

Brain research and early childhood education: directions that could lead us astray

Prof Bridie Raban, Melbourne Graduate School of Education, University of Melbourne

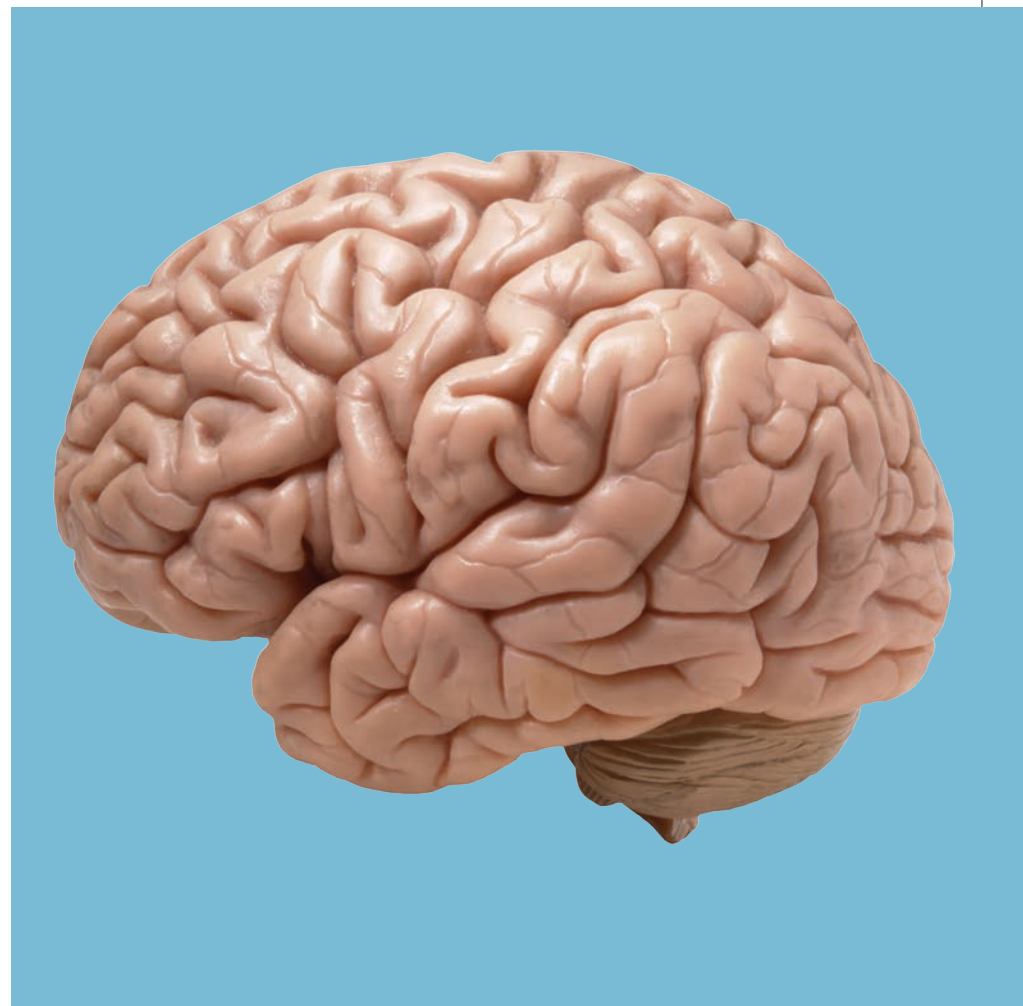
Introduction

During 2011–2012, the Australian Council for Educational Research (ACER) began the development of a National Science of Learning Research Centre. This was to be a collaborative venture between the University of Queensland Brain Institute (QBI) and ACER. The objective of this then-proposed Science of Learning Research Centre was to identify, research and understand effective teaching and learning practices in the light of current knowledge about basic learning processes and factors that influence successful human learning, and to advance research into, and knowledge about, learning itself. The proposal for this Centre, which anticipated receiving substantial federal government funding during the financial year 2012–13, included the work of educational researchers, cognitive psychologists, as well as neuroscientists.

Like many others, I have sat through several presentations that have included phrases like “Brain science says...” or “... as confirmed by neuroscience”. Therefore, this development was of interest for many of us concerned with the learning and development of young children.

US Science of Learning Centres

During the 1990s, Hilary Clinton instituted the *Decade of the Brain*. As a result of this focus, at the turn of the century, the US government invested US\$360 million in 6 Science of Learning Centres. These centres are trans-disciplinary and collaborative and further details of each of them can be found on the National Science Foundation website. The work of the LIFE Centre (Centre for Learning in Informal and Formal Environments) is probably the one that will generate findings most resonant with work in early childhood education, as these research teams are focussing on aspects of lifelong learning



Ineffective teaching strategies and policies have emerged from inappropriate interpretation of complex **neuroscience** research

before and beyond the period of school education.

The inaugural publication of the journal *Mind Brain and Education* in 2007 and a special issue on neuroscience and education of the journal *Cortex* in 2009, report 86 works published which explore links between education and neurosci-

ence. Of these, 23 appear in high-impact, clinical, science and neuroscience journals while 63 appear in journals relating to education, suggesting a strong interest on the part of educators in exploring ways that knowledge in neuroscience can inform educational contexts.

Themes emerging from the education/neuroscience literature

Beauchamp and Beauchamp (2012) advise caution and draw our attention to;

Misapplication: When findings from

Importantly, knowledge from brain research does not lead to any specific or particular outcomes for education at this time. The gap between what neuroscientists know about the brain and what **educational researchers** know about teaching and learning has yet to overlap

.....
fundamental research on the neural basis of learning and cognition are over-simplified, misinterpreted or generalised, then misapplication will prevail. Ineffective teaching strategies and policies have emerged from inappropriate interpretation of complex neuroscience research.

Multiple Disciplines: Educational neuroscience as a field necessitates a combination of knowledge from different disciplines each with their own histories, philosophies, epistemologies, theories and conceptualisations as to what counts as evidence, and this can cause problems and misunderstandings. For instance:

Language: Each discipline will have its own language and ways of communicating.

Knowledge Development: There is a need to develop 'hybrid' professionals who will access multiple knowledges. For instance, Harvard Graduate School of Education has developed a Masters degree in MBE (Mind, Brain and Education).

Value: There is a belief that education and neuroscience can contribute significantly and productively to each other, but how they might connect continues to be explored. For instance:

Collaboration: There is still the need to develop new partnerships that are interactive and recursive relationships between education, cognitive psychology and neuroscience (Bruer, 1997).

Research Design: Investigations need to involve research carried out in educational settings as well as science laboratories, hence ACER/QBI Science of Learning Research Centre development.

The developing trans-disciplinary field of the science of learning integrates, neuroscience, cognitive psychology and complex systems, along with social and educational research and practice to build a deeper understanding of different learning processes. The objectives of the emerging *Science of Learning Research Centre* are to identify, research and understand effective teaching and learning practices in the light of current knowledge and factors that influence successful human learning, and to advance research into, and knowledge about, learning itself. Research in each of these areas, it is proposed, will contribute to a deeper understanding of the learning processes and to a better understanding of ways to support successful learning (Masters, 2012).

The advent of neuro-imaging in its various forms has opened an important new window on brain development. Modern imaging techniques afford the opportunity to examine functional activity and connectivity within the living human brain. Educational neuroscience is emerging as a new field that brings together biology, cognitive and developmental science and education to investigate both genetic and environmental impacts on the brain, for learning and with implications for early childhood practice.

New journals are capturing the excitement of this new trans-disciplinary engagement, for instance, *Mind Brain & Education*, *NeuroImage*, and *Developmental Cognitive Neuroscience* to name a few. To build and sustain a strong scientific foundation for education will require the formation of two new kinds of infrastructure:

- Researchers and educators working together to craft research

questions and methods to shape practice and policy,

- A new kind of researcher/educator who has the intermediary skills required to grow this new field of 'educational neuroscience', one who specialises in connecting practical questions with research findings.

However, it is one thing to point out facts about the brain and another to translate these into how learning takes place. An even greater challenge is to move from any facts that we may agree upon about learning and convert these into facts about our practice.

Through his work as a university biology professor, Zull (2011) realised that students taught solely through lectures gained understanding slowly and at a low level, while students using a discovery approach in the lab seemed to learn quickly at first, but their comprehension didn't grow over time. What he found was that, in contrast to both of these methods on their own, students using a balance of these two approaches increased their understanding steadily and reached levels significantly higher than that of the other two groups, a finding replicated by Fischer & Rose (2001).

What we see here is the delivery of information (focus on the back cortex) with the discovery methods of proposing and testing ideas (focusing on the front cortex) require to be balanced, combining concrete experience with reflection – or what Hattie and Timperley (2007) call 'feedback', or Siraj-Blatchford referred to as 'sustained shared thinking' (2004). Zull (op.cit) argues that the transformation of experience into knowledge is a process, not a single step, and that reflection (through feedback) is a search for connections between experiences and understandings. Is our intentional teaching designed to be transformative in this way? Are our learners passive or active in the generation of their knowledge? Learners need to be challenged to use both front and back cortex – the key here is *balance*.

Add the word "brain" to educational discourse and you will get an interested audience, because we are learning new information in this domain every day. However, data to inform decisions about teaching and learning are highly limited – more popular are a number of opinions, typically referred to as *neuromyths*. The OECD (2002, p.71) explains the genesis of a neuromyth as usually starting with a misunderstanding, a misreading and in some cases a deliberate warping of the scientific established facts to make a relevant case for education or for other purposes. Indeed, using spurious knowledge about the brain to market educational innovations is big business. For instance, there is no evidence for the value of BrainGym™ but education systems have invested thousands of dollars into its implementation.

Importantly, knowledge from brain research does not lead to any specific or particular outcomes for education at this time. The gap between what neuroscientists know about the brain and what educational researchers know about teaching and learning has yet to overlap. Experiments in laboratories are a far cry from busy early childhood settings and in many jurisdictions, fMRI scans would be unethical for healthy children. Hruby and Goswami (2011) suggest caution, indicating that in the technical and interpretive concerns recently reported, correlations in brain-imaging studies, may be seriously over-stated. This should caution educators and educational researchers from taking any particular brain study finding at face-value, particularly when it is disseminated through the popular media, let alone as a

definitive form of evidence for an educational program, method, policy or theory.

As experienced educators know, no one method will work for every child, and nothing works for anyone all the time. It is crucial to be aware that neuroscience will not replace understanding arising out of social science and cognitive development. Rather, neuroscience can complement understandings derived from educational research. Brain plasticity simply means the brain has the capacity to change, not that it increases its underlying capacity and yet this is a common misinterpretation. Howard-Jones (2008) points out that we may now be at the daunting stage of realising that neuroscience has no ready-made prescriptive answers for education.

Neuromyths is a term devised by Alan Crockard (1996), a brain surgeon who became frustrated in the 1980s by how easily some scientific ideas about the brain were embedding themselves into medical culture. He identified a misleading type of 'received wisdom' within medical circles about clinical symptoms and causes. Likewise neuroscientific data to inform decisions about teaching and learning are highly limited. Such neuroscientific work is still in its infancy – and John Bruer (op.cit.) would argue that while the bridge between education and cognitive psychology has a long tradition, the bridge between cognitive psychology and neuroscience is a more recent endeavour and less well developed, and that we are not yet in a position to move from neuroscientific evidence to implications for pedagogy. Bruer (2006) goes on to argue that the brain and early childhood education argument has been based on three well-established results from developmental neurobiology:

- In early childhood there are periods of rapid development called synaptogenesis, followed by synaptic pruning,
- There are sensitive periods in development when normal experience is required for normal development, and
- Rodent studies have shown that rearing these animals in complex environments has demonstrable effects.

These results have been spun into many forms of dogma, frequently found in the early childhood literature, targeted at informing both policy and practice. On closer consideration, however, the findings of developmental neurobiology do not cohere with this popular story, neither do decades of psychological research, which shows that the rate and ease of learning depends more on prior background knowledge rather than on biological maturation and chronological age.

Zull (op.cit.) reminds us that it is one thing to point out facts about the brain and another to translate them directly into learning. An even greater challenge is to translate these facts into implications for teaching. Szucs and Goswami (2007) stress that currently, the investigation of the interactions characteristic of successful learning is outside the scope of neuroscience. There are important distinctions to be made:

- *Neuroscience* – Scientific study of the brain; biologists studying brain anatomy and physiology.
- *Cognitive Psychology* – Scientific study of the mind; behavioural scientists studying patterns of behaviour & mental processes.
- *Education* – the study of the learner and the educator – social scientists investigate and assess behaviours and learning outcomes.

These disciplines speak different languages, they rarely talk to or understand each other, they publish in different journals, hold

Neuromyths is a term devised by Alan Crockard (1996), a brain surgeon who became frustrated in the 1980s by how easily some scientific ideas about the brain were embedding themselves into medical culture

.....

separate conferences and rarely share students or even buildings.

Where we stand now in early childhood education–

- 1 *Brain research is still in its infancy and has so far simply confirmed what decades of cognitive and social science research has already told us:* that young children's experience of the world has a profound impact on early, and continuing, learning and development.
- 2 *Families (parents) play a profound role in their children's development:* A care-giving environment that emphasises warmth, continuity of care, love, and respect gives infants and young children the elements they need for healthy and sound cognitive, social, emotional and physical development – without the need for special toys, extra classes, or other forms of consumerised 'enrichment'.
- 3 *Growth and development do not stop after infancy or toddlerhood or the school age years:* With few exceptions, largely to do with sensory systems, windows of opportunity for learning and development do not slam shut at pre-set intervals. Everything we continue to learn about human growth & development – through both observation & scientific research – confirms earlier understandings that the early years of life are of critical importance for laying the foundation for a lifetime of learning and loving – also that development and learning and loving continue throughout life.

However, the myth of the first three years (Bruer, 1999) weaves together these strands taken from developmental neurobiology in an attempt to provide scientific reassurance for our beliefs about childhood, parenting and early childhood policy.

- 1 Synaptic development takes place anyway. Brain power in later life does not depend on the number of synapses formed before the age of 3. Environmental input neither initiates early synapse formation, nor influences when or at what level synaptic density peaks.
- 2 Most learning is not confined to critical periods, which themselves do not fit neatly into the first 3 years of life. There is a distinction to be made. On the one hand we talk about; **Brain-expectancy;** what the brain expects, it gets – language, visual, tactile and auditory stimuli etc. And on the other hand, **Brain-dependency;** governed by experiences – literacy and numeracy.

The myth of critical periods puts too much emphasis on *when* and not *how*, for instance, a second language should be learned. It also ignores the brain's massive propensity for *plasticity*. Indeed, the Santiago Declaration (2007) signed by Bruer (along with others) states quite clearly that; "*Neuro-scientific research, at this stage in its development, does not offer scientific guidelines for policy, practice, or parenting...Current brain research offers a promissory note, however, for the future.*"

The argument here is not that the first three years are not important for young children's learning and development; they clearly are – but more importantly, all the years of human life are important for learning and development and the significance of brain plasticity should urge us all to find better means of supporting continuous learning and development.

The research, undertaken by the SLRC, aims to identify new teaching practices which will be based on **solid scientific evidence**. These are important ambitions and the findings are eagerly anticipated

However, the urge to redress the balance of government attention towards investing in the learning and development of all members of the population, has spawned an unprecedented focus on brain research, neuroscience and neuro-education, which, it is claimed, points to the significance of the earliest years of life. This pressure has, however, now accomplished its purpose with governments around the world investing in the early years, not only when children reach school age. This is because children and their families have learning and development needs across the lifespan, and if we push the brain science message of the early years too far, why would governments invest money and other limited resources on an aging population?

Conclusion

At this time, there are varying views on the value of and potential for the burgeoning field of study now referred to as Educational Neuroscience, from cautious optimism to misguided enthusiasm. Kurt Fischer, founding President of the International Mind, Brain and Education (MBE) Society and Director of the MBE graduate program at Harvard University Graduate School of Education says: "So much of what is published and said is useless, much of it is wrong, a lot is empty or vapid, and some is not based on neuroscience at all." (Fischer, *et al.*, 2007)

"My basic recommendation is that if a product claims to be proven by brain research, forget it," says neurologist and former classroom teacher Judy Willis (2007). "Nothing from the lab can be proven to work in classrooms."

Professor Robert Sylvester (2006) of the University of Oregon bemoans the term 'Brain-based' learning – as if it were 'kidney-based' learning last year, and now its 'brain-based'. Some companies make fabulous claims and have numerous testimonials, but in many cases the products haven't been tested by anyone who is not selling them – says Patricia Wolfe (2006), founder of *MindMatters*.

However, at this time, Obama offers US\$100 million to map the human brain, 'seeking to revolutionise our understanding of the human mind'. This is further explored on the National Science Foundation website, indicating US\$ 20 million for brain research through advancing innovative neuro-technologies.

The Australian Science of Learning Research Centre (SLRC), incorporating ACER, Queensland Brain Institute and the Melbourne Graduate School of Education, has now received AU\$16 million federal government funding over the next four years. The SLRC is bringing together educational professionals and high quality researchers in areas ranging from neuroscience and cognitive development through to pedagogy and educational technology. The research, undertaken by the SLRC, aims to identify new teaching practices which will be based on solid scientific evidence. These are important ambitions and the findings are eagerly anticipated.

References

Beauchamp, M, Beauchamp, C 2012, Understanding the neuroscience

and education connections: themes emerging from a review of the literature. In S Della Sala & M Anderson (eds.) *Neuroscience in Education: The good, the bad and the ugly*. Oxford University Press, Oxford. pp. 13-30.

Bruer, JT 1997, 'Education and the Brain; A bridge too far', *Educational Researcher*, vol. 26, no. 8, pp. 4–16.

Bruer, JT 1999, *The Myth of the First Three Years*, The Free Press, New York.

Bruer, JT 2006, 'Points of view: On the implications of neuroscience research for science teaching and learning – Are there any? A sceptical theme and variations: The primacy of psychology in the Science of Learning', *Life Sciences Education*, vol. 5, pp. 104–10.

Crockard, A 1996, 'Review: Confessions of a brain surgeon', *New Scientist*, p. 21. [December].

Fischer, KW, Rose, LT 2001, 'Web of skills: How students learn', *Educational Leadership*, vol. 59, no. 3, pp. 6–12.

Fischer, KW, Daniel, DB, Immordino-Yand, MH, Stern, E, Battro, A, Koizumi, H 2007, 'Why mind, brain and education? Why now?', *Mind, Brain and Education*, vol. 1, pp. 1–3.

Hattie, J, Timperley, H 2007, 'The power of feedback', *Review of Educational Research*, vol. 77, no. 1, pp. 81–112.

Howard-Jones, PA 2008, 'Education and Neuroscience – Editorial', *Educational Researcher*, vol. 50, no. 2, pp. 119–22.

Hruby, GG, Goswami, U 2011, 'Neuroscience and reading: A review for reading education researchers', *Reading Research Quarterly*, vol. 46, no. 2, pp. 156–72.

Masters, G 2012 'The Science of Learning Centre', *Research Developments*, vol. 26, Australian Council for Educational Research, Camberwell, pp. 16–17.

OECD 2002, 2007 *Understanding the Brain*. OECD, Paris

Neuromyths. Available at <http://www.oecd.org/edu/neuromyths.html>

Santiago Declaration 2007. Available at <http://www.jsmf/santiagodeclaration/>

Siraj-Blatchford, I 2004 'Quality teaching in the early years', in A. Anning, J. Cullen & M. Fleer (eds.), *Early Childhood Education: Society and Culture*, Sage Publications, London, pp.137–158.

Sylvester, R 2006, 'Cognitive Neuroscience discoveries and educational practices', *School Administrator*, vol. 63, no. 11, pp. 32–37.

Szucs, D, Goswami, U 2007, 'Educational Neuroscience: Defining a new discipline for the study of mental representation', *Educational Neuroscience*, vol. 1, no. 3, pp. 114–27.

Willis, J 2007, "The gully in the 'Brain Glitch' theory", *Educational Leadership*, vol. 64, no. 5, pp. 68–73.

Wolfe, P 2006, 'Brain-compatible learning: Fad or fashion?', *School Administrator*, vol. 63, no. 11, pp. 10–15.

Zull, J 2011 *From Brain to Mind: Using neuroscience to guide change in education*, Stylus Publishing, Sterling, VA.

About the authors

Bridie Rabin came to Australia in 1995 from England where she was Professor of Primary Education (Early Years) at Warwick University. While in Australia she was the inaugural Professor of Early Childhood Studies at the University of Melbourne, a Senior Research Fellow (Early Childhood Education) at the Australian Council for Educational Research and more recently she has been a visiting Professor of Education at the Hong Kong Baptist University.