Why should teachers care about *cognitive* neuroscience?

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Why?

• Education changes the brain
• Experience-dependent plasticity
• Teachers as ‘Orchestrators of neuronal plasticity’
• Understanding the brain - changes in practice?
Surge of interest
Neuroscience and Education: An Ideal Partnership for Producing Evidence-Based Solutions to Guide 21st Century Learning

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Neuro-Education is a nascent discipline that seeks to blend the collective fields of neuroscience, psychology, cognitive science, and education to create a better understanding of how we learn and how this information can be used to create more effective teaching methods, curricula, and educational policy. Though still in its infancy as a research discipline, this initiative is already opening critical new dialogs between teachers, administrators, parents, and brain scientists.
Neuroscience and education: prime time to build the bridge

Mariano Sigman\textsuperscript{1,2}, Marcela Peña\textsuperscript{3}, Andrea P Goldin\textsuperscript{1,2} & Sidarta Ribeiro\textsuperscript{4}
New funding initiatives

Education and neuroscience research grants

Using insight from neuroscience to improve education

The Education and Neuroscience Initiative is a new funding scheme, launched by the Wellcome Trust and the Education Endowment Foundation in January 2014. This one-off £6 million scheme aims to develop, evaluate and communicate the impact of education interventions grounded in neuroscience research.
Teachers are interested

- 286 pre-service teachers from Western University

I am interested in learning about brain research

Strongly Disagree to Strongly Agree
What kind of evidence is driving the new field?
Evidence

Plasticity

Lederbogen et al. (2011)

Dehaene et al. (2010)
Evidence
Neuroprognosis

Kaustubh Supekar\textsuperscript{a,1,2}, Anna G. Swigart\textsuperscript{a,1}, Caitlin Tenison\textsuperscript{a}, Dietsje D. Jolles\textsuperscript{a}, Miriam Rosenberg-Lee\textsuperscript{a}, Lynn Fuchs\textsuperscript{b}, and Vinod Menon\textsuperscript{a,c,d,e,2}
Evidence
Intervention

Family-function
socioeco.

Helen J. Neville and Elif Isbell
Evidence

Intervention
Behavioral/Cognitive

Why Mental Arithmetic Counts: Brain Activation during Single Digit Arithmetic Predicts High School Math Scores

Gavin R. Price,¹ Michèle M. M. Mazzocco,²,³ and Daniel Ansari¹

¹Numerical Cognition Laboratory, Department of Psychology and Brain and Mind Institute, University of Western Ontario, London, Ontario, Canada N6G 2K3, ²Department of Psychiatry and Behavioral Sciences, and School of Education, Johns Hopkins University, Baltimore, Maryland 21287, and ³Institute of Child Development, University of Minnesota, Minneapolis, Minnesota 55455
PSAT Math

• Preliminary Scholastic Achievement Test
• 38 items: algebra, word problems, geometry
  • No single digit arithmetic
• Sat by > 3.5 Million students a year
• Predicts college entrance exam scores
Does mental arithmetic and how your brain is organized for mental arithmetic matter for the PSAT?
Methods

- 32 participants
- mean age 18 years

Arithmetic Task

3+5 = 8
2+5 = 6

Price, Mazzocco & Ansari (2013, Journal of Neuroscience)
Results

- Does arithmetic correlate with PSAT?
- Reaction time data: **NO**
- What about brain imaging data?

Price, Mazzocco & Ansari (2013, *Journal of Neuroscience*)
Both positive and negative correlations
Negative Correlation

Activity PSAT

Right intraparietal sulcus

Price, Mazzocco & Ansari (2013, Journal of Neuroscience)
Negative Correlation

- Right intraparietal sulcus (IPS)
- Quantity representations
- Associated with procedural problem solving strategies
- More engaged by children with math difficulties

Price, Mazzocco & Ansari (2013, Journal of Neuroscience)
Positive Correlation

Activity PSAT

Left Supramarginal Gyrus

Price, Mazzocco & Ansari (2013, Journal of Neuroscience)
Positive Correlation

- Left supramarginal gyrus (SMG)
- Associated with fact retrieval
- Increases in activation over developmental time

Price, Mazzocco & Ansari (2013, *Journal of Neuroscience*)

Grabner, Ansari et al. (2009)

Rivera et al. (2005)
Scaffolding Summary

• Brain activation during single digit calculation predicts high school math

• Quantity circuits \( \uparrow \) PSAT

• Retrieval circuits \( \uparrow \) PSAT

• How brain networks for arithmetic are constructed influences subsequent learning

• Foundational competence

• *Not revealed through behavioral data*
Evidence

- Experience-dependent brain changes
- Can be used to study effects of interventions
- Goes beyond behaviour
- Reveals mechanisms/relationships
- Provides an *additional* meaningful level of explanation
Cautious voices

Education and the Brain: A Bridge Too Far

John T. Bruer

1997, Educational Researcher
Cautious voices

Dorothy Bishop

BishopBlog

Saturday, 25 January 2014

What is educational neuroscience?

"They tested some brain boosting pills on me and now I'm selling maps. Want to buy one?"

©CartoonStock.com
Levels of analysis

- Test Scores
- Behaviors
- Systems
- Networks/Maps
- Neurons
- Synapses
- Molecules
Avoiding knowledge hierarchies

The Seductive Allure of Neuroscience Explanations

The Seductive Allure of “Seductive Allure”

Martha J. Farah and Cayce J. Hook
Center for Neuroscience & Society, University of Pennsylvania, Philadelphia

irrelevant, made people believe they had a better understanding of the mechanism underlying a behavioral phenomenon. Neuroscience information had a smaller effect on ratings of article quality and scientist quality. Our study suggests that neuroscience information may provide an illusion of explanatory depth. (PsycINFO Database Record (c) 2014 APA, all rights reserved).
Neuromyths

Which side of your brain is more dominant?

The 30-Second Brain Test
Neuromyths - resistant to evidence

Learning Styles
Concepts and Evidence

Harold Pashler, 1 Mark McDaniel, 2 Doug Rohrer, 3 and Robert Bjork 4

1 University of California, San Diego, 2 Washington University in St. Louis, 3 University of South Florida, and 4 University of California, Los Angeles

An Evaluation of the Left-Brain vs. Right-Brain Hypothesis with Resting State Functional Connectivity Magnetic Resonance Imaging

Jared A. Nielsen 1*, Brandon A. Zielinski 2, Michael A. Ferguson 2, Janet E. Lainhart 4, Jeffrey S. Anderson 1,3,5,6
Neuromyths - prevalent

Students are left or right brain learners

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People only use 10% of their brain

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Strongly Disagree to Strongly Agree
A new Neuromyth

No evidence for far-transfer

Same true for most Working Memory training programs

Putting brain training to the test

Adrian M. Owen, Adam Hampshire, Jessica A. Grahn, Robert Stenton, Said Dajani, Alistair S. Burns, Robert J. Howard & Clive G. Ballard

Scientifically-designed training

Strongly Disagree to Strongly Agree
No point?
Promising, productive future avenues

- Away from lab - classroom
- Direct translation unrealistic
- Training teachers in Mind, Brain and Education
- Better understanding of their learners
- Critical thinking about evidence
- Prevent adverse effects of ‘neuromyths’
Education and the Brain: A Bridge Too Far

John T. Bruer

Bridges over troubled waters: education and cognitive neuroscience

Daniel Ansari and Donna Coch
Dartmouth College, Department of Education, HB 6103, Hanover, New Hampshire, 03755, USA
Infusing Neuroscience Into Teacher Professional Development

Janet M. Dubinsky¹, Gillian Roehrig², and Sashank Varma¹

Bruer advocated connecting neuroscience and education indirectly through the intermediate discipline of psychology. We argue for a parallel route: The neurobiology of learning, and in particular the core concept of plasticity, have the potential to directly transform teacher preparation and professional development, and ultimately to affect how students think about their own learning. We present a case study of how the core concepts of neuroscience can be brought to in-service teachers—the BrainU workshops. We then discuss how neuroscience can be meaningfully integrated into pre-service teacher preparation, focusing on institutional and cultural barriers.

Keywords: mixed methods; neuroscience; observational research; professional development; science education; teacher education/development

2013, Educational Researcher
Teacher Training in Mind, Brain & Education

![Neuroscience knowledge test](image)

![Standards of Authentic Classroom Instruction](image)
Filling critical gaps

**Dyslexia**

None to Excellent

2% 11% 18% 27% 24% 18%

**Dyscalculia**

None to Excellent

64% 16% 8% 7% 5% 1%
“The main impact of educational neuroscience will be in the training of the teachers of tomorrow. If you were given the choice right now of visiting a doctor who had memorized a list of symptoms and their linked treatments, or a doctor who understood the reasons why diseases produce the symptoms they do and why treatments work, which one would you choose? “ (Thomas, 2013, p.25)
Training of young researchers

- Transdisciplinary researchers
- Training in education, psychology & neuroscience
- Creating a new field
Opinion Article

Forging a new path for Educational Neuroscience: An international young-researcher perspective on combining neuroscience and educational practices

Hannah L. Pincham a,*,1, Anna A. Matejko b,1, Andreas Obersteiner c,1, Clare Killikelly d,1, Karina P. Abrahao e, Silvia Benavides-Varela f, Florence C. Gabriel g, Joana R. Rato h, Laura Vuillier i
1. Identify an Educational Need
   - Identify a problem or issue in the classroom, or the school setting (e.g., What is the best way to teach a particular concept? How can teachers best identify students with learning disabilities?)

2. Develop a Research Proposal
   - An empirical research proposal is developed, based on the available neuroscience literature, and existing teaching practices.
   - Teachers and researchers collectively discuss whether the proposed course of action is feasible.

3. Test in the classroom
   - The educational neuroscientist conducts research in the school setting. This may involve assessing student or teacher outcomes.
   - Maximize differences to enhance generalizability of the findings.

4. Communicate and Evaluate
   - Teachers and researchers evaluate the findings together.
   - Evaluate the results, determine any shortfalls and re-design to start the cycle again.
Babysteps

- Its early days
- *But time to get on board*
- Engage teachers, educational researchers
- Engage new researchers across fields
- Train research - practitioners
- Shape the interdisciplinary field
Thank you for your attention!