

# Learning from educational neuroscience

Annie Brookman considers the potential benefits and concerns in an ever-growing field

There appears to be a growing appetite among teachers for brain-based findings to guide their work in the classroom: a 2014 survey by the Wellcome Trust found that 91 per cent of teachers have used their understanding of neuroscience to inform at least one aspect of teaching and learning (Simmonds, 2014). Help is at hand thanks to the emergence of the interdisciplinary field of educational neuroscience. This developing enterprise encompasses all scientific areas of research that can contribute to education, including developmental psychology, cognitive neuroscience, genetics and technology.

Educational neuroscience is a highly collaborative pursuit, not only through the convergence of these traditionally

independent fields: educators themselves engage closely with the research, enabling a more achievable end goal of rigorously scientific, and translatable findings that can enhance learning. Yet despite these laudable aims, there are some notable criticisms of the field. Here I will examine the present state of research, address some key concerns, and argue that educational neuroscience is a worthwhile pursuit with real potential to improve learning.

## Extending and supporting existing theories

Neuroimaging lends itself very well to educational neuroscience and is commonly used, as it allows for insights into how we reason and learn. Let's take an example.

A traditional view of learning holds that when we learn something new about how the world works, we replace our old, inaccurate or simplified knowledge. For example, as a child, you see the sun 'rise' and 'set' everyday, so likely conclude that the sun goes round the earth. At school, you're taught that actually, the earth goes round the sun. According to the traditional view, you replace your old, naive knowledge about the relationship between the sun and the earth in favour of your taught knowledge. More recently, psychologists have theorised that in fact this old knowledge never really goes away, and inhibitory control is employed to suppress it, in order to use the correct knowledge.

While behavioural evidence supported this 'inhibitory control' explanation (e.g. Houdé, 2000), the advent of neuroimaging has allowed neuroscientists to test this theory of learning more directly. Functional magnetic resonance imaging (fMRI) shows that areas of the brain associated with inhibitory control are active when reaching a correct answer (Masson et al., 2014). Further research is ongoing in this area, including studies to test whether training inhibitory control within a subject domain can lead to improved performance in that subject. In this way, neuroimaging can give further credence to our theories of learning, and allow us to design classroom interventions based on firm scientific foundations.

## Debunking existing theories

Educational neuroscience can also bust 'neuromyths', brain-based theories of learning for which there is no evidence (Dekker et al., 2012). Perhaps driven by the fact that neuroscientific results are more persuasive to non-experts than psychological results (Munro & Munro, 2014), neuromyths may appear to provide a quick and easy way to improve learning.

The Wellcome Trust survey of teachers found that the most prevalent neuromyth among teachers was the notion of different learning styles (Simmonds, 2014); for example, the idea that 'visual learners' learn better when information is presented visually. While it may be true that individuals have preferences, there is no evidence that presenting information in a preferred style improves learning (Krätzig & Arbutnott, 2006). A concerning outcome of this neuromyth is that teaching according to this theory may in fact have a negative impact on learning: learners may miss out on information that is better learnt another way, and non-preferred styles may not get the chance to develop. More than three quarters of teachers said they used this method to inform their teaching (Simmonds, 2014), highlighting the



Educational neuroscience can also bust 'neuromyths'

## references

- Asbury, K. & Plomin, R. (2014). *G is for genes*. Chichester: Wiley.
- Bishop, D. (2014, 25 January). What is educational neuroscience? [Blog post]. <http://deevybee.blogspot.co.uk/2014/01/what-is-educational-neuroscience.html>
- Bruer, J.T. (1997). Education and the brain: A bridge too far. *Educational Researcher*, 26(8), 4–16.
- Byrne, S. (2014, February 19). Interdisciplinary research: Why it's seen as a risky route. *The Guardian*. [tinyurl.com/n7lv7u](http://tinyurl.com/n7lv7u)
- Cohen Kadosh, R., Levy, N., O'Shea, J. et al. (2012). The neuroethics of non-invasive brain stimulation. *Current Biology*, 22(4), R108–R111.
- Dekker, S., Lee, N.C., Howard-Jones, P. & Jolles, J. (2012). Neuromyths in education: Prevalence and predictors of misconceptions among teachers. *Frontiers in Psychology*, 3, 1–8.
- Houdé, O. (2000). Inhibition and cognitive development: Object, number, categorization, and reasoning. *Cognitive Development*, 15, 63–73.
- Krapohl, E., Rimfeld, K., Shakeshaft, N. G. et al. (2014). The high heritability of educational achievement reflects many genetically influenced traits, not just intelligence. *Proceedings of the National Academy of Sciences of the United States of America*, 111(42), 15273–15278.
- Krätzig, G.P. & Arbutnott, K.D. (2006). Perceptual learning style and learning proficiency: A test of the hypothesis. *Journal of Educational Psychology*, 98(1), 238–246.
- Lander, E. (2015, May 14). Why basic research is important – Numberphile [Video file]. [www.youtube.com/watch?v=6gnsQjPCC78](http://www.youtube.com/watch?v=6gnsQjPCC78)

necessity of engagement between teachers and researchers. Scientists in the field not only share their new findings, but aim to filter out unfounded neuroscientific claims.

### New insights

The relationship between genetics and education is increasingly studied, with new implications for teaching and learning. The Twins Early Development Study investigated the genetic component of educational attainment at age 16. GCSE results had 62 per cent heritability, and intelligence, along with other psychological factors, accounted for 75 per cent of the heritability of GCSEs (Krapohl et al., 2014).

How is this information useful to teachers? Firstly, simply being aware of it may ease some of the huge pressure to get top grades from all students. Secondly, the policy implications of this high heritability for academic attainment are clear: an equal education does not mean equal opportunities. Education should be individualised as much as possible, in order to fit the requirements of each child. Understanding underlying processes and causal mechanisms, even at the genetic level, does not lead to a fatalistic stance – a criticism sometimes levelled at educational neuroscience. Rather it allows for an increasingly personalised approach in providing the level of educational support that each child needs. Indeed the book *G is for Genes* (Asbury & Plomin, 2013) provides 11 genetics-based policy recommendations for education, many of which emphasise pupil heterogeneity and encourage equality through helping those most in need.

The area of genetics and education is a particularly controversial one, with the potential for misunderstanding and misuse. As we continue to discover more about the influence of genes on learning

and attainment, the need for public-facing expert scientists is amplified. The complexity of genetics and heritability is evidenced by recent debates born from confusion over the difference between heritability and the effect of specific genes (Ritchie, 2015). Here we are faced with two divergent dangers: rejecting all genetic research as fatalistic and unhelpful, or accepting genetic findings fatalistically and forgetting the importance of environmental factors.

Educational neuroscience's aim to engage with all stakeholders is especially important for complex research that requires nuanced explanations of findings and implications.

### Criticisms of the field

As indicated by the Wellcome Trust survey, teachers are keen to use neuroscience. Yet some scientists have argued that the integration of neuroscience into education is not worthwhile. The concerns surrounding educational neuroscience fall roughly into two camps (Varma et al., 2008): scientific concerns regarding methods and theory, and pragmatic concerns that address practicalities and cost-benefit ratios.

Early arguments against educational neuroscience as an endeavour fell into the former category and focused on the disparate nature of education and neuroscience. The amalgamation of the two subjects was famously labelled 'a bridge too far' by Bruer in 1997. The use of neuroscience in an education setting was considered speculative, and not worthy of pursuing. This view was largely based on the assumption that the only relevance of neuroscience to education was in the

## Meet the author

'Following my undergraduate degree in psychology, I worked as a research assistant in both psychology and education. I believe that educational neuroscience is the best of both worlds, as it combines the strengths of psychological methods with the student outcome focus of education research. In my own research I conduct behavioural, neuroimaging, and classroom studies, and am ultimately working towards an intervention study informed by these. I work closely with a secondary school, and my studies are designed with teachers. Taking an interdisciplinary, collaborative approach is surely the best way to produce scientific research that can have an impact on teaching and learning.'



### Annie Brookman

is a PhD candidate in the Centre for Brain and Cognitive Development, Birkbeck, University of London  
abrook07@mail.bbk.ac.uk

fields of synaptogenesis and critical periods, with much of the evidence taken from animal research. Bruer (1997) suggested that the link between the two was only to be found in cognitive psychology – the firm ground in which to anchor education and neuroscience. In reality, educational neuroscience does not attempt to link the minutiae of neural mechanisms directly to the classroom, and does indeed incorporate cognitive psychology. Educational neuroscientists argue that all levels of explanation should be considered holistically and as interacting, from the social level down to the genetic. While Bruer's argument may have held some truth in 1997, it is incompatible with today's research landscape (which considers all levels of description).

More recently, pragmatic criticisms have emerged, relating to the cost-benefit ratio of educational neuroscience research. Most notably, Dorothy Bishop

"Education should be individualised as much as possible, in order to fit the requirements of each child"

Lawrence, N., Chambers, J., Morrison, S. et al. (2016). The Evidence Information Service as a new platform for supporting evidence-based policy: A consultation of UK parliamentarians. *Evidence & Policy* [Advance online publication]. doi:10.1332/174426416X14643531912169

Leibbrand, J.A. & Watson, B.H. (2001). *The road less traveled: How the*

*developmental sciences can prepare educators to improve student achievement*. Washington, DC: National Council for Accreditation of Teacher Education.

Masson, S., Potvin, P., Riopel, M. & Foisy, L.-M.B. (2014). Differences in brain activation between novices and experts in science during a task involving a common misconception in electricity. *Mind, Brain, and Education*,

8(1), 44–55.

Munro, G. & Munro, C. (2014). 'Soft' versus 'hard' psychological science: Biased evaluations of scientific evidence that threatens or supports a strongly held political identity. *Basic and Applied Social Psychology*, 36(6), 533–543

Ritchie, S.J. (2015). Jump the gun and you will be shot down. *The Psychologist*.

<https://thepsychologist.bps.org.uk/jump-gun-and-you-will-be-shot-down>  
Simmonds, A. (2014). *How neuroscience is affecting education: Report of teacher and parent surveys*. tinyurl.com/jot2889

Varma, S., McCandliss, B.D. & Schwartz, D.L. (2008). Scientific and pragmatic challenges for bridging education and neuroscience. *Educational Researcher*, 37(3), 140–152.

wrote in 2014 that a principal concern is that costly neuroimaging aims simply to identify brain areas associated with cognitive abilities, which is not helpful in informing education. Given that MRI costs hundreds of pounds per scan, Bishop argued that the payoff for such work is not great enough.

Most would agree that costly research should only be carried out if there are potential positive outcomes, but highly positive and beneficial outcomes in this field *are* possible. First, discovering neural correlates in their own right through basic science research helps to build the foundations for future applied research. Indeed, academics in other disciplines argue that there is no distinction between basic and applied research, since the entire research endeavour is a social investment (Lander, 2015). Second, as described in the fMRI example above, an understanding of neural mechanisms can help us identify likely candidates for effective training programmes. Third, if an intervention is known to work, an understanding of the underlying neural mechanisms may help us to understand why it works, and to improve it further. Finally, at a recent seminar on cognitive training in children, Klingberg argued that brain scans are close to being able to provide as much explanatory power in terms of an individual child's needs as a psychological assessment. While neuroimaging is costly, the price of sending a child to have a psychological assessment is also high, and neuroimaging may take a fraction of the time. The use of neuroimaging may prove helpful and efficient compared with alternative behavioural assessments.

The criticisms of educational neuroscience have encouraged researchers to crystallise the aims of the field and to carefully consider how their research should progress. Key priorities are to work across disciplines, to collaborate closely with educators, to provide relevant research, and to feed findings back to teachers. This collaborative approach leaves open the possibility for innovation (Varma et al., 2008); an exciting prospect for those working in the field. Sharing insights and methods from traditionally separate disciplines has the potential to move the field forward in unforeseen directions.

### Practical considerations

While the notion of educational neuroscience may be convincing in theory, the reality of teachers incorporating scientific findings into the classroom raises practical considerations.



Teachers may know what the most important research questions are, based on their experiences

A key concern is that teachers with a range of backgrounds may not be equipped with the skills or time necessary to interpret the scientific evidence. Fifteen years ago, policy guidelines recommended that the developmental science of childhood and adolescence should form a fundamental component of teacher training (Leibbrand & Watson, 2001) – a recommendation that has yet to be adopted. Although this would undoubtedly be an excellent start, the time and cost of keeping up to date with findings post-teacher training would be prohibitive for teachers who have notoriously long and increasingly bureaucratic workdays. At the school level, a staff member in a leadership role could act as the nexus between scientists and teaching staff, communicating with scientists and passing relevant information on to colleagues.

“Educational neuroscience is not a one-way conversation”

Taking a wider perspective, research findings would ideally influence policy and filter down to school practice, and policy would encourage these collaborations between schools and researchers. A new initiative called the Evidence Information Service (EIS) aims to facilitate dialogue between scientists and parliamentarians (Lawrence et al., 2016). This will hopefully increase evidence for policy decisions in the near

future, including education policy. Since these are more long-term goals, researchers must work hard now to forge relationships directly with schools.

### No silver bullet

One of the problems that educational neuroscience faces is its status as a multidisciplinary subject. Although interdisciplinarity is increasingly encouraged in academia, often this is not borne out in reward structures. Funding is notoriously difficult to secure for interdisciplinary projects, and submitting such work to the Research Excellence Framework was problematic as it did not fit neatly into one category (Byrne, 2014). Unfortunately, systems in the current academic structure are likely to be a further barrier to high-quality educational neuroscience research.

Moving beyond the scientific and pragmatic concerns, there remain some ethical concerns. Transcranial direct current stimulation has been applied to brain regions involved in learning, providing some promising results for children's maths ability (Cohen Kadosh et al., 2012). However, the long-term effects of this stimulation technique are currently unknown so we must proceed cautiously. Another area of apprehension is the possibility of uncomfortable research findings. Although educational neuroscience does not necessarily lead to a fatalistic approach, the search for



underlying causes raises difficult questions about school grouping according to likely future skill set.

It is indeed concerning to imagine policy taking this approach, but as with the genetic recommendations for education, with greater understanding we can better tailor individual learning plans. More importantly, the debate for what we do with data once we have it is one for society as a whole, not just scientists.

It is clear that teachers have an interest in neuroscience and want to use it to inform their practices. Concerningly, 75 per cent of teachers surveyed by the Wellcome Trust had no outside support when using neuroscience in the classroom (Simmonds, 2014). Researchers, typically funded by the taxpayer, have a duty to engage with teachers, and to provide ongoing support in interpreting findings. This is particularly apparent in light of the ever-increasing requirement for research impact. Findings can be complicated and require detailed explanations with caveats; scientists have a responsibility to disseminate research without hyperbole. As a young enterprise, educational neuroscience cannot yet offer teachers the quick and easy solutions that are often promised by the media or predatory

marketers of new education products. This is possibly the most important thing that teachers can learn from educational neuroscience at the moment: there is no silver bullet, and in order to find the best pedagogical practices we must work collaboratively and wait to see what our findings offer. Good research takes time and requires close investigation of interacting levels of description.

Finally, educators are not the only ones to benefit from this collaboration. Researchers can gain a huge amount in return. Teachers may know what the most important research questions are, based on their experiences in the classroom. They may be able to provide resources that can be used in research, such as exam questions. They will be able to tell researchers how relevant their work really is for education. Good relationships with schools can also enable easy access to research participants, where recruitment is typically hugely time-consuming. Educational neuroscience is not a one-way conversation where scientists impart their knowledge to educators. It is a dialogue and collaboration with the ultimate goal of enhancing learning for all individuals.

## Postgraduate Diploma in Trauma & PTSD

A one-year, in-depth, accredited PG Diploma (Level 7) that enables participants to dramatically increase successful outcomes for PTSD and complex traumas. This highly-rated, evidence-based course has been run by ICS for five years with students achieving outstanding results. Starting 21-22 January 2017.

Course modules include:

- ◆ Definition & Diagnosis of PTSD
- ◆ A Systematic Treatment Framework for Trauma & PTSD
- ◆ Assessment & Formulation of PTSD
- ◆ Safety, Stabilisation & Normalisation of PTSD
- ◆ The Neuroscience, Dissociation and the Psychopharmacology of PTSD
- ◆ An Evidence-based Treatment for Type I PTSD
- ◆ An Evidence-based Imagery Treatment for Type II PTSD
- ◆ Trauma and Comorbidities:
  - a) Mood disorders
  - b) Traumatic nightmares
  - c) Suicide ideation

Jan 2017–Dec 2017 over 11 weekends (none in August)

Trainer: Lucia Hall, MSc, ICS Ltd

## CPD Workshops

- A. Treating Traumatic Nightmares (15 Oct)
- B. Cognitive Processing Therapy (CPT) for Trauma (9-10 Dec)
- C. PTSD: Intro to a Systematic Treatment Approach (21 Jan 2017)
- D. Borderline Personality Disorder & Emotional Instability (25-26 Mar 2017)
- E. Emotional Regulation for Trauma & PTSD (14 May 2017)
- F. Mood Disorders: An Effective and Holistic Biopsychosocial Framework (23-24 Sep 2017)

For the Trauma & PTSD Diploma or CPD Workshops, please contact ICS:

[www.counsellingcentre.net](http://www.counsellingcentre.net)

0118 989 2399

[counselling@gmx.com](mailto:counselling@gmx.com)

Courses held at the ICS offices in Bracknell town centre, Berks (RG12 1AX)

Plenty of parking, near the train station



Integrative Cognitive Solutions Limited