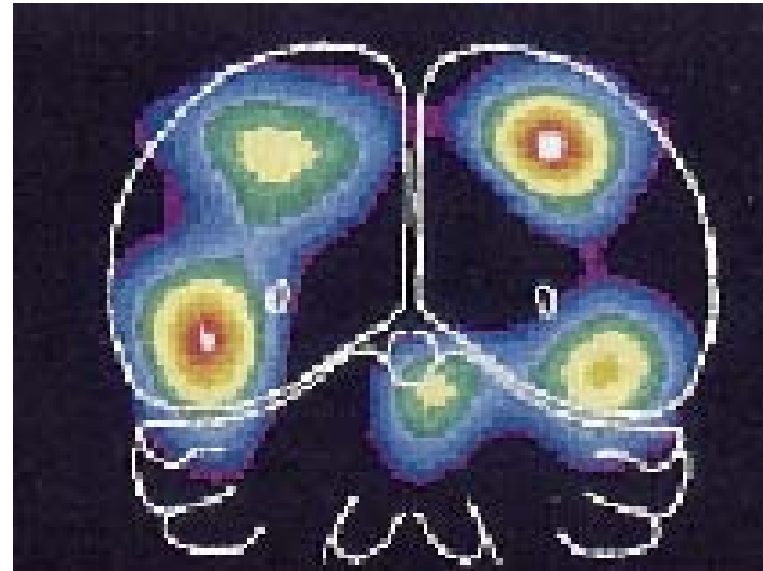
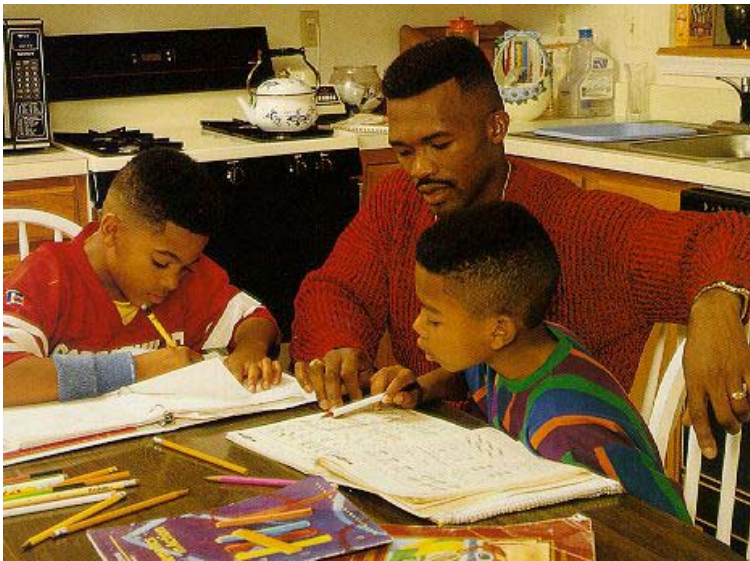


Behavior ♦ Mind ♦ Brain



Looking Through the Windows: Outline

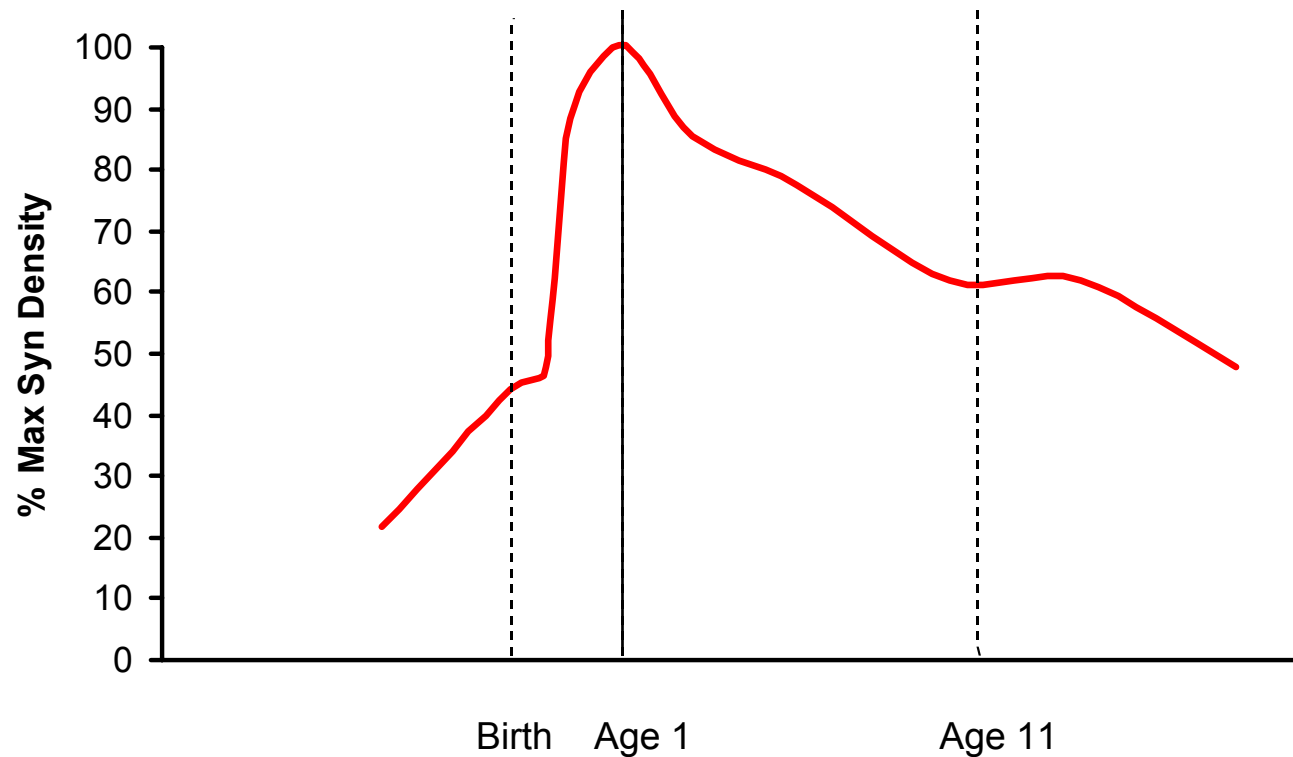
- Popular views about brain science and child development fail to recognize the importance of the behavioral level.
- Understanding mind and behavior can contribute to improved learning and teaching.
- Understanding mind and behavior is essential to advancing our understanding of the brain.

The Myth of the First Three Years

- The first three years of life is a period of rapid **synapse formation**.
- This is the **critical period** in brain development.
- During the critical period, **environmental enrichment** (depravation) has profound, irreversible effects on the brain.

Synaptic Density over the Lifespan

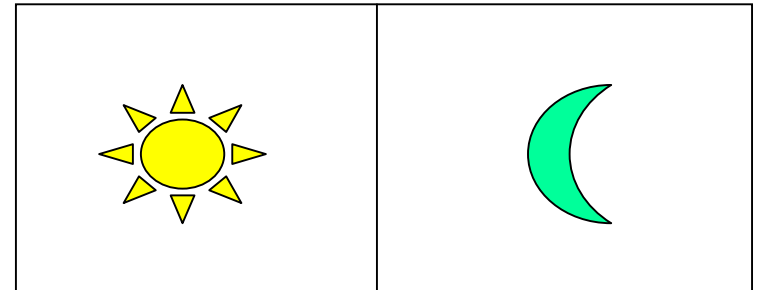
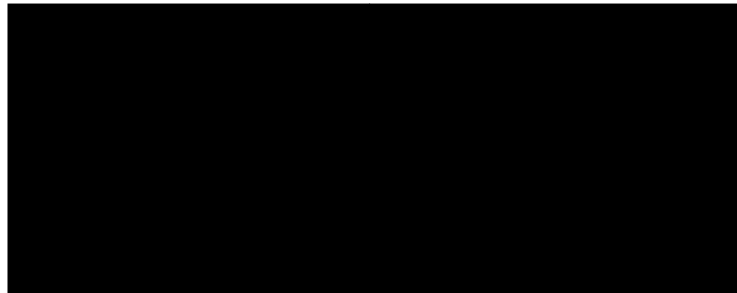
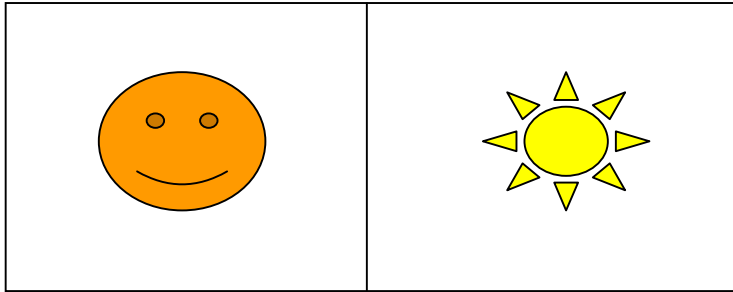
(human visual cortex)



Prefrontal Cortex and Representational Memory

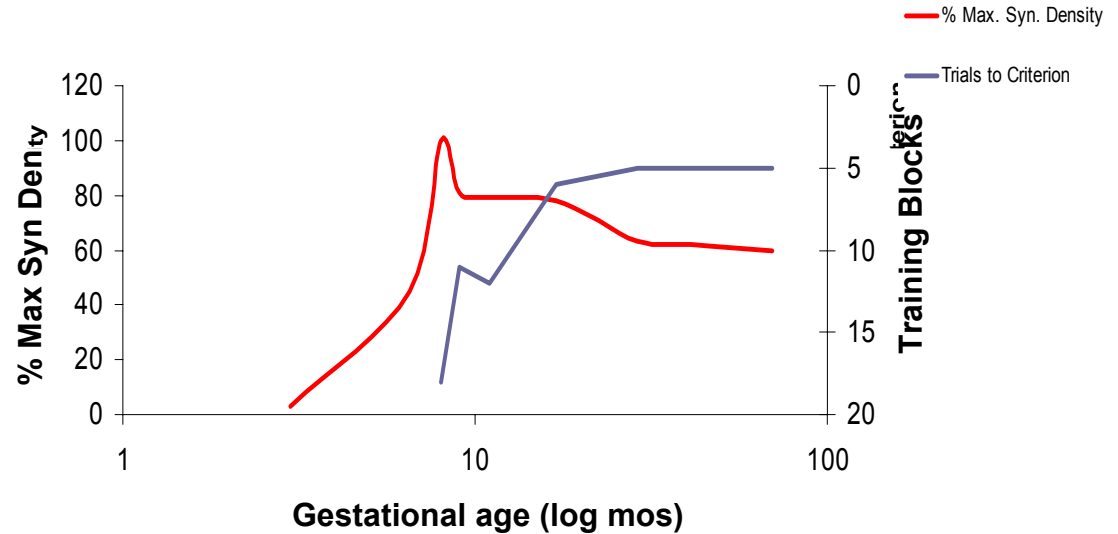


Delayed Non-Match to Sample

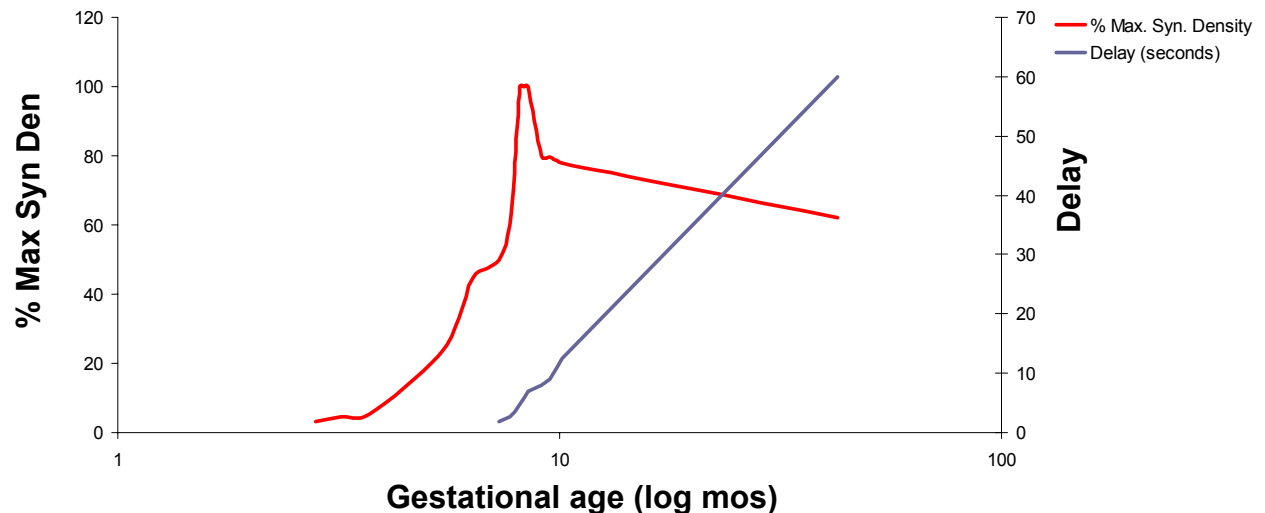


Synapses and Learning: Monkeys

Training to Criterion

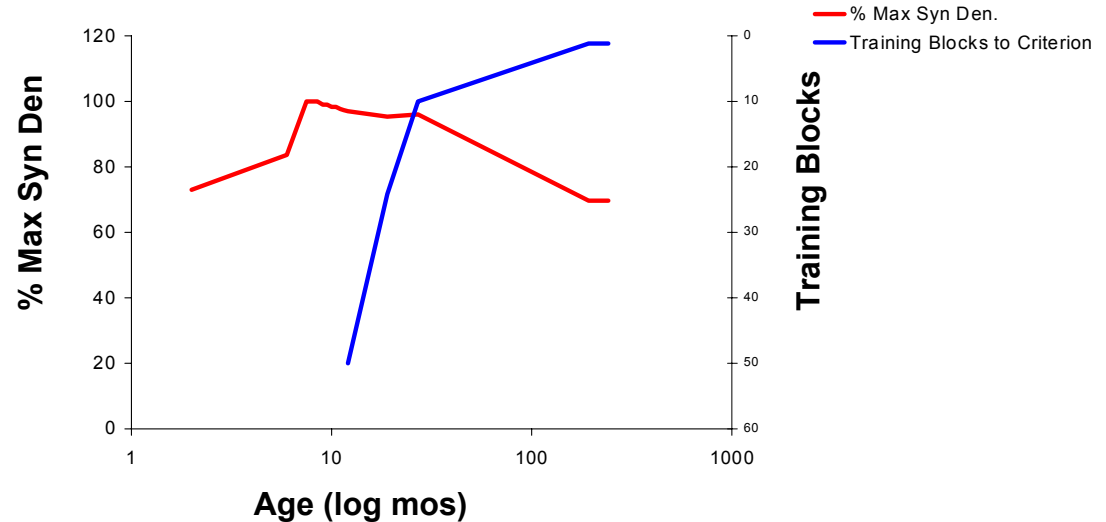


Delays Tolerated

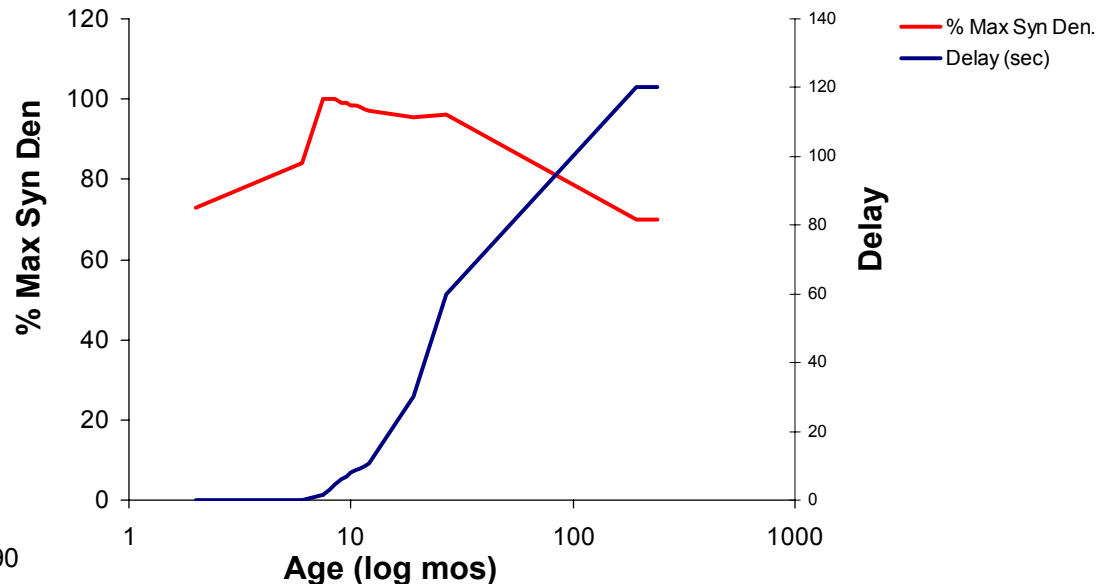


Synapses and Learning: Humans

Training to Criterion



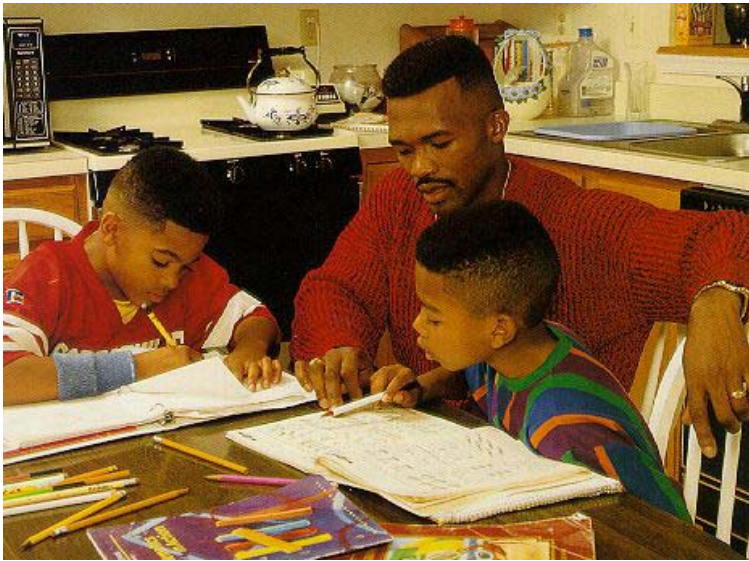
Delays Tolerated



The Brain and Birth to Three

- Myth advanced primarily by policy advocates and propagated in the popular media.
- Myth fails to make appropriate, well-founded connections between brain and behavior.
- Await a serious scientific and scholarly discussion of current understanding of behavior, mind, and brain and what that means for policy, practice, and research.

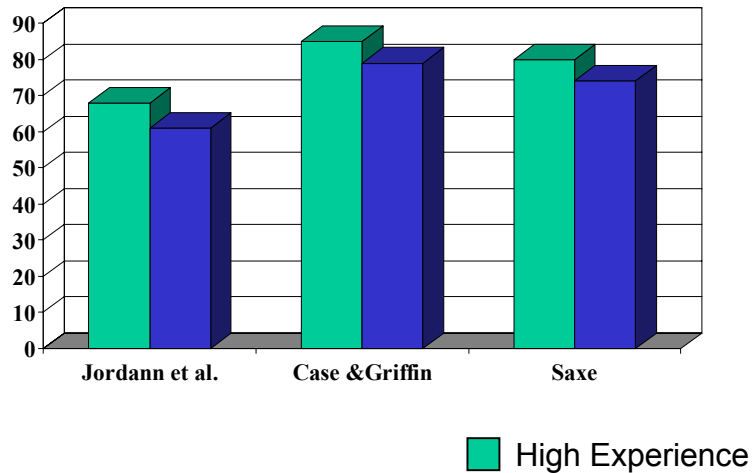
What Children Know About Number



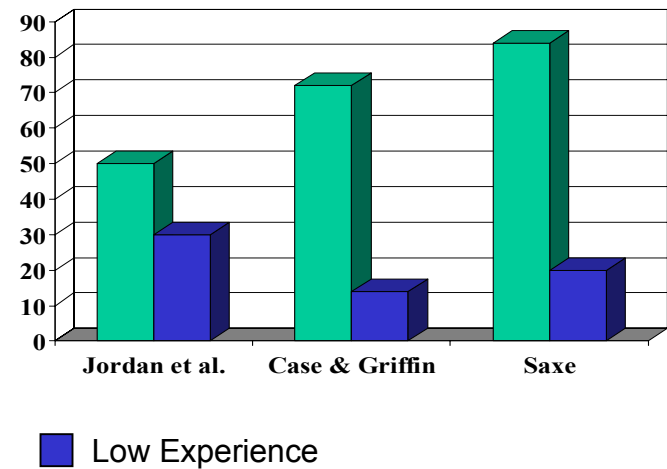
- Three systems: pre-verbal magnitudes, number words, Arabic numerals.
- Most children learn these systems and how they inter-relate prior to school entry. 4.
- Most children arrive at school able to use this understanding to count, compare, and invent strategies for solving simple number problems.

Solving Addition Problems

With Physical Objects

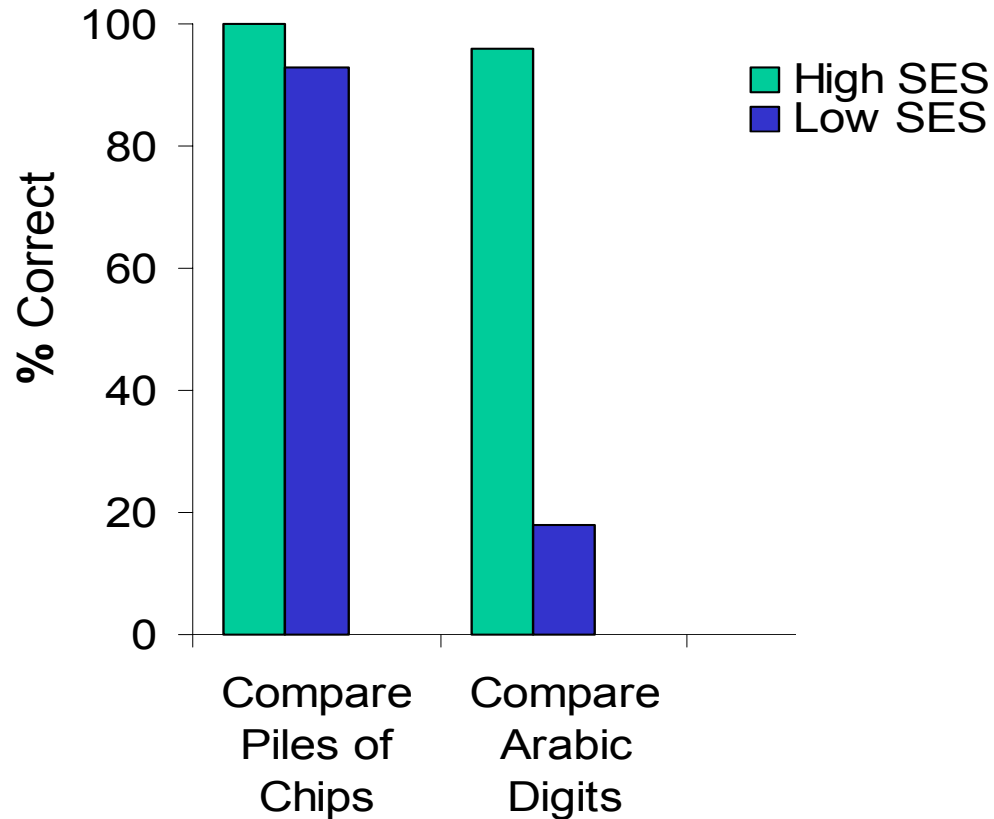


Without Physical Objects



- Jordan et al.: Middle-income vs. low-income kindergarten children
- Case & Griffin: High-SES vs. low-SES kindergarten children
- Saxe: Oksapmin trade store owners vs. Oksapmin adults

Comparison: Which is Bigger?



Solving an Educational Problem

Cognitive Diagnosis: Some children begin school without knowing how the verbal representation of number relates to their innate magnitude representation of quantity.

Cognitive Therapy: Use curricula that explicitly teach how the three representations of number inter-relate.

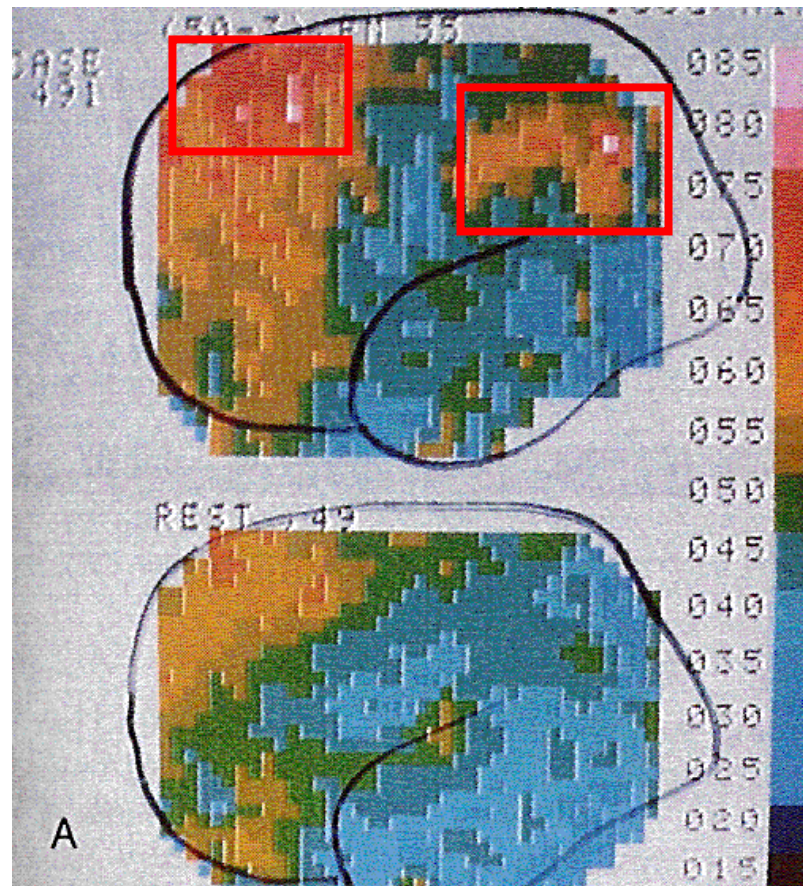
Mean Scores (s.d) on Number Knowledge Test Pre- and Post Number Worlds Instruction

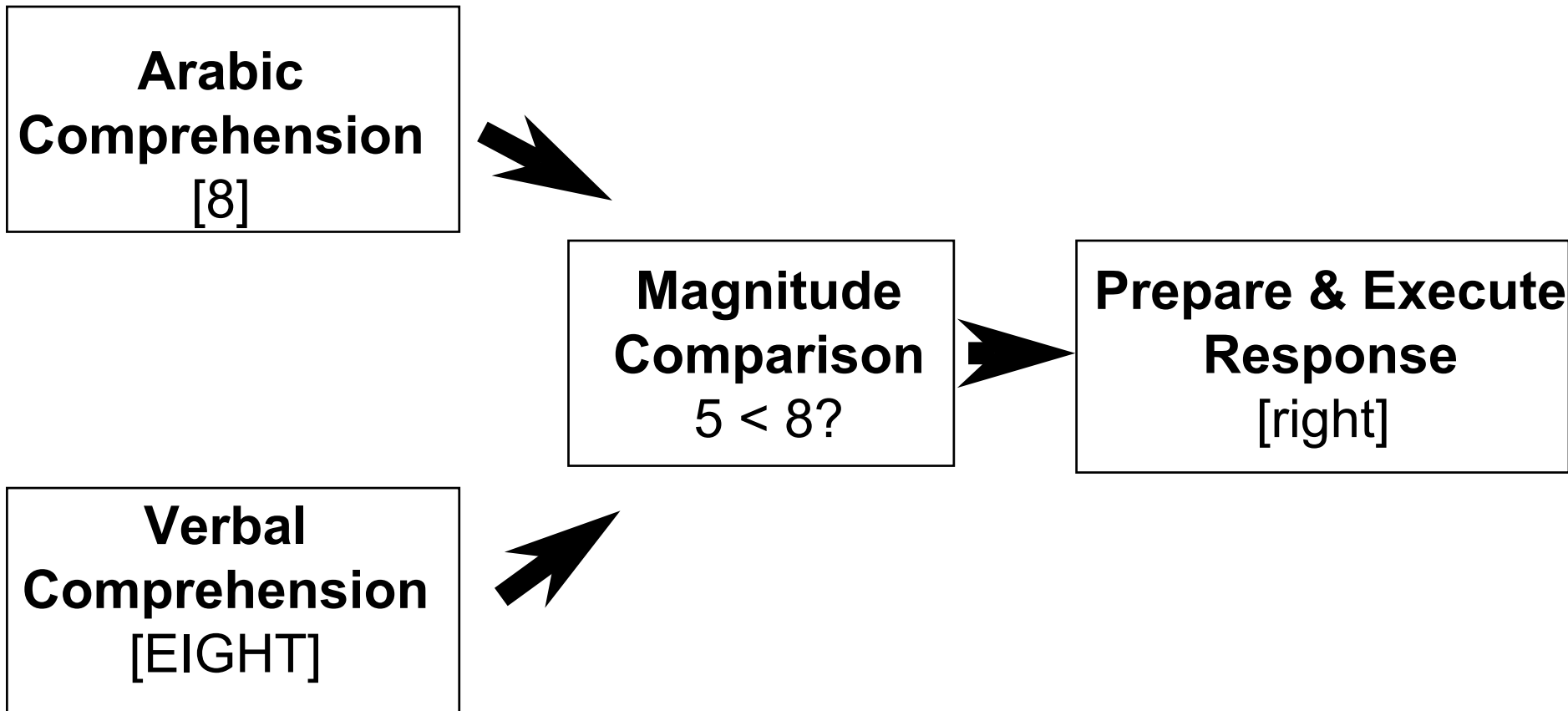
Group	Pre-K	Post-K	Post-Gr. 1
Treatment 1	6.3(2.5)	11.2(2.7)	16.5(3.0)
Treatment 2	5.7(2.5)	12.1(1.9)	17.4(2.0)
Control 1	7.2(2.4)	8.9(2.4)	12.5(2.8)
Control 2	7.2(2.0)	9.3(2.8)	14.3(2.9)
Norm 1	9.8(3.2)	11.4(2.8)	16.9(4.0)
Norm 2	10.6(1.7)	13.5(2.9)	18.8(2.9)

Expected Score: K = 9 - 11; Grade 1 = 16 -18

Imaging: A Window on the Brain

Counting
backward
from 50 by 3s

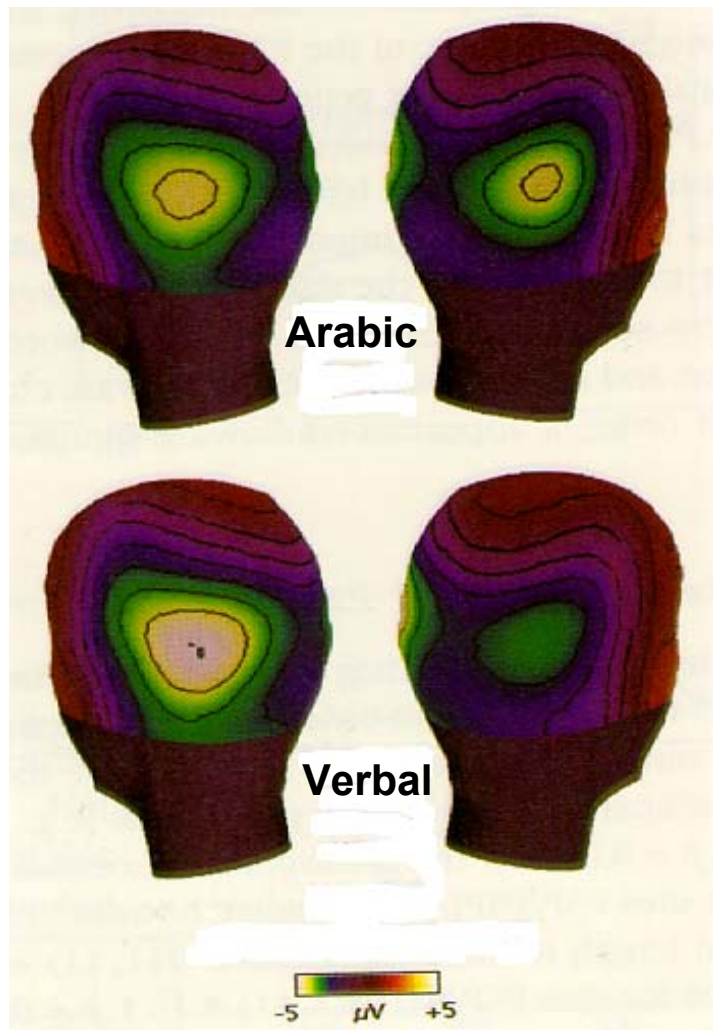




Identification
Notation effect
(arabic vs. verbal)

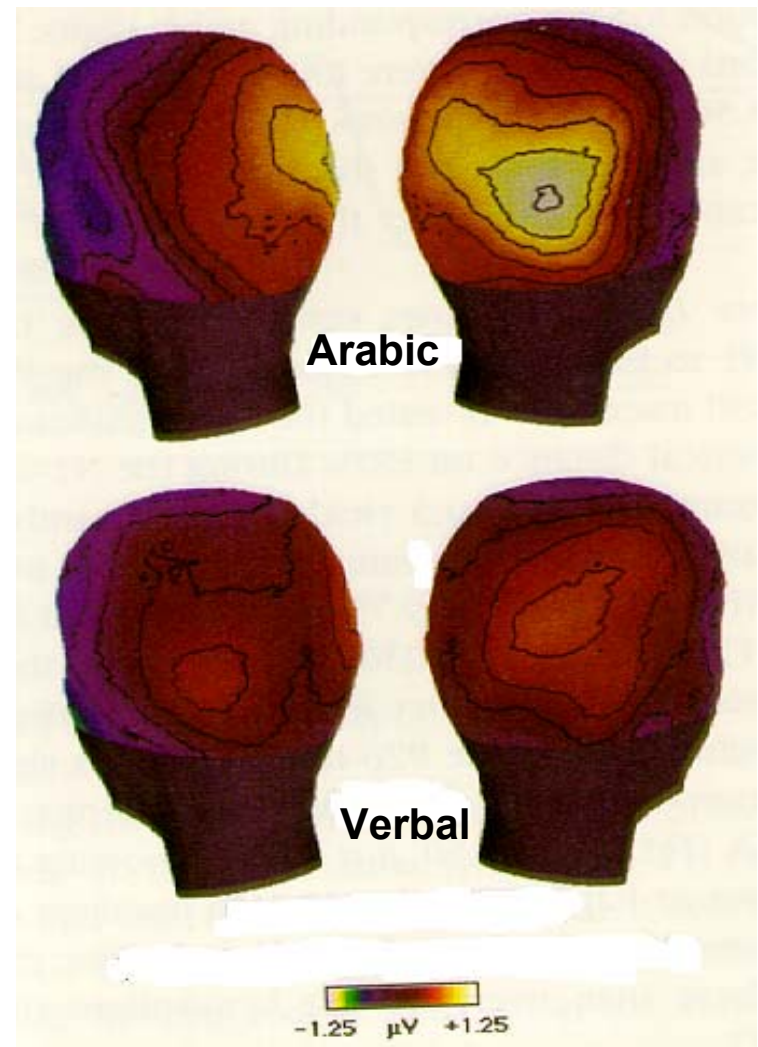
Comparison
Distance effect
(close vs. far)

Response
Response-side effect
(left vs. right)

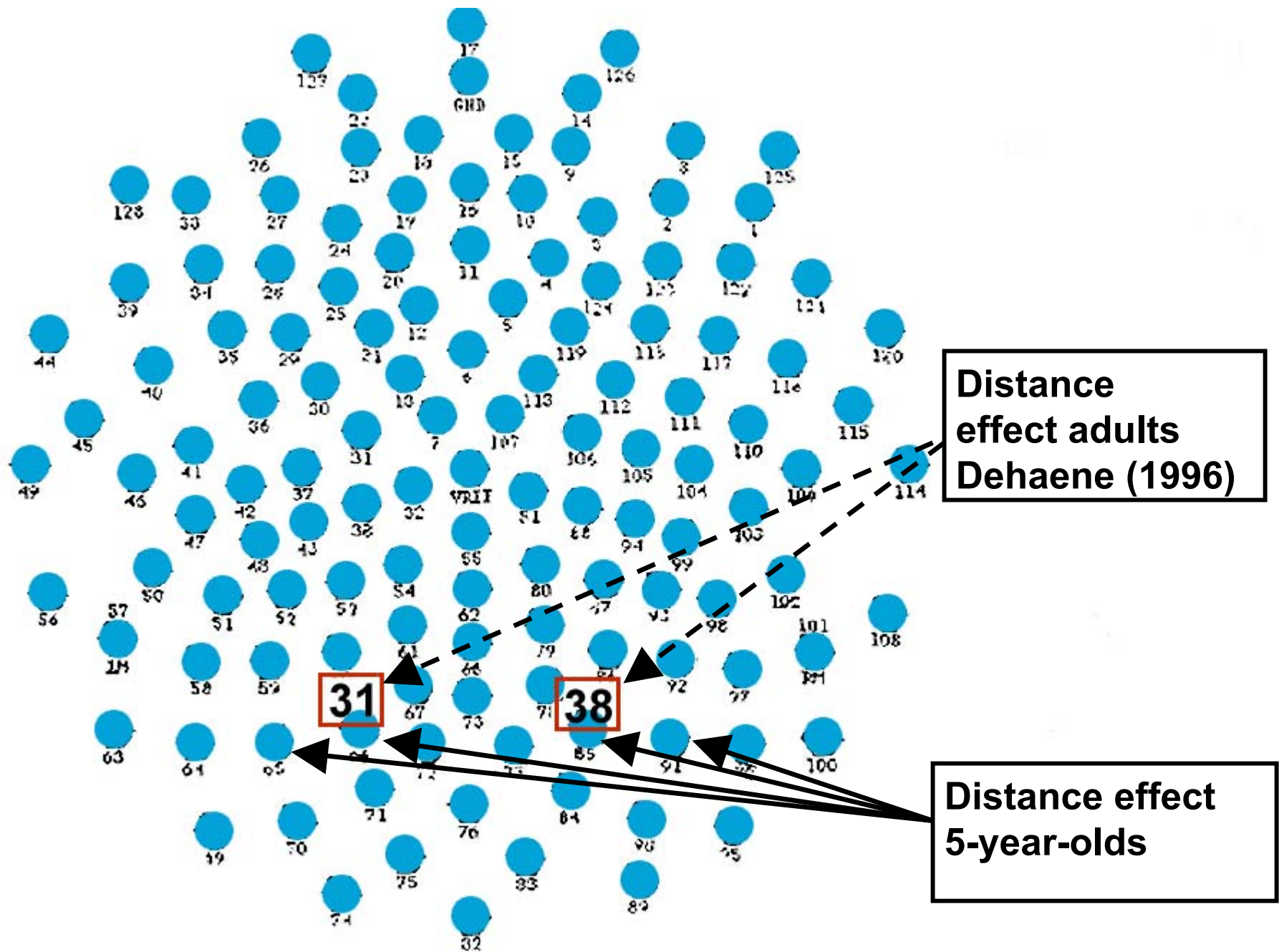


Notation Effect

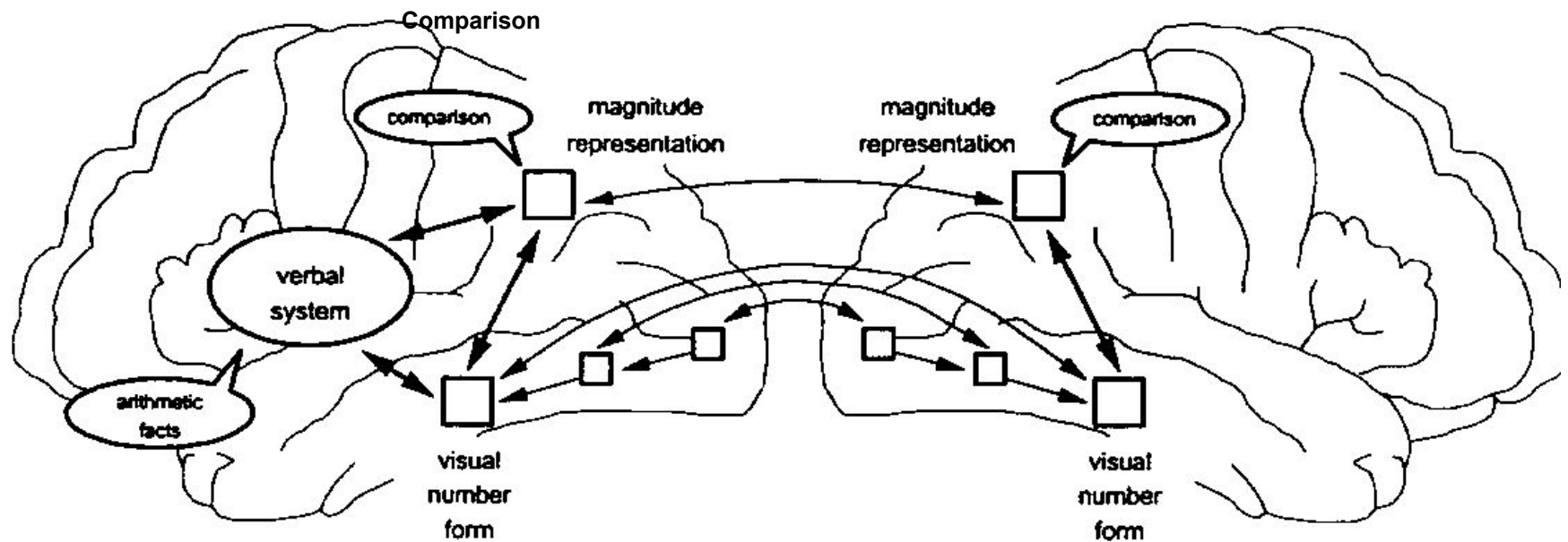
(S. Dehaene, J. Cog. Neuroscience, 8(1), p.56, 1996)



Distance Effect 210 ms before key press



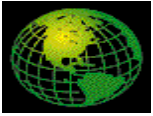
Mapping Cognitive Functions onto Neural Structures



The Future Challenge for Mind-Brain Science

The challenge for the future is to understand at a deeper level the actual mental operations assigned to the various areas of [brain] activation. Before this goal can be achieved, the experimental strategies used in PET studies must be refined so that more detailed components of the process can be isolated.

- M. Posner & M. Raichle, 1994



21st Century Science Initiative - Bridging brain, mind, and behavior

The Bridging Brain, Mind, and Behavior Program provides support for inter- and cross-disciplinary research explicitly addressing questions whose investigation requires spanning the different levels of analysis characterizing neurobiological or cognitive studies with observations obtained from behavioral research. Examples of projects the Foundation would consider within the scope of the program include, but are not limited to:

Research in new or under-developed areas of **cognitive neuroscience** that integrates behavioral, cognitive, and neural analysis in studies of human behavior and higher-cognitive functions.

§ Applied research in areas such as **training, education, and rehabilitation** that attempts to conduct and integrate research across the behavioral and cognitive levels, and, where appropriate, the neural level of analysis to develop research-based tools, methods, and protocols to improve teaching, learning, and clinical practice.

§ Research on the **genetic bases of behavior** and on genetic factors affecting brain development that integrates behavioral, cognitive, and neural studies of patients and human subjects.

§ Work that addresses how to **integrate research** that takes **social and cultural groups** as the unit of analysis with research that takes the individual **mind-brain** as the unit of analysis.



JAMES S.
McDonnell
FOUNDATION

For additional information on the foundation and for the PowerPoint version of this talk, please visit our website at:

www.jsmf.org

Brain and Behavior

An analysis at the behavioral level lays the foundation for an analysis at the neural level. Without this foundation, there can be no meaningful contribution from the neural level.

- Randy Gallistel

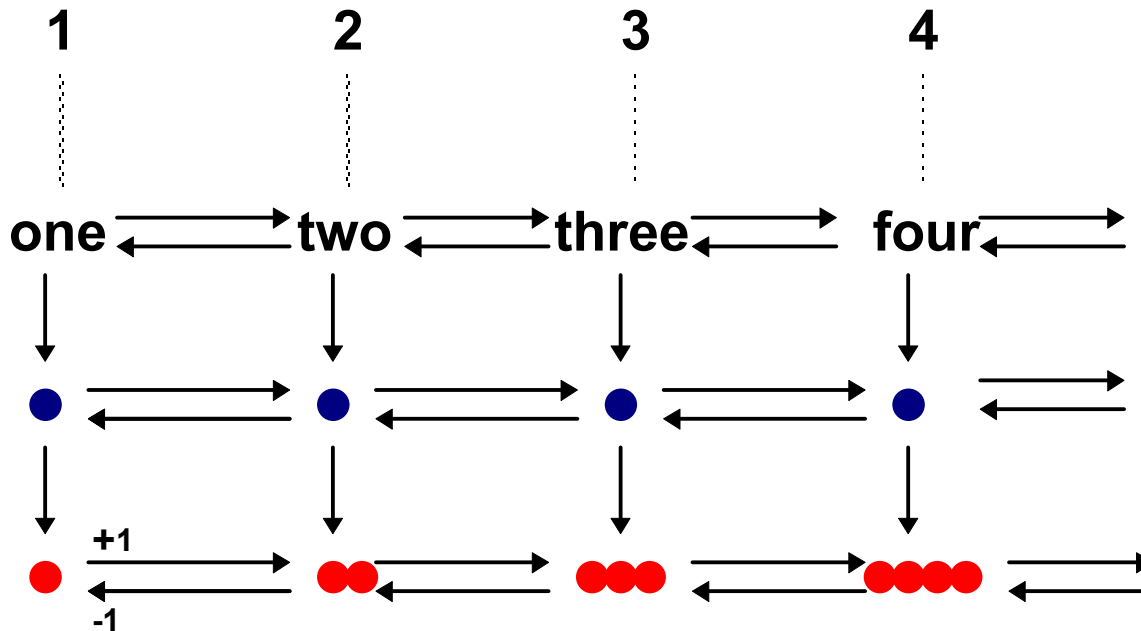
Birth to Three and Attachment

- Lack precise characterization of specific care-taking practices that lead to secure attachment.
- Lack adequate cognitive understanding of the attachment system.
- No research linking attachment theory and brain development.

The Brain and Birth to Three

- Myth advanced primarily by policy advocates and propagated in the popular media.
- Myth fails to make appropriate, well-founded connections between brain and behavior.
- Critique has been welcomed by brain and cognitive scientists, not so by pediatric psychiatrists.
- Await a serious scientific and scholarly discussion of current understanding of behavior, mind, and brain and what that means for policy, practice, and research.

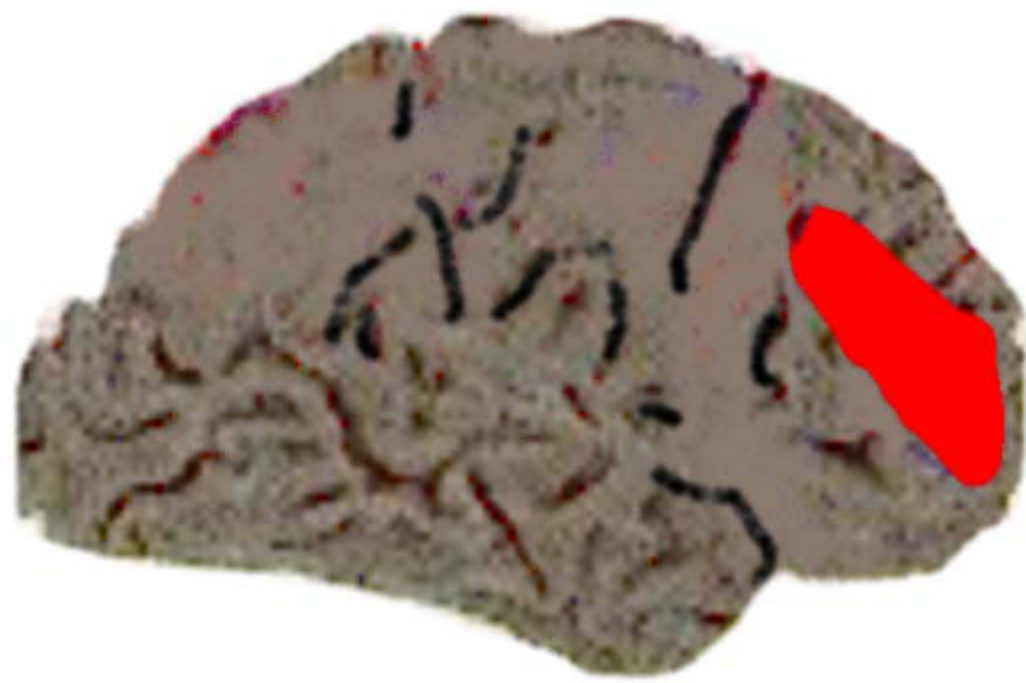
Integrating the Representations: the Mental Number Line



The Future Challenge for Mind-Brain Science

The challenge for the future is to understand at a deeper level the actual mental operations assigned to the various areas of [brain] activation. Before this goal can be achieved, the experimental strategies used in PET studies must be refined so that more detailed components of the process can be isolated.

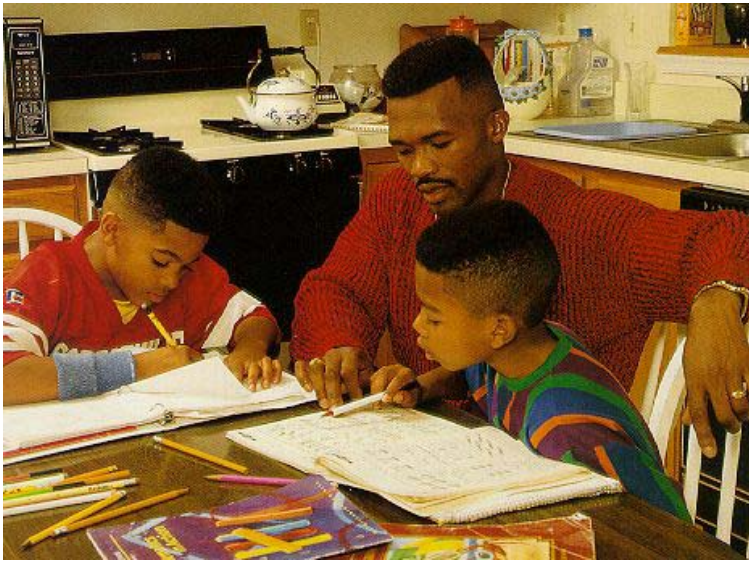
- M. Posner & M. Raichle, 1994



The Myth and Synapse Formation

- Education: The period of rapid synapse formation and excess neural connectivity (ages 0-10) is the period during which children learn most quickly and easily.
- Early Child Development: When rapid synapse formation ends (age 3), the brain is permanently hard-wired as an organ of thinking and learning.

What Children Know About Number



- Three systems: pre-verbal magnitudes, number words, Arabic numerals.
- Infants use the pre-verbal system to make simple numerical judgments.
- Children begin to learn the sequence of number words at age 2.
- Children learn what the number words and counting means around age 4.
- Children use counting knowledge to invent strategies for solving simple arithmetic problems.

Windows on the Brain

