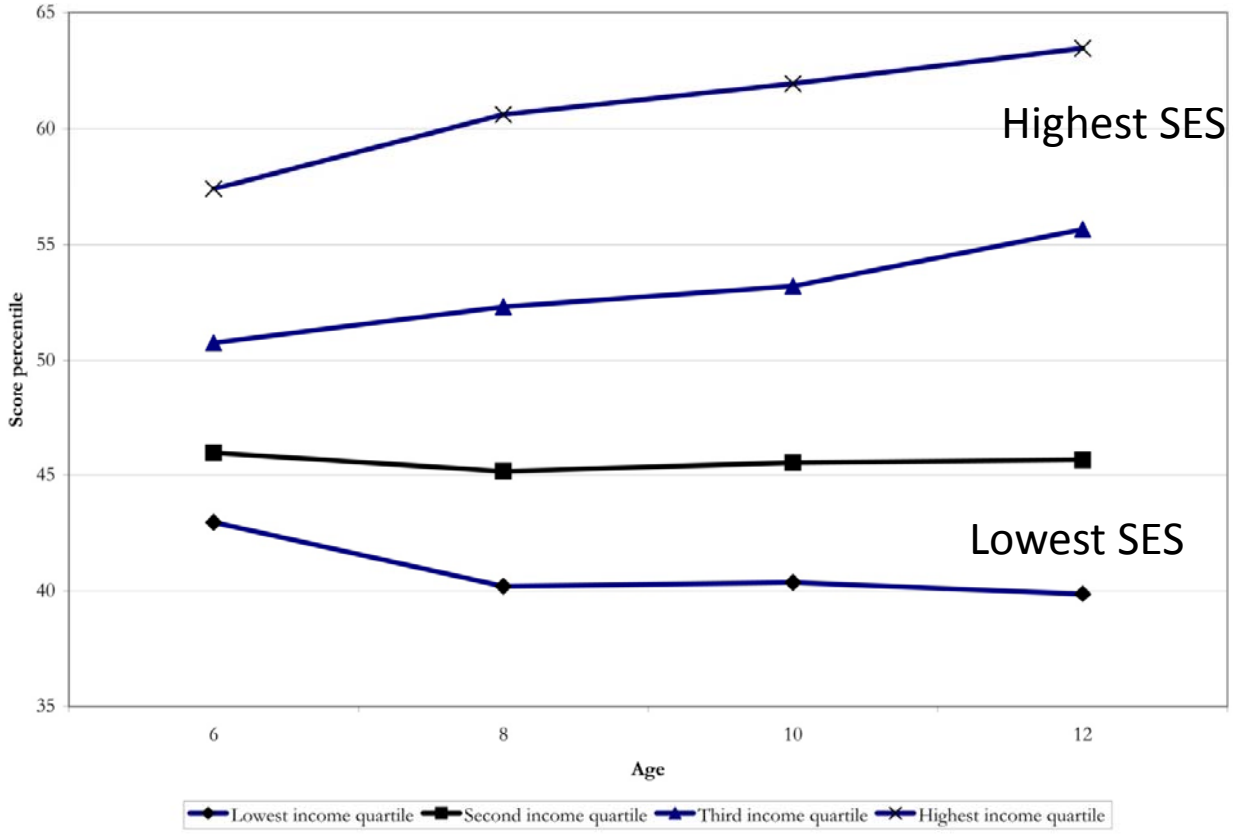
- Brain areas affected by poverty
  - Language
  - Executive Functions

4. First 5's Unique Opportunity

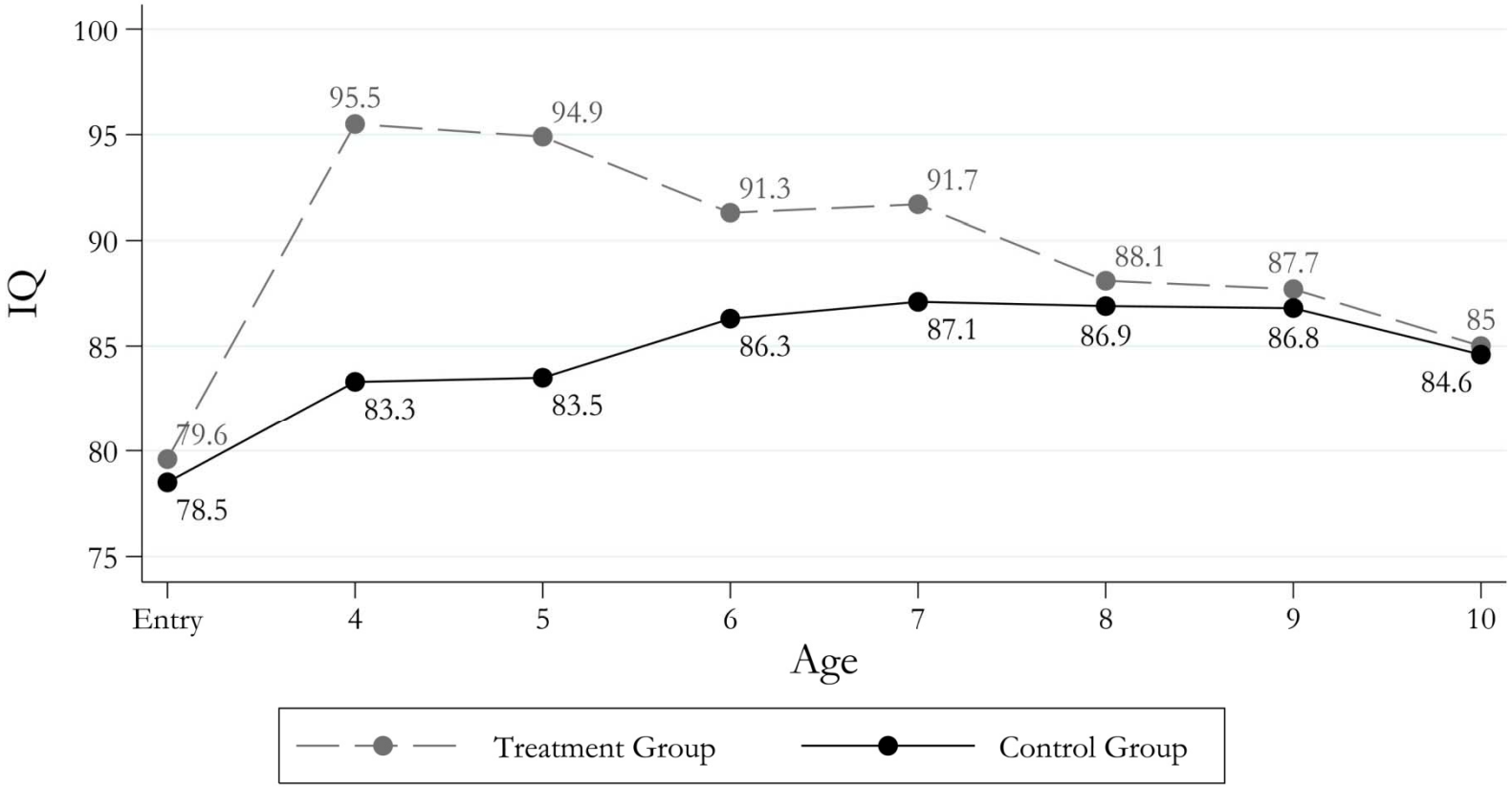


Without Intervention:

Average percentile rank on Math score, by income quartile

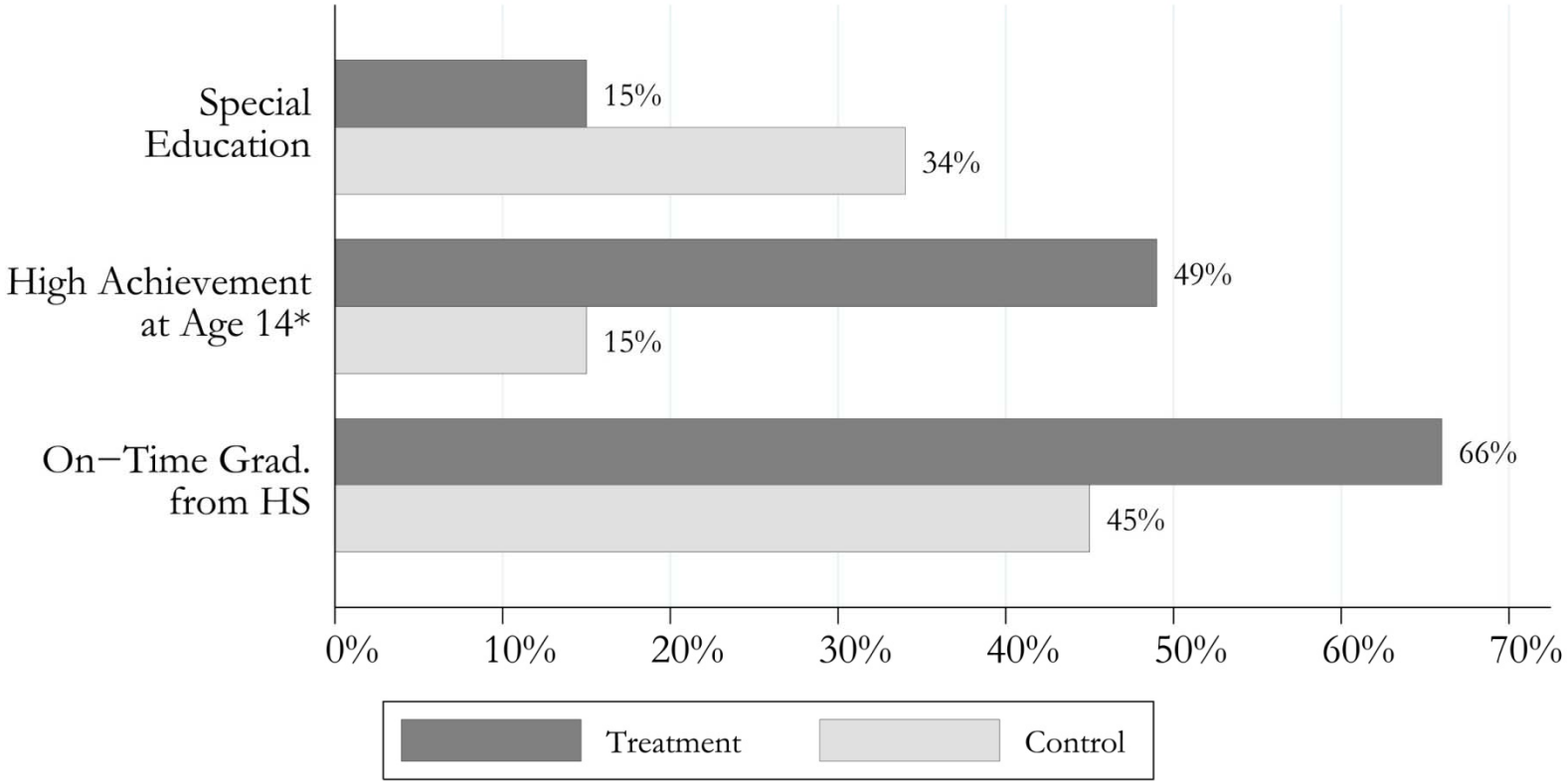


With Intervention: IQ
Perry Preschool Program



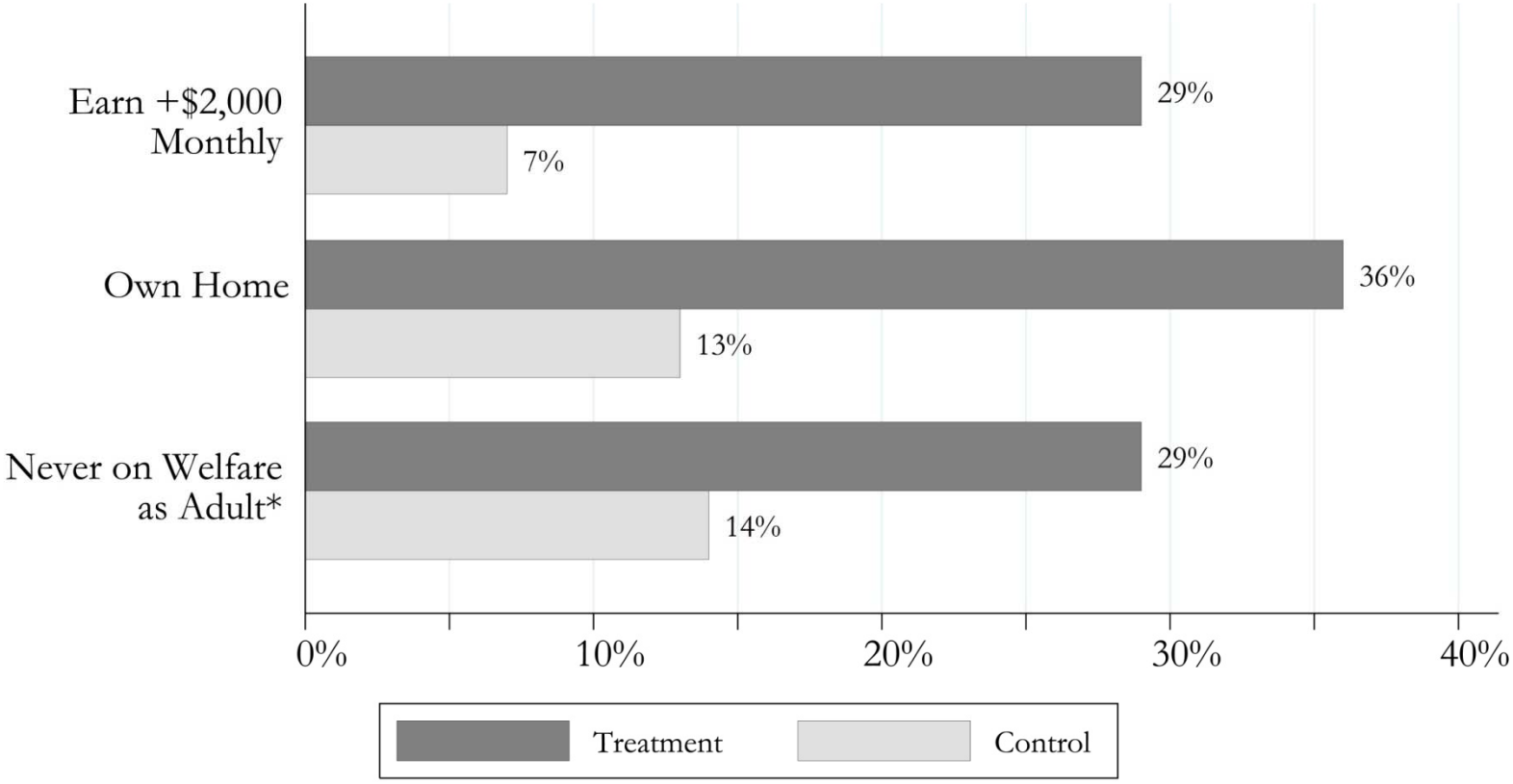
Source: Perry Preschool Program. IQ measured on the Stanford–Binet Intelligence Scale (Terman & Merrill, 1960). Test was administered at program entry and each of the ages indicated.

With Intervention: Education Perry Preschool Program



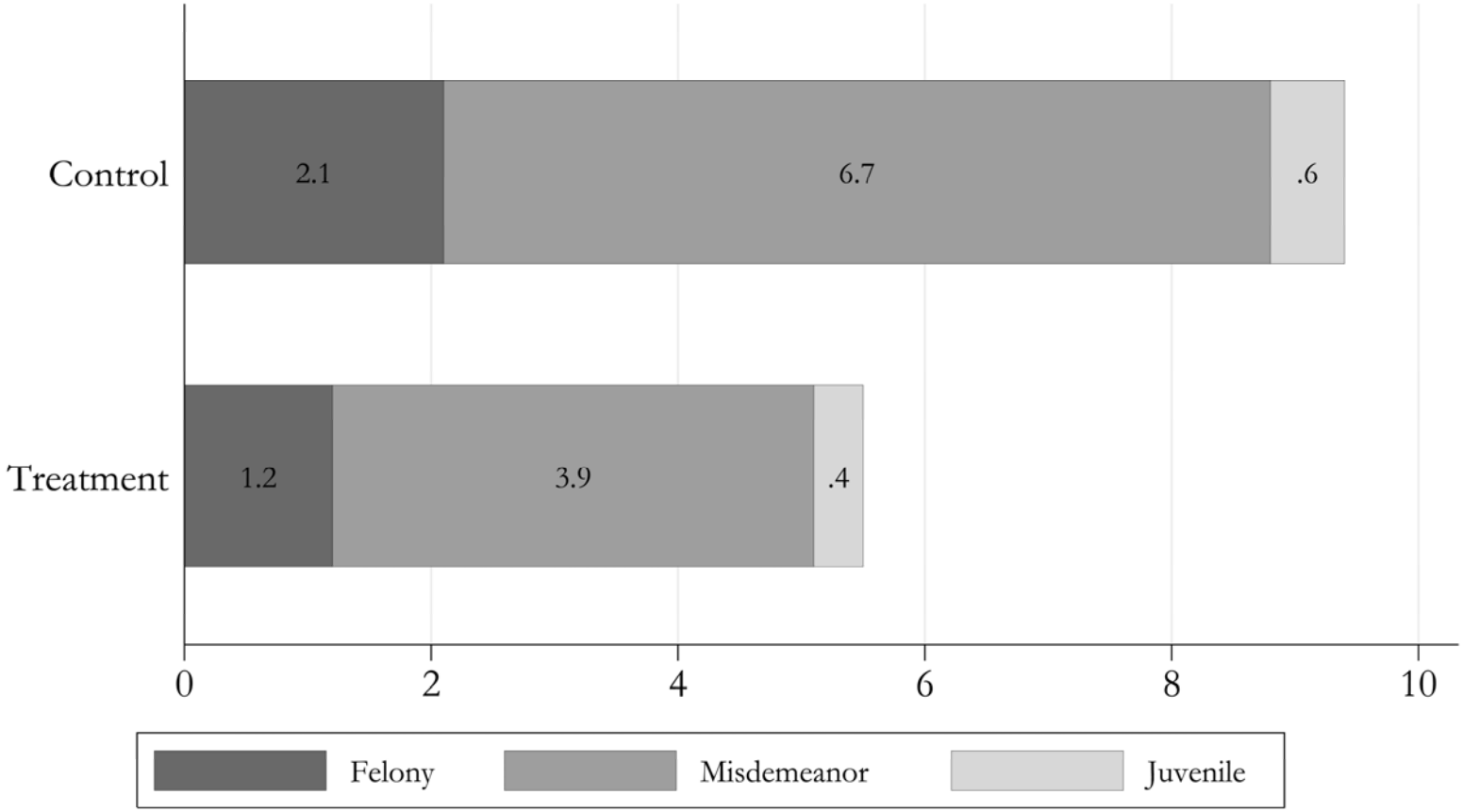
Source: Barnett (2004).
Notes: *High achievement defined as performance at or above the lowest 10th percentile on the California Achievement Test (1970).

With Intervention: Economics at 27 years Perry Preschool Program



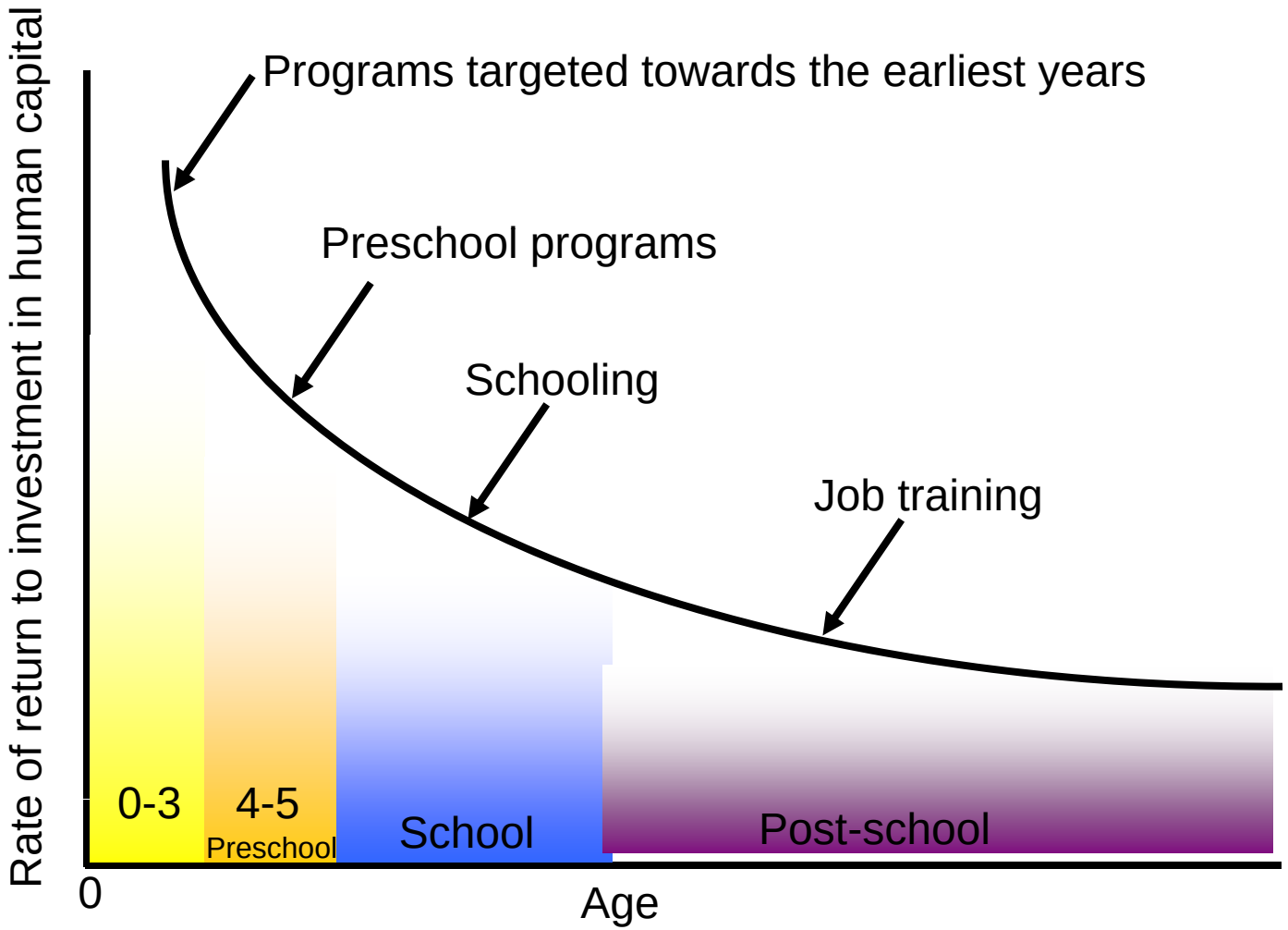
Source: Barnett (2004). *Updated through Age 40 using recent Perry Preschool Program data, derived from self−report and all available state records.

With Intervention: Arrests Perry Preschool Program



Source: Perry Preschool Program. Juvenile arrests are defined as arrests prior to age 19.

Return to Investment at Different Ages



Summary

- Human brain is rapidly developing in first 5 years
- The brain develops through learning
- Biological and psychosocial threats impair learning and change brain structure and function
- Investments in children and their families early in life pay off

Summary

- Political forces threaten services for children birth to 5
- Children from advantaged environments by and large receive substantial early investment
- Children from disadvantaged environments often do not
- Strong case for public funding for interventions in early childhood for children who are disadvantaged, ill, disabled, and at risk for long-term disorders
- Our moral obligation to support young children and their families, for their sake and ours

Lucile Packard Children's Hospital AT STANFORD

Thank you!

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