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A Multiperspective Approach to Neuroeducational Research

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Abstract

There is increasing interest in research that combines neuroscientific and educational perspectives on learning, but significant philosophical issues divide these perspectives. This article examines the value of such neuroeducational research and how concepts from different perspectives may be interrelated through a 'level of actions' model. This model, which encourages a multiperspective approach, may be helpful in avoiding some of the worst transgressions of sense-making in constructing concepts that span neuroscience and education. Application of the model is explored in the context of teaching strategies intended to foster creativity, and its affordances and limitations are discussed.

Keywords: neuroscience, neuroeducational research, learning, brain

Neuroeducational[1] Research and the Interrelation of Diverse Perspectives on Learning

To include concepts of brain function in educational thinking appears a common sense notion that has become popular with many educators (Pickering & Howard-Jones, 2007) and is stimulating discussion internationally, as evidenced by the recent OECD Brain and Learning project (OECD, 2007). In the UK, the NeuroEducational research network (NEnet, www.neuroeducational.net) at the University of Bristol has played a key role in recent national efforts to develop collaboration between the fields of neuroscience and education. In 2005–2006, NEnet co-ordinated an interdisciplinary seminar series, funded by the UK research councils, entitled 'Collaborative Frameworks in Neuroscience and Education'. Over 400 teachers, neuroscientists, educational psychologists, researchers and policy-makers met over six events across the country to discuss the issues and opportunities that might be provided by such a venture. The series gave rise to a commentary, whose popularity (downloading 110,000 copies in the first 6 months) demonstrated the rapidly growing and broadly-based educational interest in the brain (Howard-Jones, 2007). The commentary emphasized the need for two-way dialogue and for projects in which neuroscience and education collaborate in terms of both fundamental research and in the communication of its concepts. Such a two-way approach to ventures in neuroscience and education can serve two principle aims. The first aim is to enrich, develop and promulgate educational understanding and practice (Geake, 2004). The second aim, interrelating with the first, is to further scientific understanding of

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behaviours associated with learning, through the study of contexts more closely resembling those found in the 'real world'. This article outlines the philosophy of approach taken by researchers within NEnet in their recent efforts to pursue these aims.

Theories, Methods, Collaborations

While the demand grows for collaborations between neuroscience and education that embrace expertise and concepts from both perspectives, such collaborations are not straightforward. One fundamental issue is the significant philosophical divide between perspectives. Educational research, with its routes in social science, places strong emphasis upon the importance of human development, social context and the interpretation of meaning. Neuroscience, on the other hand, is more concerned with controlled experimental testing of hypotheses and the identification of cause-effect mechanisms that can be generally applied. Concepts and language also differ widely, even with respect to the meaning of fundamental terms such as 'learning'. In cognitive neuroscience, learning is often synonymous with general memory abilities at the level of the individual. These include declarative memory, such as our ability to explicitly recall facts, but also non-declarative forms of memory such as the acquisition of skills and habits, conditioned emotional responses and even habituation to a repeated stimulus (Squire, 2004). Educators, on the other hand, more often describe learning in terms of social construction, through authentic exploration, engaging activities, interactive group work and student ownership of the learning process, emphasizing the importance of context. Additionally, educators may consider learning as closely bound to issues of meaning, the will to learn, values and the distributed nature of these and other aspects of learning beyond the level of the individual (TLRP, 2006; 2007).

These differences represent a major challenge for researchers at the interface between neuroscience and education and there may be no single solution to bridging them. Instead, one may expect some diversity in the approaches taken by emerging centres of research activity. Discussion within NEnet, which has been heavily influenced by the ESRC-TLRP seminar series, has given rise to a 'levels of action' model to help examine the potentially complex interrelationship between the different learning philosophies that meet in this emerging new field (Howard-Jones, 2008b; 2010, pp. 79–97). This model also suggests how the different methodologies associated with educational research and neuroscience can be usefully interrelated in neuroeducational research. The model builds on the brain->mind->behaviour model of cognitive neuroscience(Morton & Frith, 1995) and extends it to place greater emphasis on social processes. In Figure 1, the representation of two individuals interacting helps remind us of the complexity that can arise when processes more often studied at an individual level operate within a social environment.

The two individuals in Figure 1 may be two learners or, perhaps, a teacher and learner. In this diagram, the space between the individuals is filled by a sea of symbols representing human communication in all its forms. The lines separating brain, mind, behaviour and this sea of symbols are shown as dotted, to emphasise the somewhat indistinct nature of the boundaries between them and the difficulty in considering these as separable concepts. This levels-of-action model helps maintain awareness of the useful-

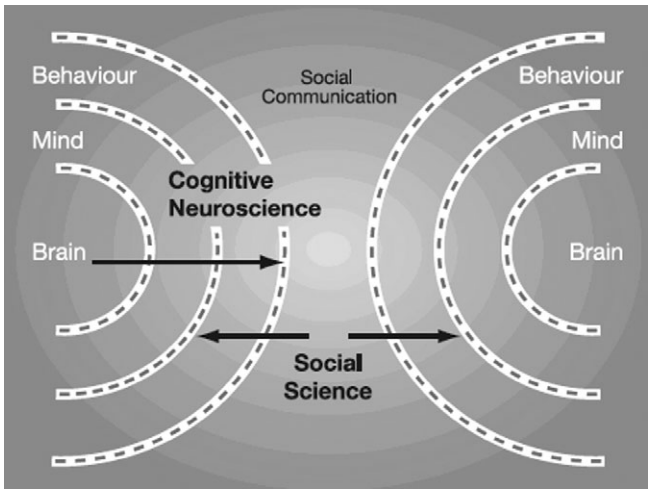

Figure 1: To interrelate the most valuable insights from cognitive neuroscience and the social science perspectives of education (represented by arrows), the brain->mind->behaviour model may need to be socially extended. Even two individuals interacting, as represented here, is suggestive of the complexity that can arise when behaviour becomes socially mediated. Such complexity remains chiefly the realm of social scientists, who often interpret the meaning of such communication in order to understand the underlying behaviour. Cognitive neuroscience has established its importance in understanding behaviour at an individual level but is only just beginning to contemplate the types of complex social domains studied by educational researchers

ness and limitations of different perspectives on learning. For example, work within NEnet has included an fMRI study of creativity fostering strategies (Howard-Jones *et al.*, 2005). This imaging study, which included a focus on the biological correlates of creativity, was useful in revealing how those parts of the brain associated with creative effort in a story telling task were further activated when unrelated stimulus words had to be included. Results provided some helpful indication, at the biological level of action, of the likely effectiveness of such strategies in the longer term. For example, had no such increased activity been observed, this might suggest that such strategies, although known to bring about outcomes that are judged as more creative, may do so without additional rehearsal of the processes regarded as creative. However, that cannot be the end of the story for educators. Taken in isolation, the study provides a poor impression of the issues involved in effectively implementing these strategies in the classroom. When and how should they be used? To understand these issues, real world contexts must be meaningfully interpreted. However, the meanings ascribed to actions of students and teachers in the classroom, including their use of language, are multiple, ambivalent and transitory. Although the production and perception of language have been fruitful areas for laboratory-based scientific research, the interpretation of meaning within everyday contexts is essentially a problematic area for experimental scientific paradigms. Interpretations of meaning that cannot be judged by the methods of natural science may be considered beyond its jurisdiction (Medawar, 1985). The recent flourishing of journals focusing on social cognitive neuroscience may demonstrate accelerating progress in this area, but interpretation of social complexity remains chiefly the realm of social scientists. Rather than natural science then, it is social science, with its own concepts of reliability

and validity, that appears most accomplished in interpreting meaning at the social level of action, in order to understand the fuller significance of human communication (Alexander, 2006). Such considerations, in the context of our research on creativity, prompted an action research project in which an interdisciplinary team and a group of trainee teachers co-constructed concepts about the fostering of creativity that were both scientifically valid and educationally relevant. This subsequent study highlighted the importance of teachers' broader awareness of cognition and brain function in implementing such strategies (Howard-Jones *et al.*, 2008). Here, experiential accounts and meaning-based interpretations of discourse were useful in understanding the factors influencing pupils' creative progress, and how these might relate to concepts of brain and mind. Our qualitative work drew on educators' personal and classroom experience, together with findings from the fMRI study and further research from cognitive psychology and neuroscience that made these findings scientifically meaningful. It provided useful insights about pedagogical practice and how decisions to apply particular strategies should take into account the learner(s), their progress and the specific educational context (Howard-Jones, 2008a).

It would appear that neither natural nor social science, in isolation, presently offer sufficient epistemological traction to travel across all the levels of description shown in Figure 1. In this diagram, two of the most frequently travelled pathways of investigation associated with different perspectives are depicted by arrows. Cognitive neuroscience is shown to extend from brain to behaviour but little further, reflecting its present difficulties in penetrating complex, meaning-based social interaction. However the role of cognitive neuroscience is essential, as in our fMRI study of creativity, for supporting careful consideration of individual brain-mind relationships with biological and psychological evidence, and improving understanding of teaching and learning strategies at these levels of action. When it comes to a fuller understanding of how such interventions are applied in specific contexts, issues at the social level of action, such as individual differences in teachers' interactions with children, require exploration from social science perspectives more familiar to educational researchers. It is an interesting exercise to imagine how pathways associated with other perspectives might be depicted on this diagram. For example, phenomenological perspectives, that emphasise the role of mental reflection in understanding our own and others' behaviour, might be shown as an arrow from mind to the sea of symbols. (However, note how this diagram gives greater weight to 'outsider' perspectives and this can limit its helpfulness in representing perspectives that draw on experiential evidence and illuminate important issues of human agency- see below.)

Challenges, Results and Implications

Philosophy investigates the 'bounds of sense: that is, the limits of what can coherently be thought and said' (Bennett & Hacker, 2003, p. 399). Those who attempt to work at the interface of neuroscience and education will find themselves straddling at least two, very different, philosophies about learning, each expounding a very different set of concepts. Here, researchers are faced with the challenge of using language and developing new concepts that reside clearly within the bounds of sense as interpreted by both of these

communities. Examples of common 'sense' transgressions in this new area are prevalent (Geake, 2008), but many appear linked to two extreme constructions of the mind-brain relationship.

In the extreme dualist camp, some educational issues are in danger of becoming entirely 'medicalised'. When educational issues become associated with biological issues, they can sometimes be characterised as entirely biologically determined and so removed from educators' domain of influence. One example is management of the increasing numbers of pupils considered to have challenging developmental disorders such as ADHD. Here, the increasing use of psychoactive drugs and images of differences in brain activity can lead to an increased sense of biological determinism (Degrandpre, 1999), and thus a diminished sense that outcomes are amenable to educational intervention. Another example might be the tendency for debates around dyslexia to be unhelpfully characterised as two options in conflict, a type of 'all-or-none' theorising that either dyslexia is a mental construction or derives entirely from a biologically determined cause (Nicolson, 2005). In the extreme monist camp, of course, such debates are meaningless, since mind and brain are conflated, and psychological and biological concepts are not distinguished. This monist departure from 'sense' is often found in popular language (e.g. 'my brain is confused') or in 'brain-based' educational programmes where synaptic connections become confused with psychological ones (see Wolfe, 1998) discussed by (Davis, 2004; Howard-Jones, 2008b).

At the root of such misunderstanding is the fact that interrelating mind and brain is not straightforward. Indeed, a whole field of scientific research has been founded on efforts to achieve such understanding. In the field of cognitive neuroscience, researchers believe that mind and brain must be explained together (Blakemore & Frith, 2000). The notion of mind is regarded as a theoretical but essential concept in exploring the emerging relationship between our brain and our behaviour, including our learning. Seen in this way, the study of cognition appears as a vital bridge in linking our knowledge of the brain to observations of behaviours, including those that involve learning. For this reason, it has been pointed out that without sufficient attendance to suitable cognitive psychological models, neuroscience will have little to offer education (Bruer, 1997).

The levels-of-action model incorporates the brain-mind-behaviour of cognitive neuroscience and thus helps avoid the dangers of dualist and monist notions. However, it remains flawed in another important sense. Educators are encouraged to develop autonomous learners, personally motivated and able to learn in response to their own free will. Indeed, effective teaching and learning is considered by many to depend upon the promotion of learners' independence and autonomy (e.g. see TLRP, 2007, p. 9). Some researchers within neuroscience, on the other hand, are presently unsure how, and even whether, free will comes into existence. Studies of apparent mental causation suggest that unperceived causes of action fail to influence our experience of will, suggesting that conscious will is an illusion: just the mind's way of estimating its own *apparent* authorship by drawing causal inferences about relationships between thoughts and actions (Wegner, 2003). This can be considered as another type of biological privilege likely to cause conflict for those working at the interface between neuroscience and education (Giesinger, 2006). However, such debates are not confined to education, since denying the existence of free will brings neuroscience into conflict with the entire

legal system (Burns & Bechara, 2007). These arguments are bound up with those about consciousness and are unlikely to be resolved in the near future (Tancredi, 2007), allowing educators and other professionals to continue sharing, to a greater or lesser extent, a firmly held assumption that free will is a major causal factor in much behaviour.

At present, and perhaps reflecting again its close relationship to consciousness, it is not easy to represent human agency in Figure 1. However, given the growing emphasis on learning autonomy in education, researchers working at the interface between neuroscience and education must remain mindful that learning is best represented as a dynamic scenario in which change can include transformation of learners' (and teachers') own biological processes, perceptions and interpretations of meaning. The role of free will and reflexive self-determination may be powerful and essential contributions to learning that require careful consideration at all the levels represented here (biological, cognitive, behavioural and social). Returning to the particular example of our trainee drama teachers trying to foster creativity, we found it useful to carry out experiential arts-based workshops with professional actors prior to beginning the action research cycle, to gain insights related to free-will and ethical issues regarding control, through reflection with the artistic team (Howard-Jones & Border Crossings, 2005). This also generated video footage that supported subsequent discussion of these and other concepts with the trainee teachers.

Work within NEnet has successfully produced both scientific knowledge and practical educational understanding that can be implemented in the classroom. However, it has also drawn attention to a number of serious challenges for workers at the interface of neuroscience and education. Here, researchers must traverse the boundaries of diverse traditions of knowledge making and establish coherent interdisciplinary dialogue, maintaining 'sense' as it is commonly determined and understood by these very different traditions.

The emergence of a field of enquiry at the interface between neuroscience and education is generating a new dialogue around some very fundamental issues. It has not been possible to explore these issues in full within this short article. Instead, it is hoped that some sense of the challenge for workers in this area has been outlined. In addition, the article has attempted to convey the need for these challenges to be met with a creative, positive, critical and educationally grounded re-examination of how the diverse perspectives on learning offered by the natural and social sciences may be usefully interrelated.

Note

1. Our network prefers the term 'neuroeducational' rather than educational neuroscience, as we believe this better reflects a field with education at its core, uniquely characterised by its own methods and techniques, and which constructs knowledge based on experiential, social and biological evidence.

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