cortex 45 (2009) 555–557

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/cortex

Discussion forum

Using and misusing neuroscience in education-related research

Joanna A. Christodoulou[a,*] and Nadine Gaab[a,b]

[a]Harvard University, Graduate School of Education, Cambridge, MA, United States
[b]Harvard Medical School, Children's Hospital Boston, Department of Medicine, Division of Developmental Medicine; Laboratories of Cognitive Neuroscience, Boston, MA, United States

The relationship between neuroscience and education can prove most fruitful when it fosters a bidirectional exchange of ideas and approaches. The connection between neuroscience and education can be guided by defining roles, approaches, implications, and applications. The purpose of this discussion is to clarify the perspectives of neuroscience and education towards maximizing the communication and utility of research progress. Clarifying the roles and contributions can prevent misuses and foster the positive uses of neuroscience in education (and vice-versa).

1. Roles for education and neuroscience: managing brain terrain and educational dilemmas

Describing the roles of neuroscientists and educators requires, initially, a simplification and generalization of *who* and *what* to mark the terrain and challenges. Among the contributions that can be offered by neuroscientists are proficiency in methods of scientific inquiry (e.g., neuroimaging), parsing of cognition into operationalized definitions, and an understanding of the brain systems and pathways (*brain terrain*). Commonly, the educator's perspective can offer experience teaching children, using curricula, creating educational settings, and managing features of the learning and teaching dynamic (e.g., motivation, role of affect, interplay of performance and context). Another invaluable contribution of expertise in a field, whether in neuroscience or education, is the ability to identify the boundaries of knowledge; what are the next big questions the field can and should answer? These features are indeed a limited and oversimplified sampling of the contributions of neuroscientists and educators, but can be considered a start in parsing the interest and inventory of these specialists. The types of questions that educators can ask of neuroscientists are nearly infinite, but the direct instructional experiences of educators with children (or the considerations of) can direct attention to salient questions or concerns for educational progress.

Neuroscience can allow for a *descriptive* rather than *prescriptive* approach to informing educators. Rather than seeking from neuroscience directives informing educational practice directly (i.e., how can neuroscience lead to better teaching or learning), neuroscience research is most valuable in describing aspects of educational concern (e.g., why do readers with dyslexia read differently). Thus, a direct link between findings from neuroscience research and instruction in the classroom, following a *prescriptive* approach, has as of yet been secondary to *understanding*, consistent with a *descriptive* approach. Particularly because education interests encompass such diverse topics as teaching and learning dynamics, student profiles, content area concerns, disabilities, individual differences, and indeed many more, the *understanding* of educationally relevant concerns is essential for pursuing change.

2. Approaches for education and neuroscience: collaborations

Dialogue between neuroscience and education can be fostered at several levels. One approach would entail conversations

* *Corresponding author*. Larsen 103, 14 Appian Way, Harvard University, Graduate School of Education, Cambridge, MA 02138, United States.
E-mail address: christjo@gse.harvard.edu (J.A. Christodoulou).
0010-9452/$ – see front matter
doi:10.1016/j.cortex.2008.06.004

between neuroscientists and educators where school staff, for example, could identify questions of interest to be pursued. At the outset, the role of the educators should be as collaborators and partners engaged in a dialogue. Members of faculty and staff should be encouraged to share research ideas, perplexing issues, areas of curiosity, and areas for which students often asked ''but why do we have to do this...?''.

A similar initiative has recently been spawned between reading researchers and educators, proving successful in its pursuit of research directly relevant to stakeholders concerned with student performance. The organization, Strategic Education and Research Partnership (SERP), describes a mission of building bidirectional and substantive connections between practice and research; producing inventive and practical education tools; and fostering a collaborative community of contributors and participants (SERP, 2008). This innovative model serves as an exemplar for operating at the crossroads of fields, and is directly relevant and applicable to education and neuroscience interests.

3. Implications: neuromyths and behavior-myths

With the integration of ideas and information from diverse fields such as neuroscience and education come challenges in framing information. In the case of neuroscience and education, some translating attempts have resulted in misleading interpretations of the data. Termed *neuromyths*, consumers of neuroscience face such claims as 'we only use 10% of our brain' and 'the left side of the brain is responsible for language and the right side for abstract thinking' (e.g., as criticized by Beyertsein, 1999; Corballis, 1999; Goswami, 2006). Unfortunately, neuromyths abound. Other neuromyths vary on content or focus. What they tend to share however is a violation in discussing findings from neuroscience (e.g., over-generalizing findings). Alternatively, *behavior-myths* abound that misrepresent observable characteristics; for example, 'dyslexics see letters backwards' demonstrates the erroneous overgeneralization for individuals with dyslexia (e.g., Pennington et al., 1986). In the same way, these *behavior-myths* could lead to faulty research questions.

Thus, the translation of information has the potential to become lost from the original neuroscience approach, leading to faulty 'neuromyths'. A necessary solution to this is to enable and train mediators and translators in the field of MBE. These translators would provide a common language and frame of reference for contextualizing and understanding results. Direct communication between the neuroscientist and the educator would be ideal, but facilitators offer a good alternative.

4. Applications: teaching principles

One application of neuroscience for informing education is explaining the science behind teaching principles. Many schools use teaching principles to guide the approach and framework for interacting with students and fostering learning. Collaborating with school staff can identify questions of highest relevance to educators that neuroscience could address. The resultant objective would be to discuss the evidence and support from the cognitive neurosciences for the core teaching principles at the school. This interactive approach would involve operationalizing the components in education based on neuroscience. For example, schools commonly discuss modeling practices to facilitate learning. To translate this teaching principle to research topics in neuroscience could involve a discussion of mirror neurons (e.g., Rizzolatti and Craighero, 2004), for example, to demonstrate the ways in which neuroscience does and does not corroborate the principle. Because explorations of the mirror neuron system are relatively nascent, we advocate caution in overgeneralizing this or any other neuroscience finding. In this case, mirror neurons can be considered one example of translating neuroscience discoveries to understanding specific types of learning, and by extension, one type of learning principle relied upon by some educators. We would not advocate that mirror neurons can inform educational practice. Rather, we highlight that mirror neurons can inform our understanding of how, for example, the perception and execution of motor actions may operate at the level of the brain (e.g., Lepage and Théoret, 2007; Rizzolatti and Craighero, 2004; Rizzolatti, 2005).

Many educators know and have access to instructional practices and direct teaching experiences with children; this suggests a natural role for neuroscientists to explain the 'why' and 'how' behind practices. For example, neuroimaging methods could be used to test theories of developmental dyslexia to characterize for whom, when, and how reading difficulties manifest in brain functioning (e.g., Paré-Blagoev, 2007).

5. Synthesis

We summarize by highlighting the substantive importance of neuroscience for education, but also of education for neuroscience. Each perspective has a toolkit to draw from with methods and content specific to the field. While this discussion focused on contributions of neuroscience to education, the bidirectionality of the exchange between neuroscience and education can be equally informative and constructive.

REFERENCES

Beyertsein B. Whence cometh the myth that we only use ten percent of our brain? In Della Sala S (Ed), *Mind Myths: Exploring Popular Assumptions about the Mind and Brain*. New York, NY: J. Wiley & Sons, 1999: 314–335.

Corballis MC. Are we in our right minds? In Della Sala S (Ed), *Mind Myths: Exploring Popular Assumptions about the Mind and Brain*. New York, NY: J. Wiley & Sons, 1999: 291–313.

Goswami U. Neuroscience and education: from research to practice? *Nature Reviews Neuroscience*, 7: 406–411, 2006.

Lepage J-F and Théoret H. The mirror neuron system: grasping others' actions from birth? *Developmental Science*, 10: 513–529, 2007.

Paré-Blagoev J. The neural correlates of reading disorder: functional magnetic resonance imaging. In Fischer KW, Bernstein JH, and Immordino-Yang MH (Eds), *Mind, Brain, and Education in Reading Disorders*. Cambridge: Cambridge University Press, 2007: 148–167.

Pennington BF, McCabe LL, Smith SD, Lefly DL, Bookman MO, Kinberlinc WJ, et al. Spelling errors in adults with a form of familial dyslexia. *Child Development*, 57: 1001–1013, 1986.

Rizzolatti G. The mirror neuron system and its function in humans. *Anatomy and Embryology*, 210: 419–421, 2005.

Rizzolatti G and Craighero L. The mirror-neuron system. *Annual Reviews in Neuroscience*, 27: 169–192, 2004.

SERP Strategic Education Research Partnership (n.d.). Retrieved March 20, 2008 from the SERP Web site: http://www.serpinstitute.org/content/index.php.

Received 1 April 2008
Revised 20 May 2008
Accepted 2 June 2008
Action editor Sergio Della Sala
Published online 11 June 2008