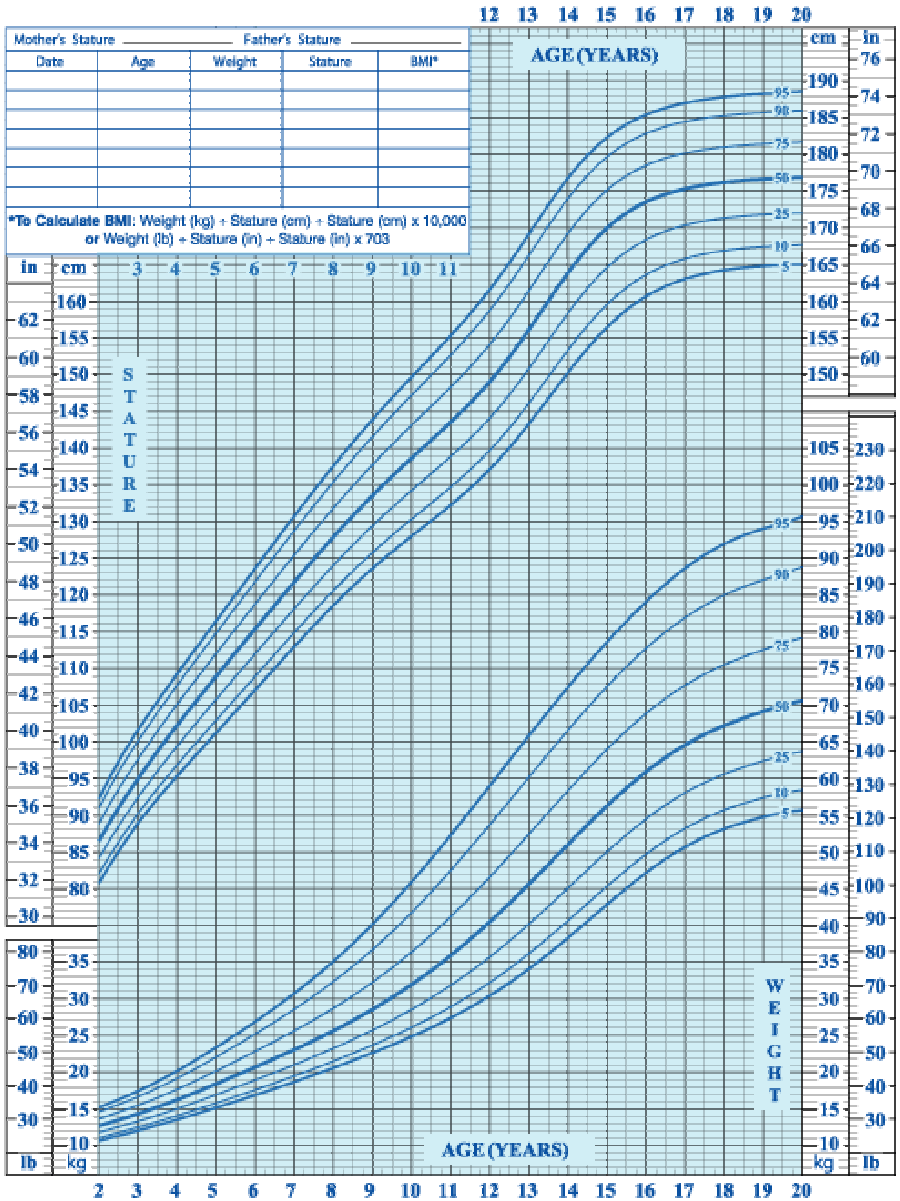
2 to 20 years: Boys
Stature-for-age and Weight-for-age percentiles

NAME ______________________

Mother's Stature ____________ Father's Stature ____________

Date	Age	Weight	Stature	BMI*

*To Calculate BMI: Weight (kg) ÷ Stature (cm) ÷ Stature (cm) x 10,000
or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703



SOURCE : Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts

Conclusion:

The window of biological opportunity when physical training is most efficient and its effects most easily retained is not fully exploited in our sports programs.

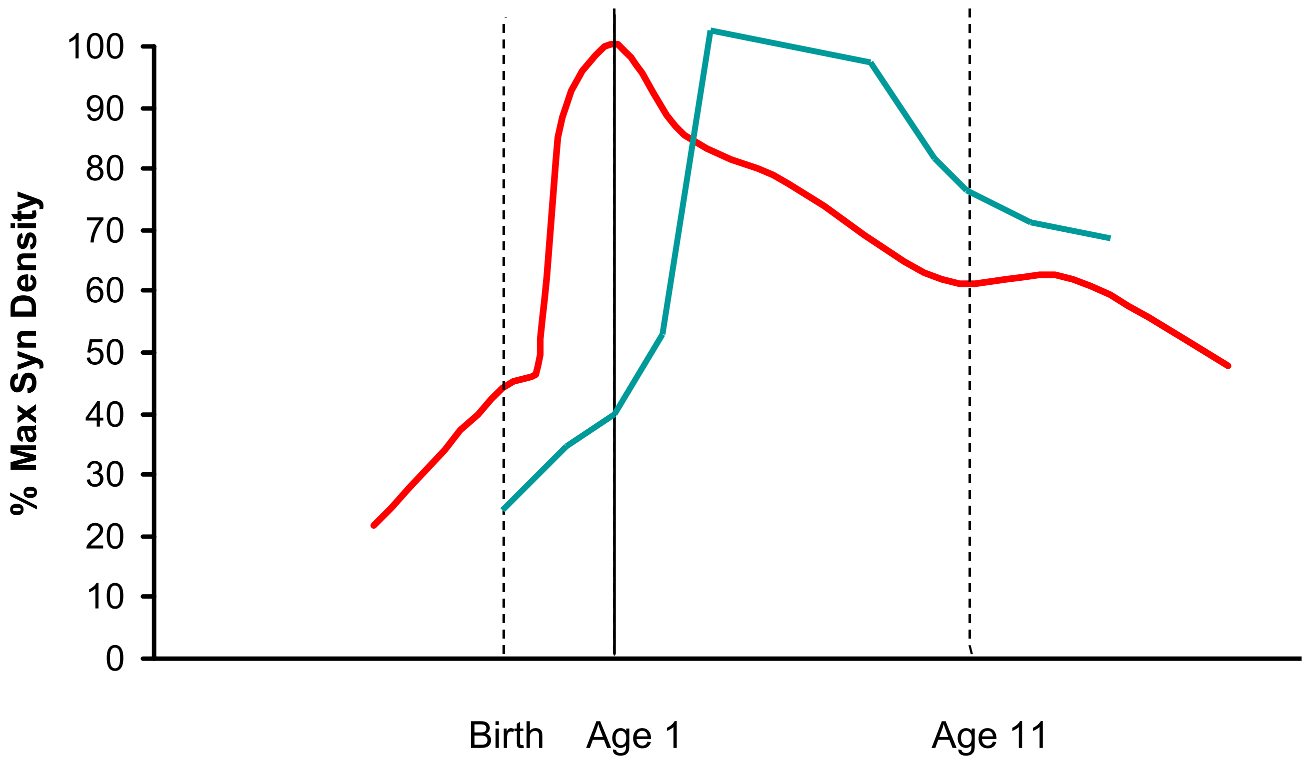
What is wrong with drawing this conclusion from the growth chart?

The pediatrician is drawing a conclusion about physical function, based only upon data that tells about gross structural change.

What other kind of data do we need to arrive at this conclusion?

We need data on specific structure-function relationships.

Synaptic Density and Glucose Metabolism (visual cortex)



Redrawn from P. Huttenlocher 1987

Conclusions:

"Thus, it is now believed by many (including this author) that the biological "window of opportunity" when learning is efficient and easily retained is perhaps not fully exploited by our educational system." *(H. Chugani, Preventive Medicine 27:184-88, 1998)*

Wayne State neurobiologist Harold Chugani points out that the school-age brain almost "glows" with energy consumption, burning a 225 percent of the adult levels of glucose. The brain learns fastest and easiest during the school years. (E. Jensen, Teaching with the Brain in Mind, p.32)

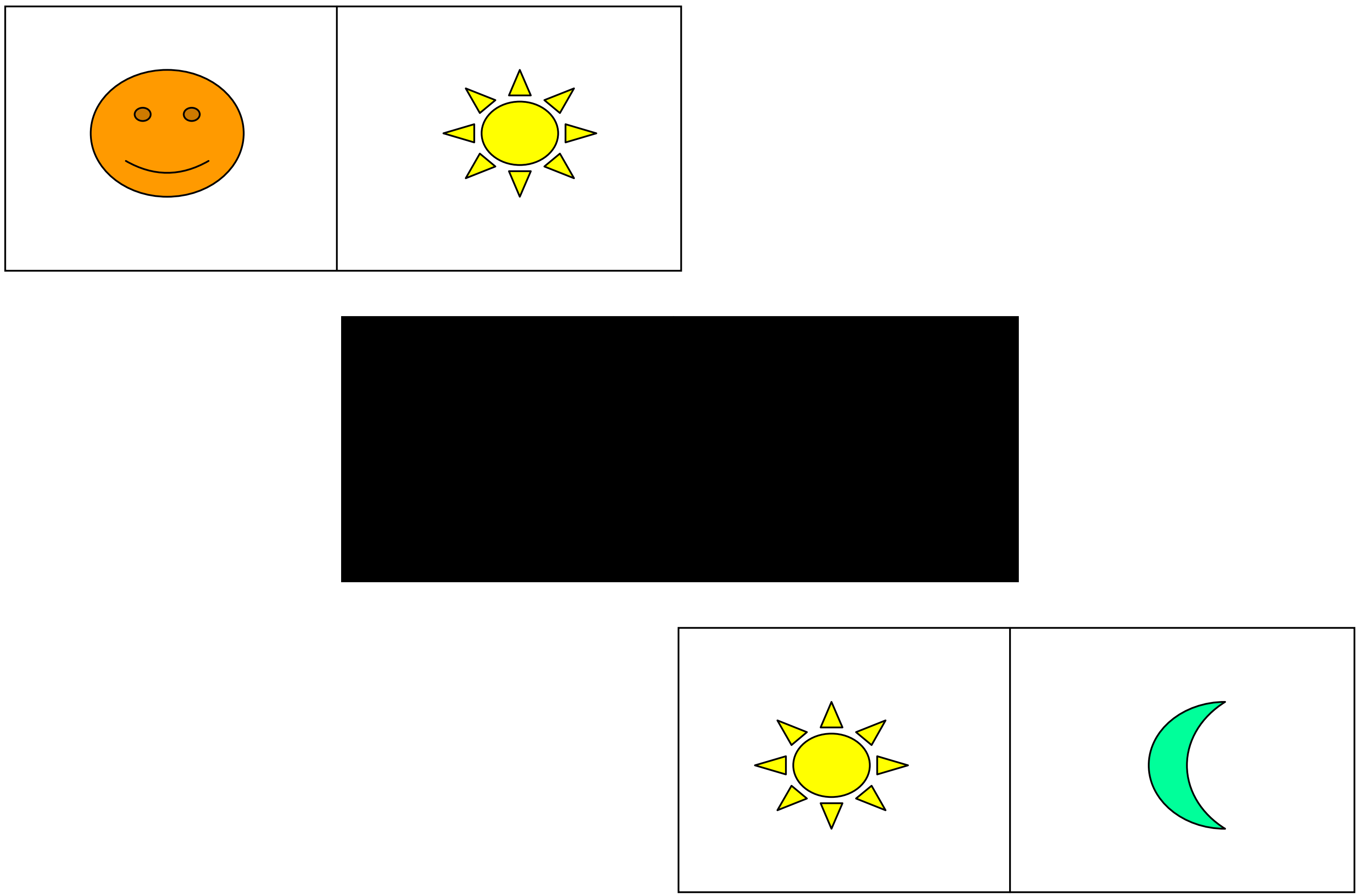
What is wrong with drawing this conclusion from the data on changes in synaptic density and brain metabolism?

The pediatrician is drawing a conclusion about mental function, based only upon data that tells about gross changes in brain structure.

What other kind of data do we need to arrive at this conclusion?

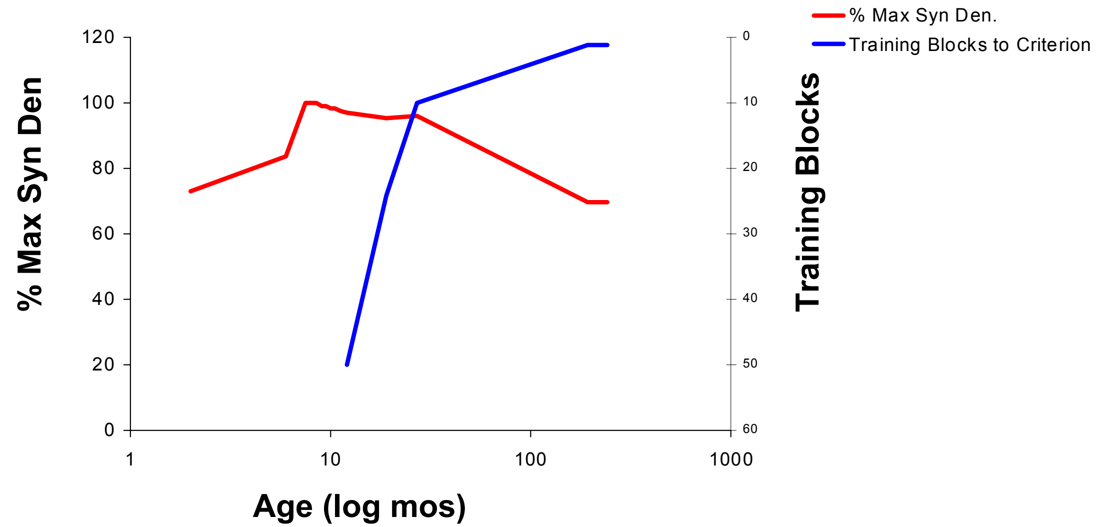
We need data on specific structure-function relationships.

Delayed Non-Match to Sample

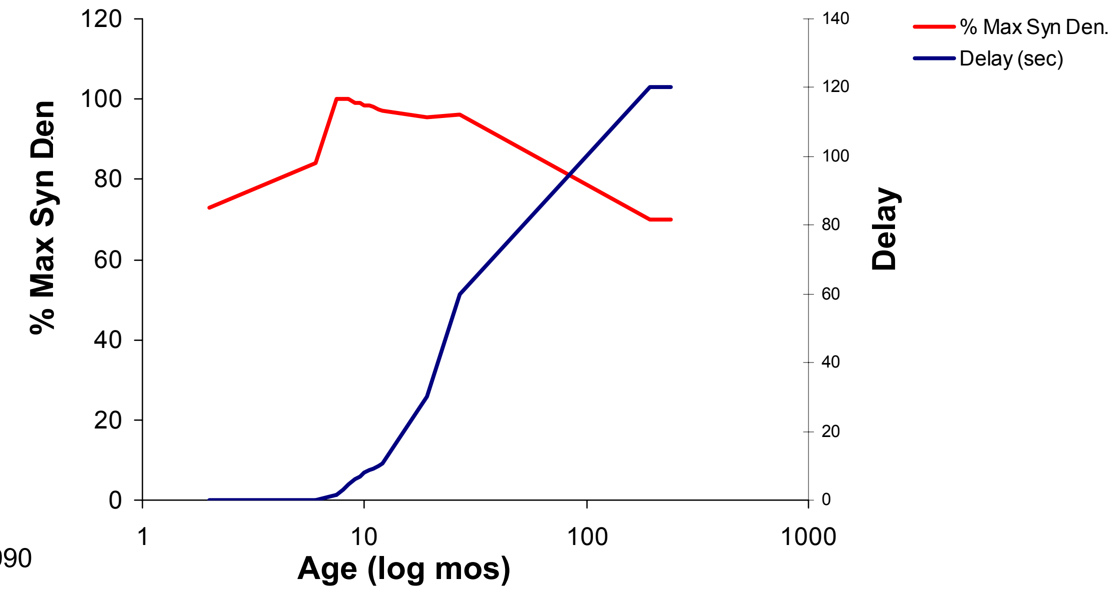


Synapses and Learning: Humans

Training to Criterion

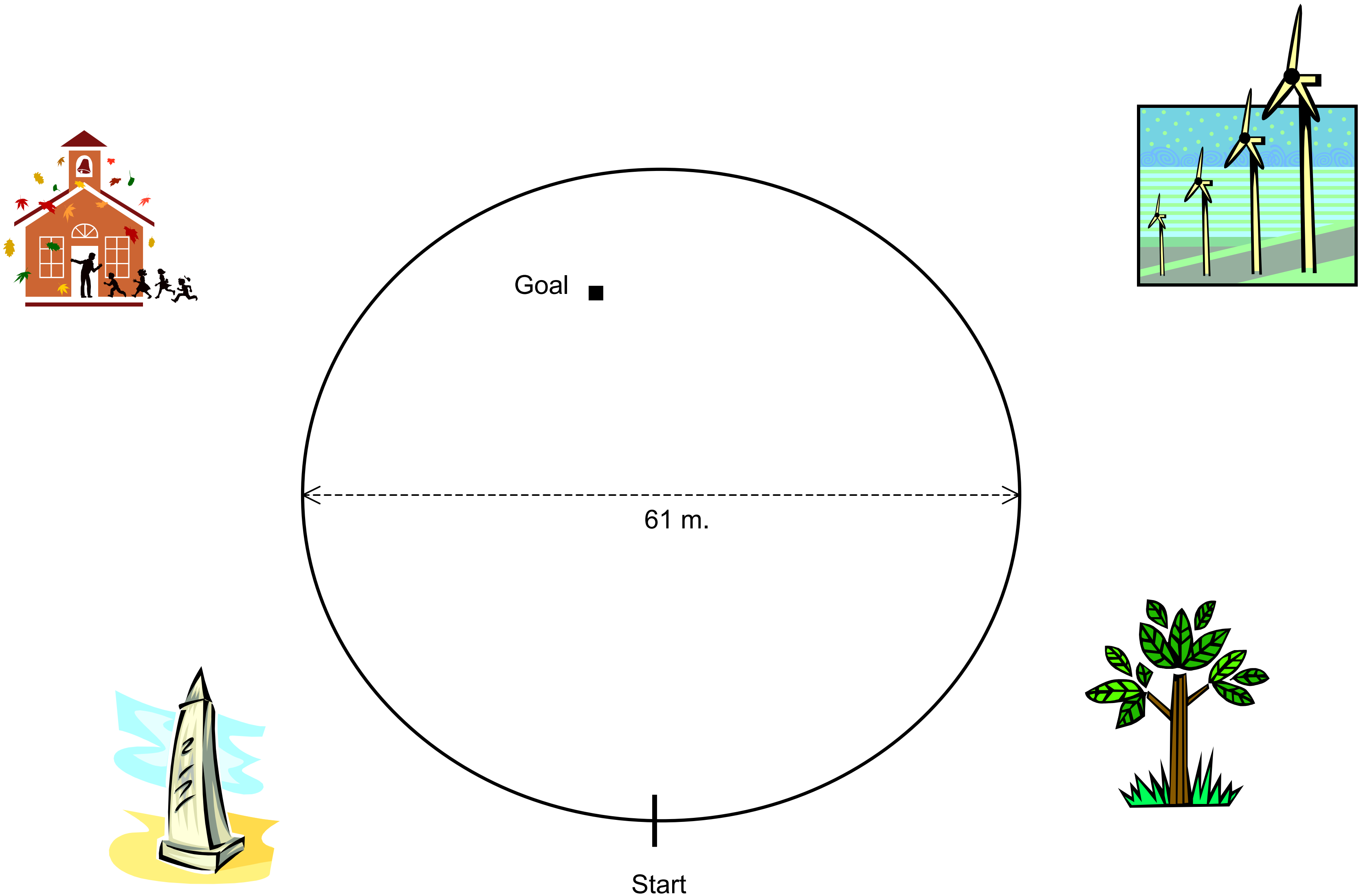


Delays Tolerated

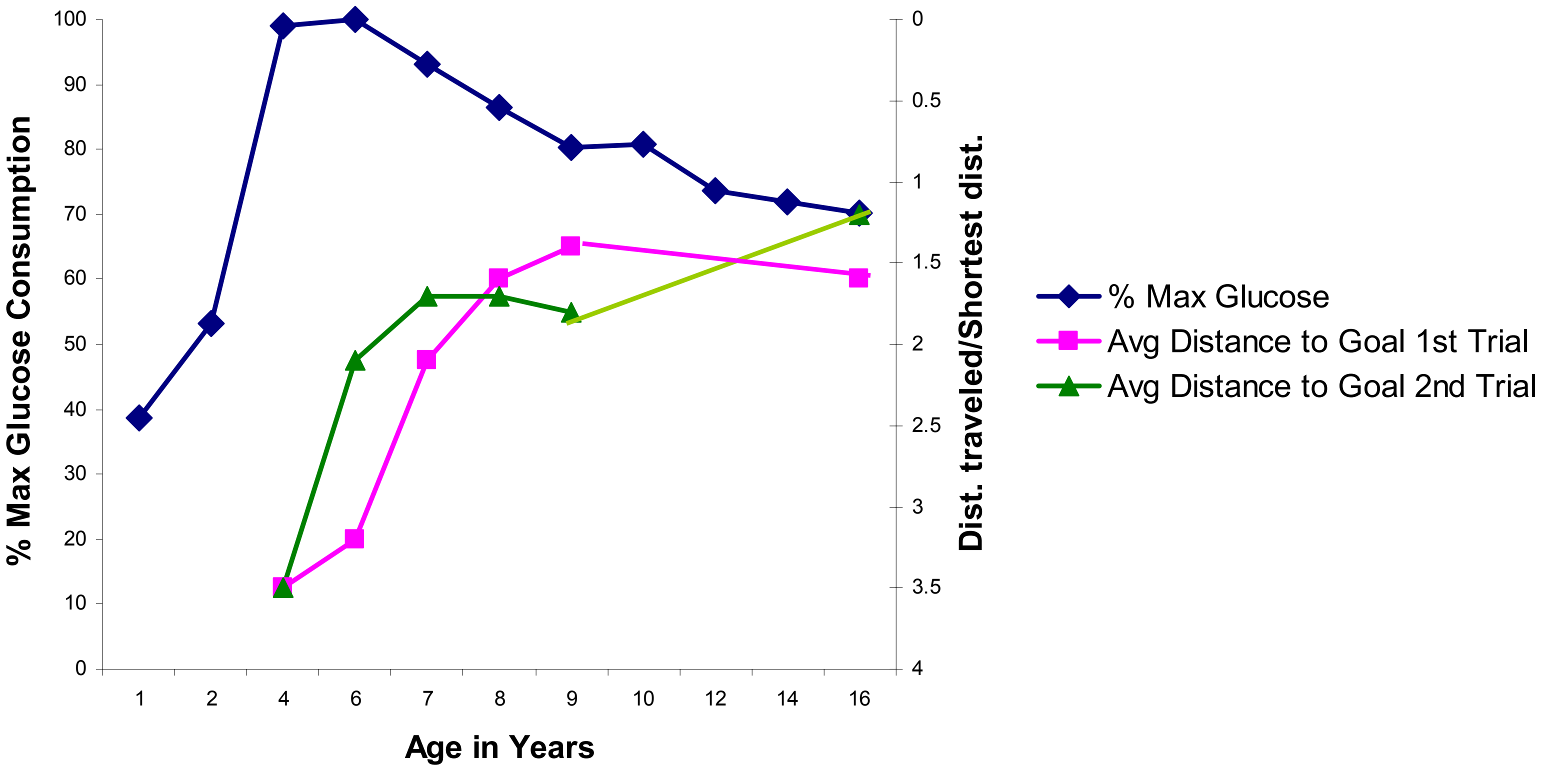


From Huttenlocher 1987, Diamond 1990, Overman 1990

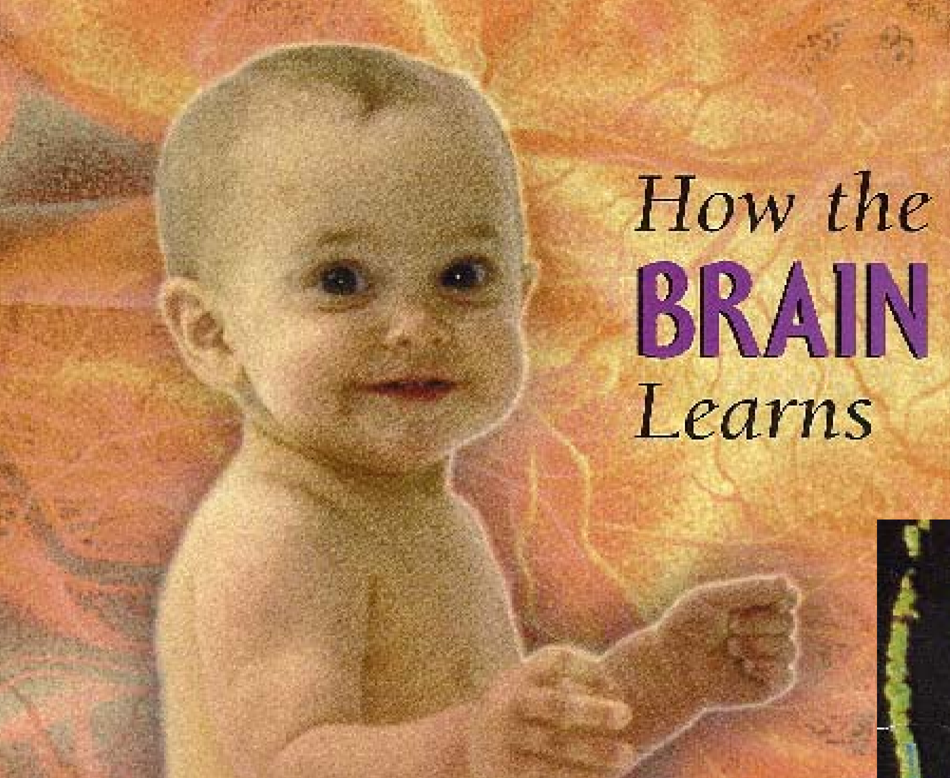
Open Field Navigation Task

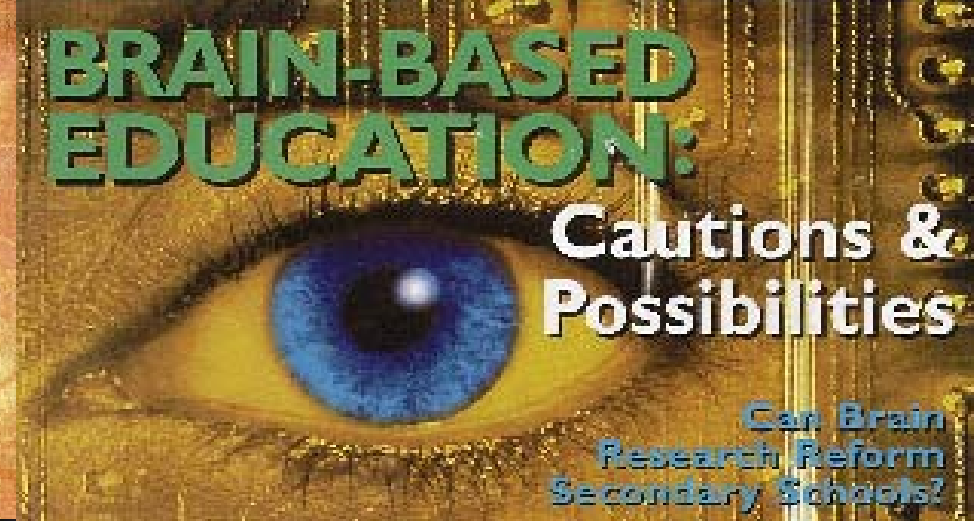


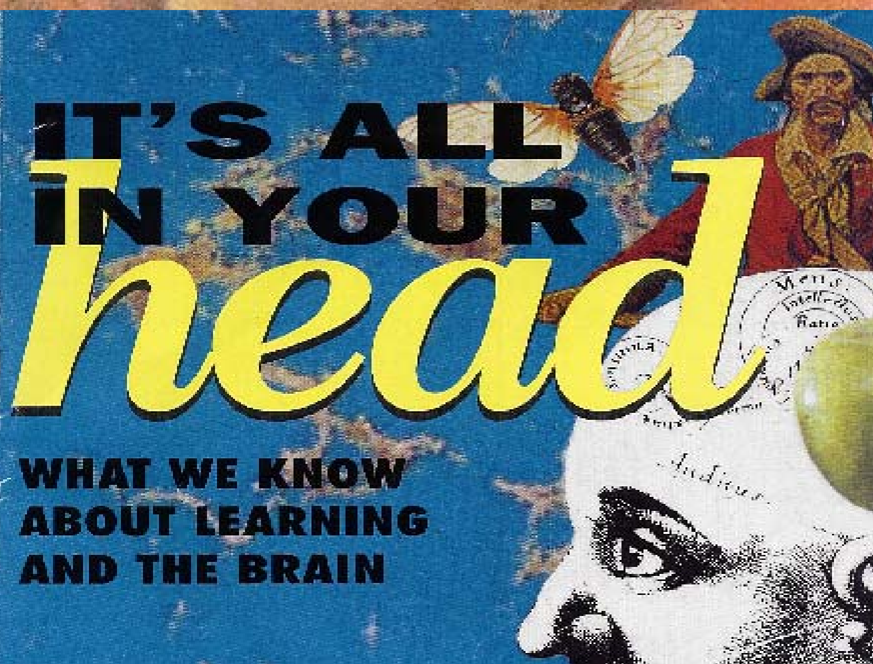
Learning an Open Field Navigation Task

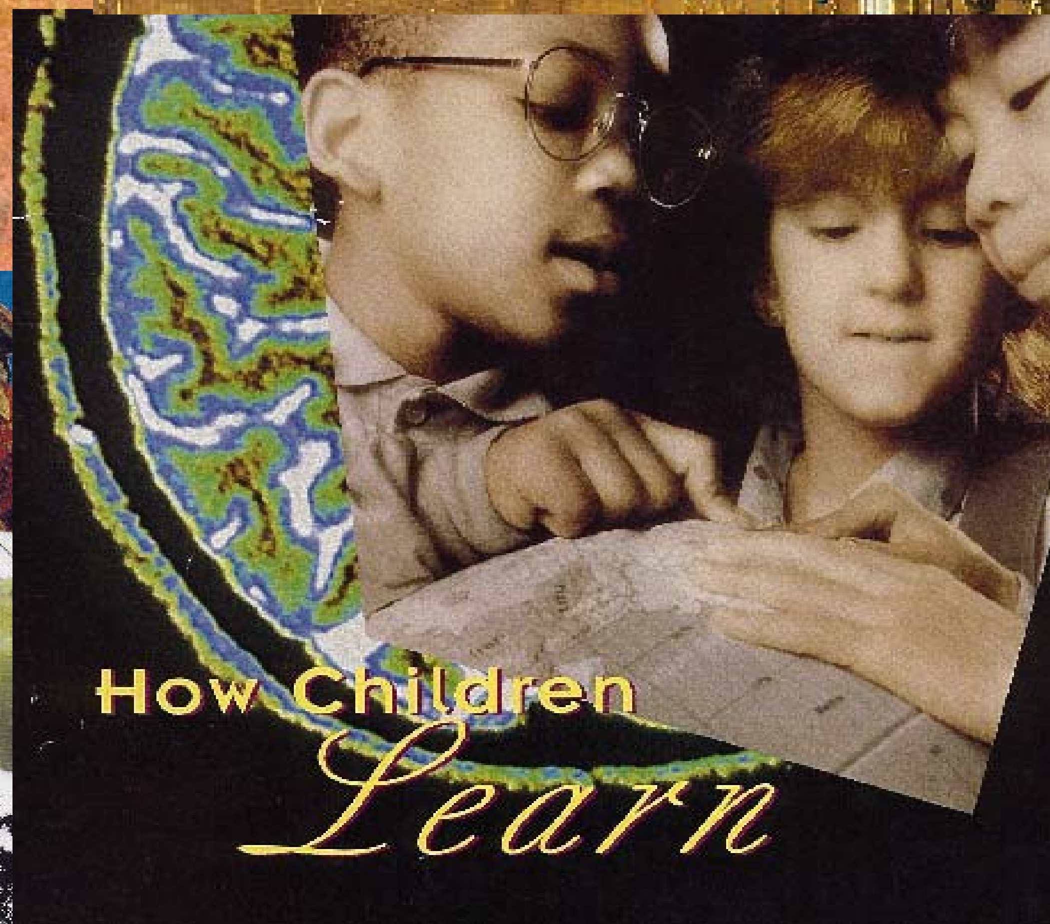


H.T. Chugani; Overman et al.


How the
BRAIN
Learns

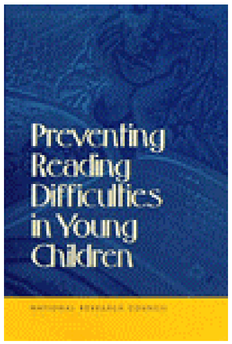

BRAIN-BASED
EDUCATION:
Cautions &
Possibilities
Can Brain
Research Reform
Secondary Schools?


IT'S ALL
IN YOUR
head
WHAT WE KNOW
ABOUT LEARNING
AND THE BRAIN


How Children
Learn

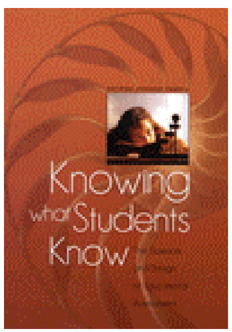
National Reading Panel

• No brain science mentioned or cited



• Cites two neuroscientific studies (Shaywitz, 1996, Shaywitz et al. 1998)

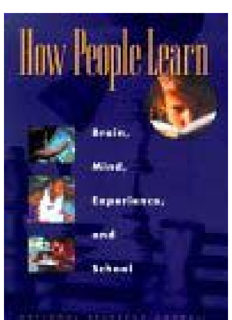
• Finding anomalous brain systems says little about change, remediation, response to treatment



• Six page appendix, “Cognition and Brain Science”

• Dismisses “brain-based” claims about lateralization, enriched environments, and critical periods

• Promise of cognitive neuroscientific research on dyslexia (Shaywitz, Tallal, Merzenich)



• One ten-page chapter

• Learning is encoded by structural changes in the brain

• No practical benefit to educators at this time

• Brain scientists should think critically about how research is presented to educators

Scientific Correspondence

October 1999 Volume 2 Number 10 pp 861 - 863

Brain development during childhood and adolescence: a longitudinal MRI study

Jay N. Giedd[1], Jonathan Blumenthal[1], Neal O. Jeffries[2], F. X. Castellanos[1], Hong Liu[1], Alex Zijdenbos[3], Tomá Paus[3], Alan C. Evans[3] & Judith L. Rapoport[1]

Pediatric neuroimaging studies[1-5], up to now exclusively cross sectional, identify linear decreases in cortical gray matter and increases in white matter across ages 4 to 20. In this large-scale longitudinal pediatric neuroimaging study, we confirmed linear increases in white matter, but demonstrated nonlinear changes in cortical gray matter, with a preadolescent increase followed by a postadolescent decrease. These changes in cortical gray matter were regionally specific, with developmental curves for the frontal and parietal lobe peaking at about age 12 and for the temporal lobe at about age 16, whereas cortical gray matter continued to increase in the occipital lobe through age 20.

1. Child Psychiatry Branch, National Institute of Mental Health, Building 10, Room 4C110, 10 Center Drive, MSC 1367, Bethesda, Maryland 20892, USA
2. Biometry Branch, National Institute of Neurological Disease and Stroke, Federal Building, Room 7C06, 7550 Wisconsin Avenue, Bethesda, Maryland, 20892, USA
3. Montreal Neurological Institute, McGill University, 3801 University Street, Montreal, Quebec H3A 2B4, Canada

If the increase is related to a second wave of overproduction of synapses, it may herald a critical stage of development when the environment or activities of the teenager may guide selective synapse elimination during adolescence. (Giedd et al., 1999)

New imaging studies are revealing – for the first time – patterns of brain development that extend into the teenage years. Although scientists don't know yet what accounts for the observed changes, they may parallel a pruning process that occurs early in life that appears to follow the principle of **"use-it-or-lose-it:"** neural connections, or synapses, that get exercised are retained, while those that don't are lost. At least, this what studies of animals developing visual systems suggest. (*NIMH, Office of Communications and Public Liason)*

THE WHITE HOUSE CONFERENCE ON TEENAGERS

…because now we're beginning to learn that the brain goes through yet another, and equally critical, growth spurt during the early teenage years. Though the research is still preliminary, scientists now believe that this is the time when all the hard-wiring of the brain takes place, when a teenager's intellectual, emotional and physical capacities are developed for a lifetime

npr

"Our best guess is that this process is guided by the use-it-or-lose-it principle. So those cells and connections that the teenager is using will survive and flourish. Those cells and connections that are not being used will wither and die. … which is why we feel that if children are using their brain at this point for academics or sports or music or video games that is what their brain will be hardwired or optimized for." (Dr. Jay Giedd, *Morning Edition, May 2, 2000)*

My E-mail, Tuesday, May 2, 2000

-----Original Message-----
From: XXXXXXXXXXXX
Sent: Tuesday, May 02, 2000 10:18 AM
To: John Bruer
Subject: Inquiry

I heard this incredible piece on NPR this morning the abstract for which I will reproduce below. This has unbelievable developmental implications -- helps explain why junior high school kids don't learn anything! If the pruning of the brain actually happens twice, this also helps explain the incredible leap in learning rates of adolescents (once the pruning begins, not during the explosion of cell growth).

A Basic Scientific Issue

NEUROSCIENCE:
Strengthening Visual Connections
Max Cynader*

Studies of the plasticity of the visual cortex during the critical period of postnatal development are particularly germane in light of recent controversies about the importance of early childhood experience in determining cortical competency in adults. These controversies--which have profound implications for early childhood education, parenting, and child care (5)--have been characterized more by polemics than by solid neuroscience research. ***The visual cortex represents the best model system that we have for understanding how sensory stimulation of the early brain influences brain circuitry and function throughout life.*** Its study should increase our knowledge of the ways in which early sensory inputs determine the long-term capabilities of the brain.

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Science, Volume 287, Number 5460, Issue of 17 Mar 2000, pp. 1943-1944

Which field of brain research is concerned with investigating structure-function relationships?

Cognitive neuroscience attempts to determine how neural structures implement mental functions.

How do cognitive neuroscientists make structure-function inferences?

They conduct brain imaging/recording experiments where the experimental tasks are based on prior analyses of how component mental functions contribute to the task.

Which field of research is concerned with analyzing tasks and behaviors into their component mental functions?

Cognitive psychology

How do cognitive psychologists do their work?

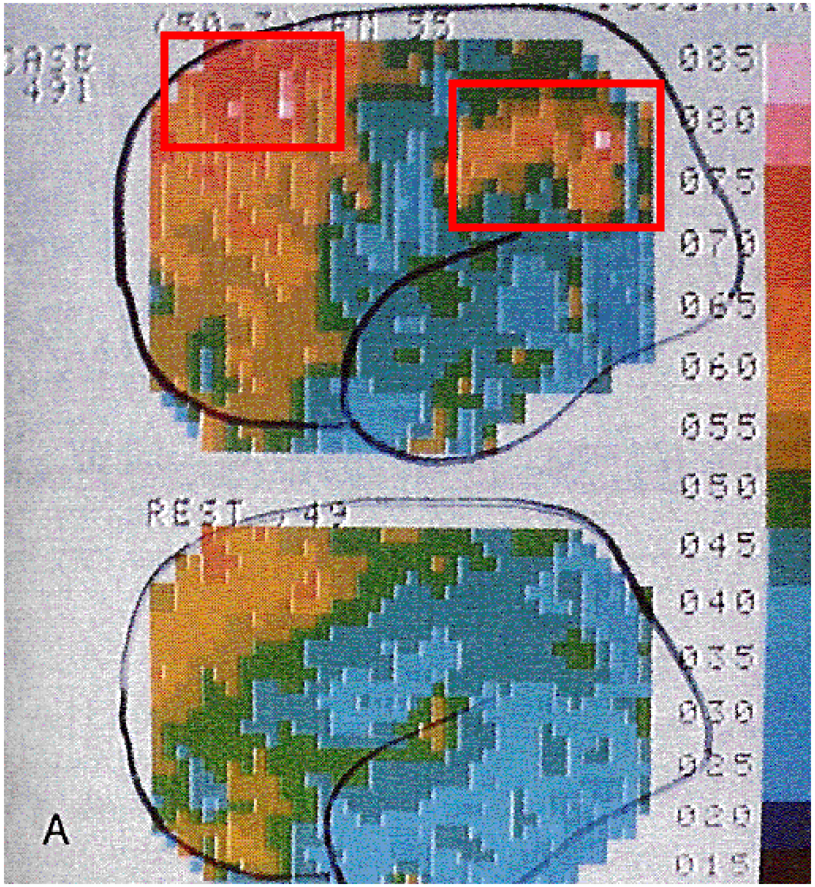
They conduct behavioral experiments and computational modeling to develop functional models showing how component mental functions account for specific skills and behavior.

What are the implications of this approach for cognitive neuroscience?

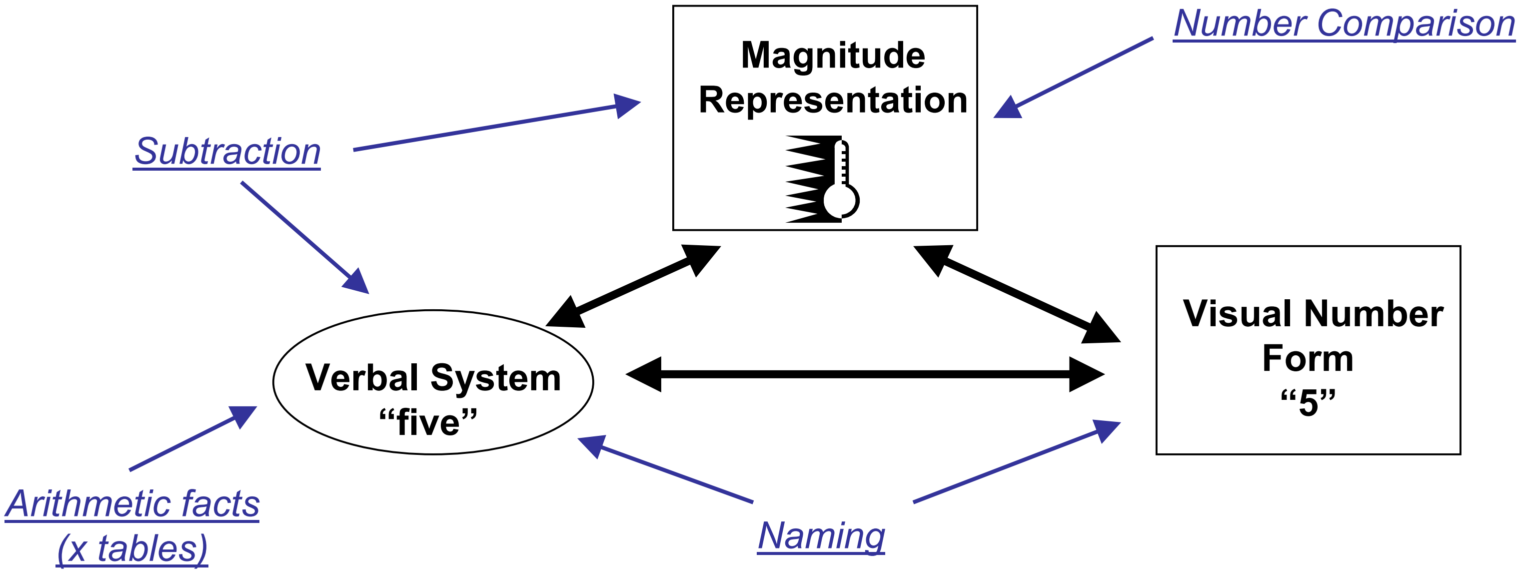
• Brain imaging studies are as good as the cognitive analyses or models underlying the experimental task.
• Cognitive analyses are essential for appropriate interpretation of brain imaging experiments.
• Given this current conceptual primacy, cognitive neuroscience can make *function* → *structure* inferences about *localization*, but not *structure* → *function* inferences.

Imaging: A Window on the Brain

Counting backward from 50 by 3s

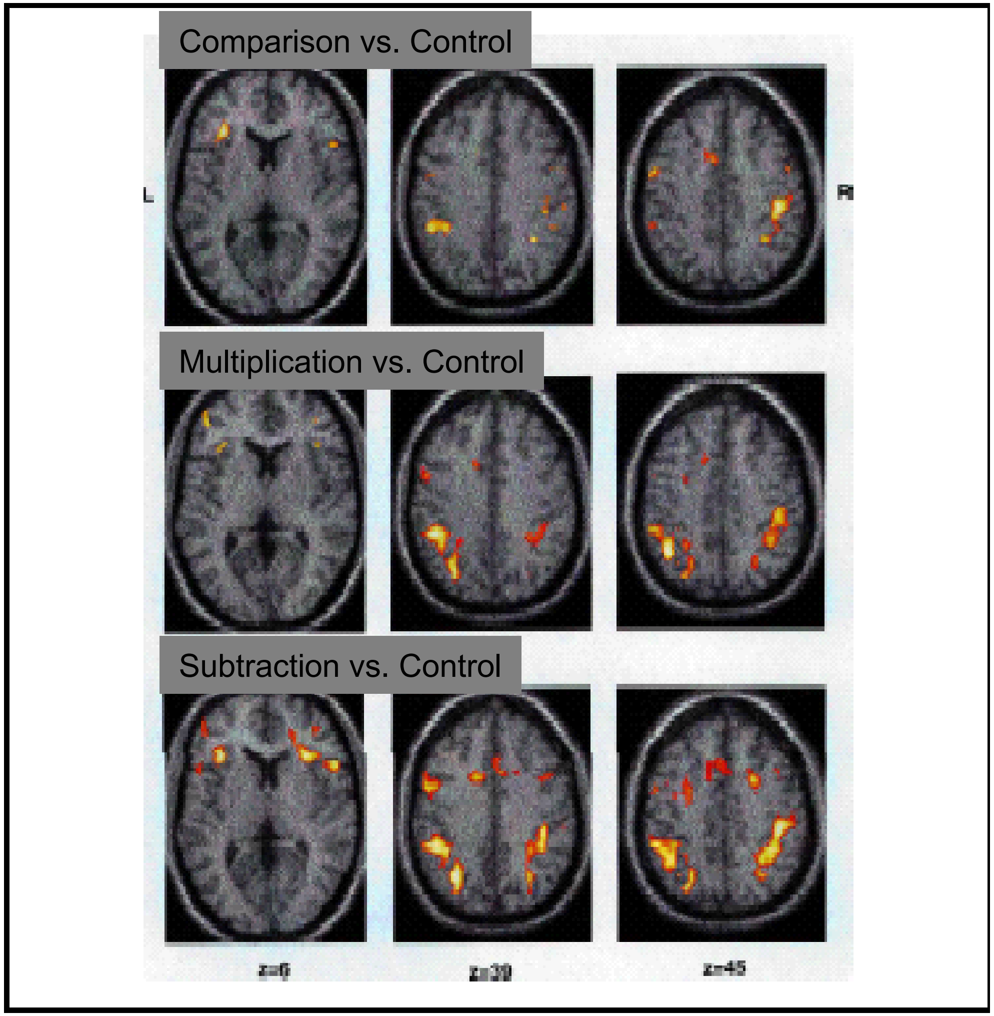


Roland & Friberg (1985) J. of Neurophysiology 53(5):1227



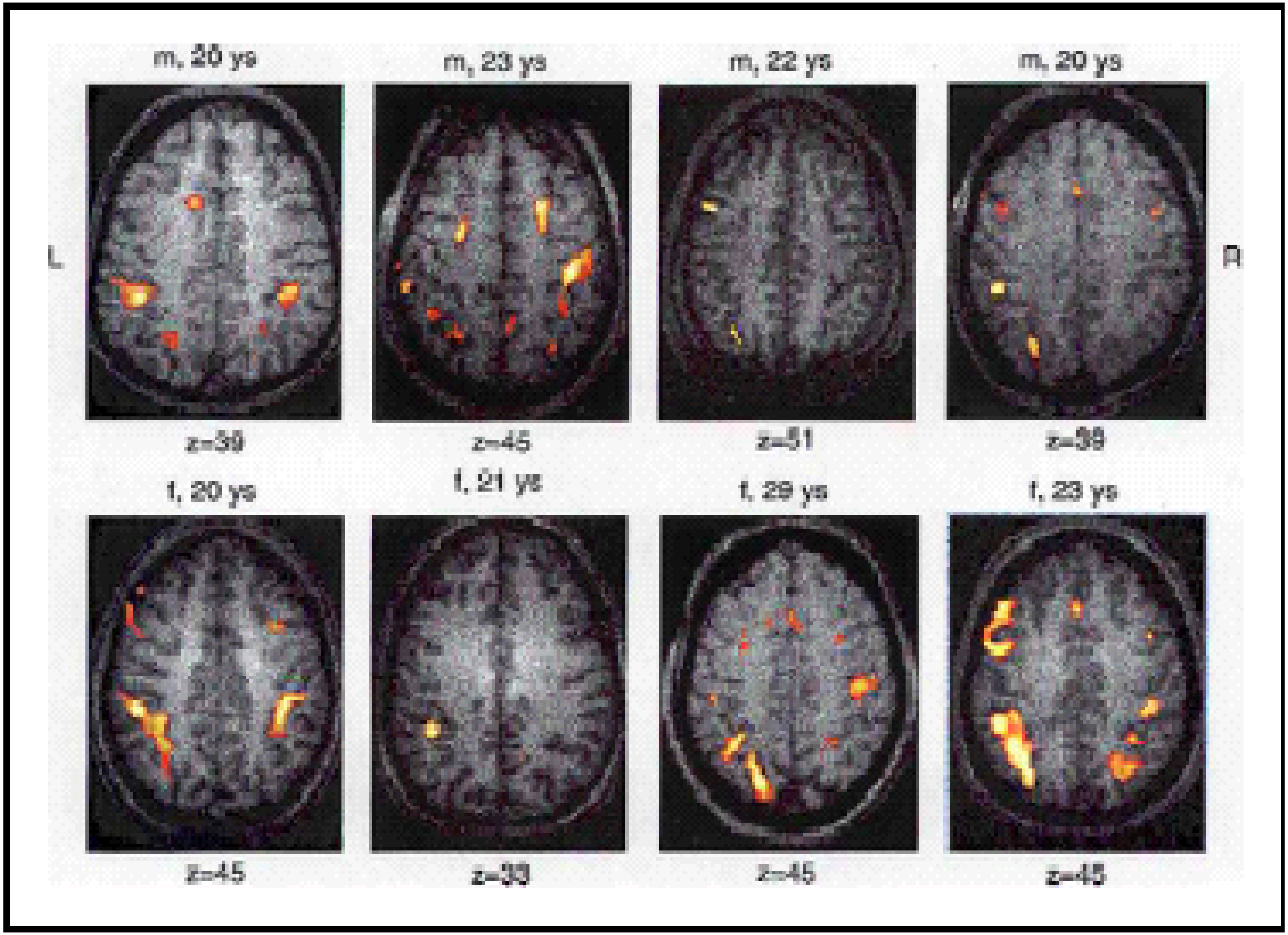
Task	Stresses
Mentally name letters	Control condition
Name target digit	Visual & verbal systems/representations
Compare target digit with standard, mentally say "larger", "smaller"	Magnitude system/representation.
Multiply target digit by 3, mentally name	Verbal system/representation
Subtract target digit from 11, mentally name	Magnitude representation (relative to multiplication)

Number Tasks: Activated Brain Areas



Chochon et al.,Journal of Cognitive Neuroscience 11:6, pp. 617–630

Individual variation in number processing



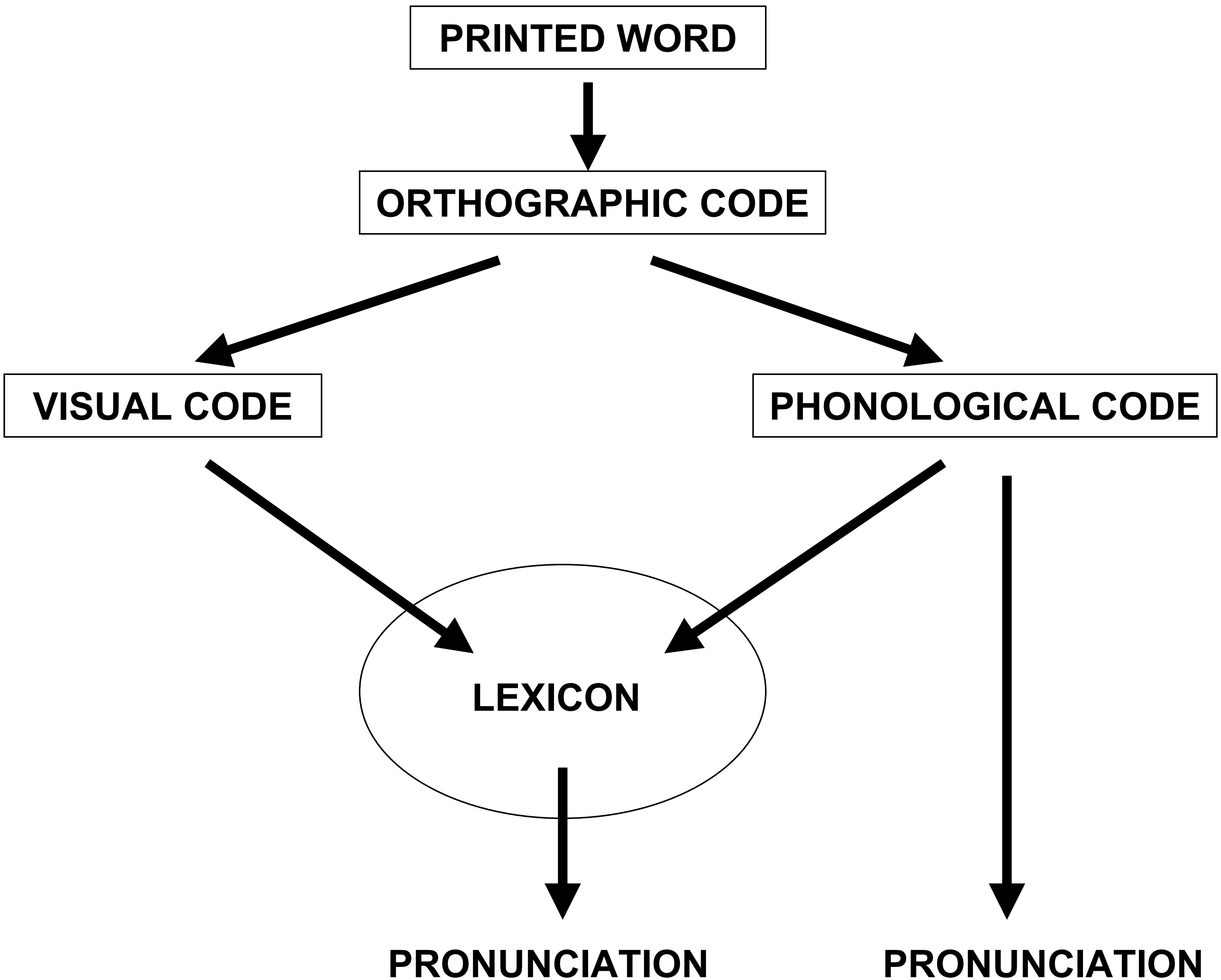
Chochon et al.,Journal of Cognitive Neuroscience 11:6, pp. 617–630

Proc. Natl. Acad. Sci. USA
Vol. 95, pp. 2636–2641, March 1998
Neurobiology

Functional disruption in the organization of the brain for reading in dyslexia

SALLY E. SHAYWITZ*†, BENNETT A. SHAYWITZ*‡, KENNETH R. PUGH*§, ROBERT K. FULBRIGHT¶,R. TODD CONSTABLE¶, W. EINAR MENCL*§, DONALD P. SHANKWEILER§, ALVIN M. LIBERMAN§,PAWEL SKUDLARSKI¶, JACK M. FLETCHERi, LEONARD KATZ§, KAREN E. MARCHIONE*, CHERYL LACADIE¶,CHRISTOPHER GATENBY¶, AND JOHN C. GORE¶**
*Department of Pediatrics, ‡Department of Neurology, §Haskins Laboratories, ¶Department of Diagnostic Radiology, **Department of Applied Physics,
Yale University School of Medicine, New Haven, CT 06520; and iDepartment of Pediatrics, University of Texas Medical School, Houston, TX 77030

Previous efforts using functional imaging methods to examine brain organization in dyslexia have been inconclusive largely, we think, because the experimental tasks tapped the several aspects of the reading process in somewhat unsystematic ways. Our aim therefore was to develop a set of hierarchically structured tasks that control the kind of language-relevant coding required, including especially the demand on phonologic analysis, and then to compare the performance and brain activation patterns (as measured by functional MRI) of dyslexic (DYS) and nonimpaired (NI) readers.


PRINTED WORD
ORTHOGRAPHIC CODE
VISUAL CODE
PHONOLOGICAL CODE
LEXICON
PRONUNCIATION
PRONUNCIATION

Shaywitz et al. 1998 Experimental Task

Phonological Task Hierarchy	**Dyslexics** (% Errors)	**Normals** (% Errors)
Line orientation (/> vs. \<)	5.1	3.0
Letter case (Bb vs. bB)	***7.6***	***2.6***
Single letter rhyme (T vs. V)	***11.0***	***1.2***
Non-word rhyme (leat vs. jete)	***31.5***	***9.3***
Semantic category (rice vs. corn	***13.8***	***4.6***

Significant difference b/n dyslexics and normals

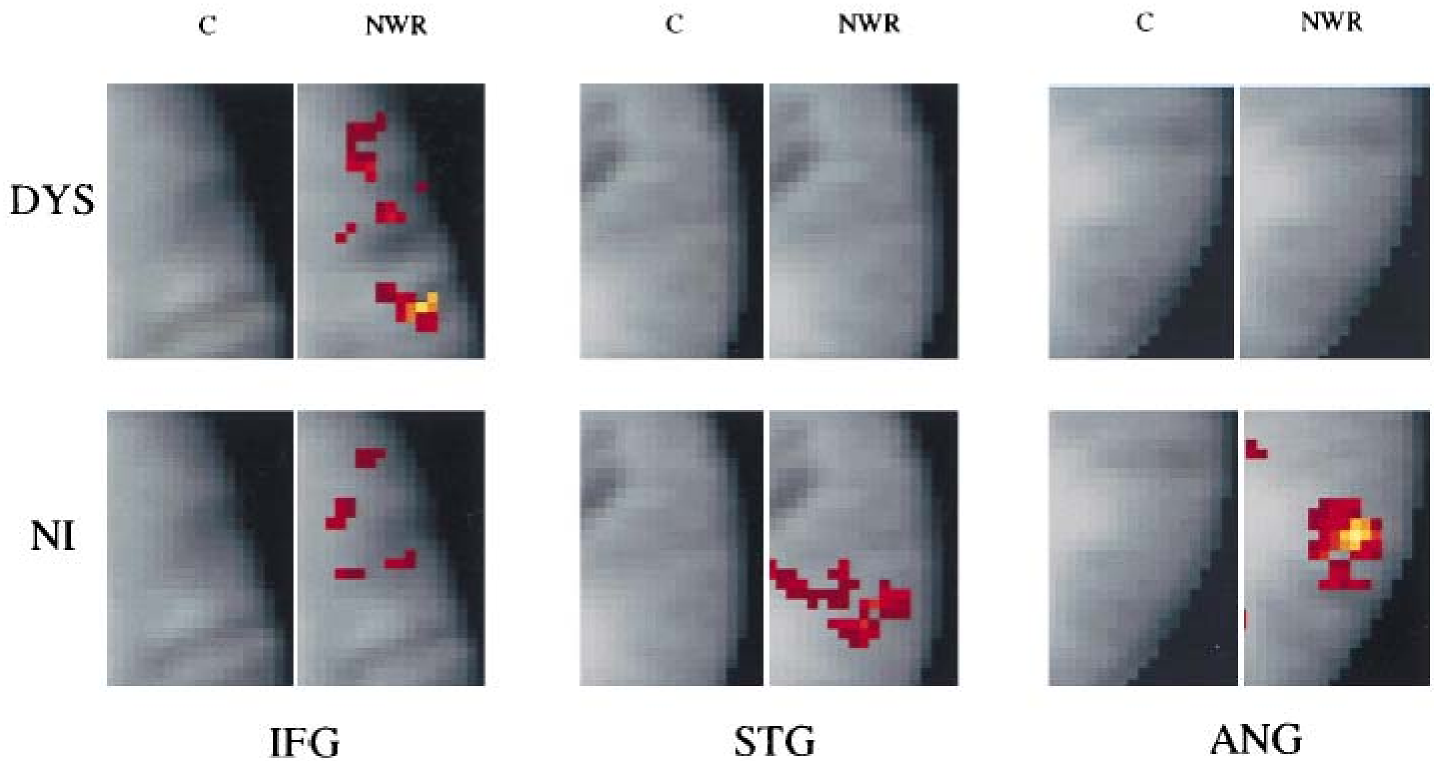


FIG. 2. Composite activation maps in DYS and NI readers for the C and NWR judgment tasks. As shown, DYS and NI readers differ in the degree of activation produced in different brain regions during phonologic (NWR) compared with orthographic (C) coding; DYS readers demonstrate a pattern of relative overactivation anteriorly in IFG in contrast to relative underactivation posteriorly, in STG and the angular gyrus. Composite maps (with z-axis Talairach position) are shown for the left anterior region (IFG, $z = 33$) and two regions in the left posterior system [post STG (STG, $z = 12$) and the angular gyrus (ANG, $z = 23$)]. Composite maps are based on brain activations representing C and NWR. The median t value was obtained for each pixel in each of the Talairach-transformed images of the 29 DYS and 32 NI readers, respectively. Those t values greater than 0.2 were cluster-filtered (cluster size = 3) and overlaid on composite anatomic images that were obtained by adding Talairach-transformed anatomical images from the two groups. The cluster criterion used in this composite differs from that used in the statistical analysis; when combining multiple activation maps from different subjects, it is necessary to change the threshold and cluster criterion to compensate for imprecise overlap of activation regions between subjects.

What value do these function → structure inferences have for educators?

What implications do these function → structure inferences have for educational practice?

Instructional Implications: None

- Numeracy
  - Numeracy requires integrating three representations of number
  - Learning problems arise from inadequate integration of these representations
  - Training studies show learning problems remediable when representations and their integration are taught explicitly (Resnick, Case & Griffin)
- Early Reading
  - Word recognition requires integrating linguistic representations
  - Dyslexia can arise from inadequate integration of orthographic/phonological representations
  - Training studies show explicit integrative instruction is beneficial (Bradley & Bryant 1983, NRP, NRC)

Are functional explanations all we need as a basis for an applied science of learning?

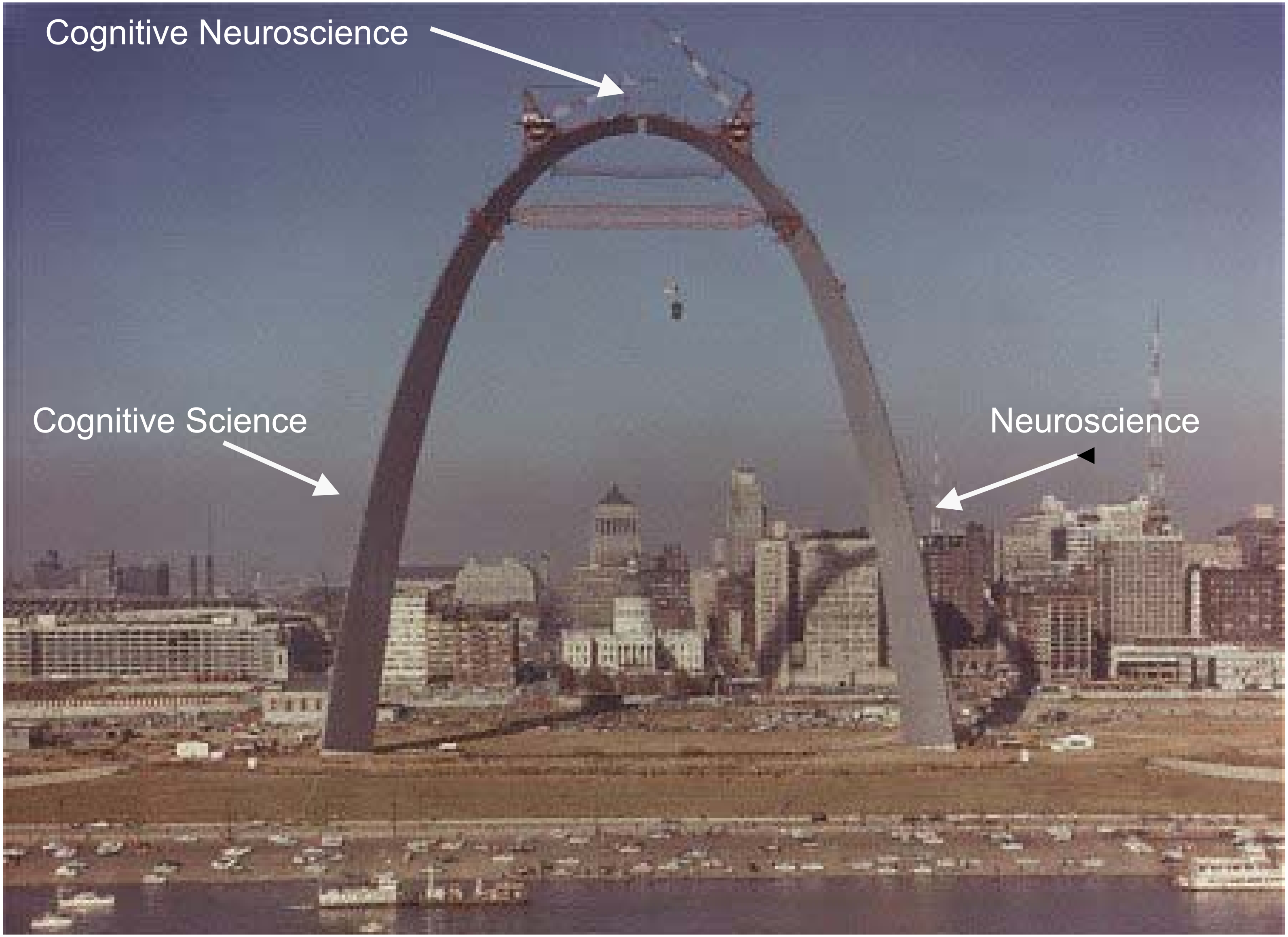
- Currently, such explanations are the best we have
- Practically, these explanations provide a vast, largely untapped resource for improving instruction.
- Functional explanations are fundamental both for an applied science of learning and for advances in cognitive neuroscience.
- Imaging data adds nothing

How could brain science contribute to a an applied science of learning?

- Cognitive neuroscience is the most likely place to look for future educationally relevant insights.
- Cognitive neuroscience is supported by two legs: cognitive science and basic neuroscience.
- Basic neuroscience findings that support *structure* → *function* inferences might eventually place independent biological constraints on cognitive theories and analyses.

What questions must cognitive neuroscience address in order to draw *structure* → *inferences*?

- *How* (not just *where*) do neural structures implement mental functions?
- How do brain structures – synapses, neural networks – code and transmit information?
- What are the metabolic and physiological sources of the signals measured with various imaging technologies?
- What is the appropriate model for studying brain development and learning?


Cognitive Neuroscience
Cognitive Science
Neuroscience