Education, Neuroscience and the Mereological Fallacy

1 Introduction

There has been a surge of interest in recent years within education in particular towards the potential of neuroscience for educational insights. It is an intuitive and seemingly promising collaboration given the supposed connections between the two disciplines, in particular with respect to concepts and phenomena such as learning, thinking, understanding, emotions and intelligence. But the question is: ‘Are the two disciplines conceptually compatible?’

This question may seem to be more than a little unusual, given the promising work of the collaboration to date, which has led to the creation of a new sub-discipline, namely, neuroeducation. More generally speaking, the brain-based learning movement has been exploring the primitive links between neuroscience and education (as well as other disciplines) for a number of years now. All the indications are promising.

This paper, however, seeks to examine more closely the compatibility of the two disciplines, with the hope of elucidating whether the brain, which neuroscience is naturally focused on examining, can be intelligibly considered as the agent of the psychological phenomena in question. Indeed, the primitive connections between neuroscience and education are predicated on one simple view: that an examination of the brain and its workings will shed new light on previously unattainable information about concepts such as learning, thinking and understanding. Underpinning this view, it has become commonplace to hear of the brain as the ‘learning organ’. This author questions the assertion that it is the brain which learns, thinks or understands anything – in keeping with Ludwig Wittgenstein and Bennett and Hacker (2003) – and seeks to recalibrate the discussion surrounding the notion of the ‘learning, thinking brain’.
2 Preliminary Definitions

2.1 What is Neuroscience?

It is particularly difficult in such a short paper to capture a satisfactory definition of a discipline as diverse as neuroscience. Nevertheless, a broad – admittedly vague – definition must be established for the bounds of this work. The author, however, wants to be entirely clear at this point, that no intentional disservice is intended to be committed against neuroscience with this preliminary definition.

Bennett and Hacker (2003, p. 2) suggest that ‘cognitive neuroscience operates across the boundary between two fields, neurophysiology and psychology’. More specifically, cognitive neuroscience will be examined in this paper, in particular to examine the role which it can (or cannot) play with reference to education. In one of the first major works of the cognitive neuroscience movement – Cognitive Neuroscience: The Biology of the Mind – one of the fathers of the movement, Michael Gazzaniga (along with two other cognitive neuroscientists, Richard Ivry and George Mangun) outline in the preface of the text that ‘Cognitive neuroscience is taking the scientific community by storm’ (Gazzaniga, Ivry and Mangun, 1998, p. xiii), and offer the following insight as to what cognitive neuroscience offers to the brain sciences in general:

Scientists now realize that studying the mind’s complex processes – perception, language, attention, memory, control of movement, feelings, and consciousness itself – has become a task that is not only scientifically tractable, but is approachable by cognitive and neural means. The disciplines of cognitive psychology, behavioural neurology, and neuroscience now feed off each other, contributing a new view to the understanding of the mechanisms of the mind. This development has led to the emergence of the field of cognitive neuroscience.

(p. xiii)

Notice first, the inter-changeability between the concept of ‘mind’ (an entity of no material substance) and ‘brain’ (a material, tangible object) borders on absurd. This view is steeped in mind-brain identity theory which, it has to be said, divides opinion from within neuroscientific circles. Nevertheless, Gazzaniga and his co-authors feel sufficiently satisfied – evident from the title of their book – to view cognitive neuroscience as the ‘biology of the mind’. This problem will not be examined in any detail in
this work. Second, these authors seem to have attributed a range of abilities to the mind, such as ‘perception, language, attention, memory, control of movement, feelings, and consciousness itself’ and outline that an examination of the brain and its neurophysiology will lead to a more detailed understanding of how the mind’s processes work. For the moment, let it be clear that Gazzaniga et al. (1998) have given significant reason to question the credentials of neuroscience as credible science. Indeed, any science which is predicated on the belief that an examination of the neurophysiology of the brain will lead to a fuller understanding of the ‘mind’s processes’ is due an extensive examination, particularly if these underpinnings are philosophically weak. Gazzaniga et al. (1998) set out to show that ‘the brain enables the mind’ (p. xiii). This was what these authors saw, at their time of writing, to be the aim of cognitive neuroscience. Much of that aim remains intact to this day.

Purves et al. (2013) offer the following more up-to-date definition of cognitive neuroscience:

Cognitive neuroscience is a relatively new discipline that has arisen from the recent marriage of neuroscience, a biomedical field that has flourished both conceptually and technically during the past century, and cognitive science, a field of study rooted in the long-standing interest of natural philosophers and psychologists in understanding human mental processes. Consistent with these progenitors, research on cognitive neuroscience integrates investigations of brain structure and function, and seeks to measure cognitive abilities and behavior to understand how the human brain works at all levels.

(Purves et al., 2013, p. 1)

At first glance, it appears that most of the difficulties with the definition Gazzaniga et al. (1998) offered have been sufficiently well mastered in this more up-to-date text. Indeed, even on the concept of the mind, the authors note that the ‘mind is a notoriously difficult term to define’ (Purves et al., 2013, p. 2). These authors continue:

Cognitive neuroscience is defined by the work at the intersection of cognitive science and neuroscience. Thus, cognitive neuroscientists must have grounding in both these domains. They must be able to think about the cognitive processes that shape our behavior and the contents of our mental lives, and understand cognitive psychology and related fields. But they must also be able to relate those processes and theories to underlying brain function, which requires proficiency in the key findings and the tools of neuroscience. Cognitive neuroscience thus
combines all the difficulties of measuring brain function with all the problems of trying to accurately assess cognition and behaviour, as well as the complexities of trying to link them together.

(p. 9)

Taking these two definitions together – Gazzaniga et al. (1998) and Purves et al. (2013) – it should be eminently clear that the intersection between cognitive processes and neurophysiological processes is the interest of the cognitive neuroscientist. In light of this definition, it also becomes clearer what the appeal of cognitive neuroscience might be for education: namely, to find a foothold in a deeper and more scientific understanding of the underlying precepts of the cognitive processes of interest to education, such as learning, thinking and understanding. This author asks: can cognitive neuroscience deliver on these promises in an educational context? This question will be examined throughout this paper. Indeed, as Bennett and Hacker (2003) observe, ‘The logical or conceptual relations between the physiological and the psychological are problematic’ (p. 2). This is the motivation for the critique of neuroscience in this work, particularly in relation to education.

Geake and Cooper (2003), suggest the following definition of cognitive neuroscience, set in the context of what should be of interest education:

Cognitive neuroscience is a wide field embracing a rich variety of experimental paradigms and approaches, from the bimolecular to the behavioural. … Areas of experimental interest include vision, spatial cognition, audition and music, emotions, memory, motor function, language, and consciousness, most (if not all) of which can inform our understanding of cognitive behaviours relevant to education, for example, intelligence, learning, memory, motivation, literacy, creativity.

(pp. 8-9)

The appeal of neuroscience for education, therefore, appears to be that it purports to be capable of providing answers to some of education’s most vexing questions surrounding learning, memory and intelligence. It is this apparent appeal for education, in truth, as opposed to a firm definition of neuroscience, which is the aspect of neuroscience which requires examination in this work.
To be entirely fair also, it is important to note that there are many neuroscientists and neurobiologists who are, indeed, careful with what they posit about the brain. However, it is the remit of this work to demonstrate that there remain too many cases where the neuroscientific doctrine is founded on conceptual errors. Moreover, being founded on an ignorance of simple philosophical precepts leads to rather glaring and troubling consequences about what is posited to be neuroscientifically possible. In relation to education, this work aims to show that the remit of neuroscience should be more carefully considered, and fundamentally restricted. Predicating educational reform on neuroscientific conceptual errors, surely, ought to be prevented.

2.2 WHAT IS BRAIN-BASED LEARNING?
Brain-based learning is a collection of learning ‘theories’ which purport to explain learning through developing a fuller understanding of the role the brain plays in learning. It is a study which calls on evidence from educationalists, cognitive psychologists and neuroscientists to support its claims. According to Gulpinar (2005), Brain-Based learning theory encompasses twelve main principles, listed as follows:

1. All learning engages the entire physiology;
2. The brain/mind is social;
3. The search for meaning is innate;
4. The search for meaning occurs through patterning;
5. Emotions are critical to patterning;
6. The brain/mind processes parts and whole simultaneously;
7. Learning involves both attention and peripheral perception;
8. Learning is both conscious and unconscious;
9. There are at least two approaches to memory (rote learning system, spatial/contextual/dynamic memory system);
10. Learning is developmental;
11. Complex learning is enhanced by challenge and inhibited by threat associated with helplessness and fatigue;
12. Each brain is uniquely organized.

(Gulpinar, 2005, pp.302-303)

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This definition provides a standard understanding of brain-based learning models; although alternative brain-based learning theories might differ slightly from others. Nevertheless, the attraction for appealing to brain-based learning models is apparent: there is a systematic attempt within brain-based learning theories to explain how learning occurs, and how best to teach on the basis of this explanation; claims which are substantiated in evidence from mind/brain philosophy, Gestalt psychology, cognitive psychology and neuroscience.

Jensen (2008), suggests that keeping pace with the fast-moving nature of neuroscience and brain research in general is one of the challenges facing modern-day educationalists (p. xii). Rather worryingly, the same author suggests that modern-day education is founded on a new knowledge of the brain and its workings, which previous generations of educationalists weren’t so fortunate to have. This, he suggests, is why embracing the brain-based learning movement is so important:

Based on research from the disciplines of neuroscience, biology, and psychology, our understanding of the relationship between learning and the brain now encompasses the role of emotions, patterns, meaningfulness, environments, body rhythms, attitudes, stress, trauma, assessment, music, movement, gender, and enrichment. By integrating what we now know about the brain with standard educational practices, Brain-Based Learning suggests that schools can be transformed into complete learning organizations.

(Jensen, 2008, p. xii)

Perhaps these claims would be more credible if Jensen (2008) didn’t go on to claim that ‘we are all great natural learners’ (p. xiii). Isn’t it also deeply troubling that Jensen (2008) continues to set brain-based learning up as the savior to education:

When students are provided with a learning environment that is optimal for learning, graduation rates increase, learning difficulties and discipline problems decrease, a love for learning flourishes, administrators focus on the real issues, and learning organizations thrive. In short, creating an organization around the way the brain naturally learns best may be the simplest and most critical educational reform ever initiated. In fact, of all the reforms, nothing provides a better return on your investment of time, energy, and money than developing a brain-based approach to learning.

(p. xiii, this author’s bold-type)
If brain-based learning is adopted, attainment improves, problems disappear, and a ‘love’ for learning flourishes. The ‘learning organization’ is the aim, and the student will thrive in this environment which is founded on an appreciation of how the ‘brain learns’. Money is saved, and our investment is safe. These are bold claims. Where is the evidence for them? It does not exist. Are these claims underpinned by coherent and credible science? This paper will show that they are not. There are neuroscientists, to their credit (Goswami (2006), Tallis (2010), Howard-Jones (2010), Rose (2013)), who seek to dispel so-called ‘neuromyths’ from finding their way into education and other disciplines, but too many ill-considered and philosophically weak arguments still remain.

In the above exert, this author has emphasized one point of particular interest: namely, the line ‘brain naturally learns’. This emphasis will become clearer throughout the paper. For the moment, however, let it be clear that it is common practice for the brain-based learning movement to posit that that brain is the learning organ, and that learning environments, organizations and curricula should be shaped around this learning brain. Indeed, as Jensen (2008) notes, with reference to the brain, ‘the vast complexity of our ‘thinking organ’ has left scholars short of an efficient explanation of how it works’ (p. 2). So it is clear that the leaders in the field of brain-based learning take the brain to be the learning, thinking, understanding organ; the hub of cognitive and psychological phenomena. This claim seems intuitive, but the consequences of such seemingly innocent reasoning will be shown later to be profoundly problematic.

For the time being, however, let it be clear what brain-based learning has as its core aim. To quote Jensen (2008) one last time: ‘Brain-based education considers how the brain learns best. The brain does not learn on demand by a school’s rigid, inflexible schedule. It has its own rhythms.’ (p. 4). This tenet of brain-based learning will be shown to be the work of science-fiction rather than science-fact. For too long now, neuroscience has provided a cover of credibility to brain-based learning, giving the impression that the concept of the learning, thinking brain is a modern-day magnificent scientific achievement. A quick search on the Amazon.co.uk website (which hardly constitutes research, but it does give a feel for how increasingly popular this field of brain-based learning is) will return over 1100 books on brain-based learning. These ideas have permeated the mainstream thinking within education.
They are rife within educational discourse throughout the world. And they are all predicated on the belief that the best way to educate children is to consider how their ‘brains learn best’.

2.3 The Royal Society, Brain Waves Project (2011): Prominent Neuroscientists Add Weight to the Debate

One of the most prominent supporters of the neuroscience-education collaboration was the endorsement put forward by the Royal Society in 2011, when the term ‘neuroeducation’ became commonplace as a sub-discipline in its own right. The project entitled, ‘Brain Waves Module 2: Neuroscience: implications for education and lifelong learning’, commissioned by the Royal Society urges that an increased level of neuroscientific training is necessary for beginning and current teachers, due to the relevance neuroscience has for education and its usefulness for attaining insights into how children learn.

Despite the efforts of The Royal Society to dispense with so-called ‘neuromyths’ and to warn that caution is required within the neuroscience-education collaboration, their report makes four major recommendations for education and teacher training:

1. Neuroscience should be used as a tool in educational policy;
2. Training and Continued Professional Development (CPD) should include a neuroscientific element in relation to relevant education issues, particularly for Special Educational Needs (SEN);
3. Neuroscience should inform adaptive learning technology;
4. Knowledge exchange should be increased.

Let it be clear in the process of critiquing these recommendations that this author does not seek to undermine the elements of The Royal Society’s report which have addressed many of the intricate problems which have plagued neuroscientific discourse for many years. Indeed, other publications – such as Geake (2005), TLRP (2007), and Howard-Jones (2010) – set about making clear where neuroscience has gone wrong in the past, making clear that the neuromyths which have hindered neuroscience should be discarded in order for the discipline to be taken seriously. This, however, is where this author parts with The Royal Society (2011), and other such publications. Indeed, it is
lamentable and puzzling in equal measure, why such efforts would be expended to recalibrate the boundaries of sense within neuroscience, only to make bold and unfounded assertions about its applicability to other disciplines such as education. If neuroscience is at a time of cautious optimism, (Geake, 2005, p.10; Goswami 2006; Royal Society 2011, p. v), then its adoption to education should be suspended. Indeed, given that the authors of The Royal Society (2011) report acknowledge that neuroscience presents ‘opportunities as well as challenges for education’ (p. v, this author’s emphasis) and that the discipline of neuroscience is still relatively infantile in nature, insomuch that the authors ‘urge caution in the rush to apply so-called brain-based methods, many of which do not yet have a sound basis in science’ (p. v), it seems strange that this document ends with a recommendation that neuroscience should be used to inform educational policy, and that teachers should be trained in neuroscientific principles. As Rose observes, ‘the claims of mainstream neuroeducation … have been oversold’ (TES, 2013). This overhyped, self-attributed remit needs to be recalibrated, and the bounds of what is neuroscientifically possible within education need to be reset. The fact that The Royal Society (2011) have endorsed this project demonstrates the widespread belief within prominent research communities that the collaboration between neuroscience and education is one which is likely to work.

Bruer argued that any attempt to concatenate ideas from neuroscience and education was to be considered as a ‘bridge too far,’ going on to claim that, although the brain and discoveries about the brain should ‘fascinate us,’ we should however remain cautious (perhaps even pessimistic) about how useful neuroscience can be to educational practice:

… we should be wary of claims that neuroscience has much to tell us about education, particularly in those claims derived from the neuroscience and education argument. The neuroscience and education argument attempts to link learning, particularly in early childhood learning, with what neuroscience has discovered about neural development and synaptic change. Neuroscience has discovered a great deal about neurons and synapses, but not nearly enough to guide educational practice. Currently, the span between brain and learning cannot support much of a load. Too many people marching in step across it could be dangerous.

(Bruer, 1997, p.15)
Before going on to examine in more detail the credentials of the collaboration between neuroscience and education, let it be clear that this author is acutely aware of the historical context surrounding neuroscience as a discipline. It is often contested that neuroscience is a ‘fast-changing’ discipline, to the extent that what might have held two or three years ago, may not be apt in the present moment. This work, however, contains no such temporal concerns. The criticisms leveled in what will follow are conceptual concerns, rather than empirical ones. Consequently, these conceptual concerns cannot be resolved by empirical evidence; they transcend the advancements in neuroscience however fast-changing the discipline might be. The author, therefore, has chosen a range of contributing references from different points in the neuroscientific timeline to demonstrate that these conceptual concerns have the tendency to resurface despite advancements in neuroscientific methods and techniques. What Bruer said in 1997, therefore, is equally apt today. Indeed, as this author has already cited, Rose (cited in TES 2013) has voiced similar concerns about the overhyped nature of the neuroeducation and brain-based educational models. More importantly, the conceptual concerns which are highlighted in this author’s adoption of Bennett and Hacker (2003), are not resolved with neuroscientific advancements over time; they are resolved only with a more careful approach to how we speak about the brain, and by giving more careful consideration to the distinction between neurophysiological and psychological phenomena.

3 THE MEREOLOGICAL FALLACY IN NEUROSCIENCE

Neuroscientists and neurophilosophers often attribute a range of activities to the brain which would normally be attributed to the entire human being. Brains ‘process information,’ ‘create meaning,’ ‘perceive patterns,’ ‘make connections’ and ‘search for patterns.’ Now where is the scientific evidence for these claims? There are no laboratory demonstrations of brains creating meaning or perceiving patterns. These are activities carried out by human beings, not by their brains. No one would dispute that without a functioning brain an individual couldn’t process information or search for patterns, but it doesn’t follow that the individual’s brain is doing the information processing or the searching. This is the fundamental undertone of the mereological fallacy: to ascribe an attribute to the brain, which should have been ascribed – and indeed can only be ascribed – to the whole human being.
Bennett, Dennett, Hacker, and Searle (2007, pp. 154-155) cite examples of neuroscientists who mistakenly attribute properties to the brain which are correctly attributed to the person:

**J Z Young:** ‘We can regard all seeing as a continual search for the answers to questions posed by the brain. The signals from the retina constitute ‘messages’ conveying these answers. The brain then uses this information to construct a suitable hypothesis of what is there.’

(Source: Programs of the Brain, p. 119)

**F Crick:** ‘When the callosum is cut, the left hemisphere sees only the right half of the visual field … both hemispheres can hear what is being said … one half of the brain appears to be almost totally ignorant of what the other half saw.’

(Source: The Astonishing Hypothesis, p. 170)

**S Zeki:** ‘The brain’s capacity to acquire knowledge, to abstract and to construct ideals.’


Bennett and Hacker (2003, pp.68-70) also cite other examples of prominent neuroscientists making claims of the brain being capable of performing what would sensibly be understood as human activities. Some of the authors cited in Bennett and Hacker (2003) include: Crick, Edelman, Blakemore, Damasio, Libet, Frisby, Gregory, Marr, and Johnston-Laird. The author directs the reader to these pages for a fuller understanding of the long list of examples of the mereological fallacy in neuroscientific discourse. For the moment, however, it should be eminently clear that there are simply too many cases of prominent neuroscientists falling prey to the mereological fallacy in what they posit about the brain. Once so many leading proponents of the science appear to be making the same philosophical errors, it becomes entirely more difficult for the science to attain any significant credibility.

The problem is also rife within educational discourse. Indeed, in Northern Ireland The Council for the Curriculum, Examinations and Assessment (CCEA) have adopted neuroscientific principles as part of the underpinning rationale for curriculum reform. CCEA’s chief executive in 2003, Gavin Boyd, claims, ‘it seems foolish to wait until we are absolutely certain about everything, before we start to convey to
our young people some of the basics about how the brain works and how this impacts on their learning’ (Boyd, cited in Thompson and Maguire, 2001, p. 2). The ‘basics’ which Mr. Boyd was citing included the claim that ‘thought is filtered through the emotional part of the brain first’ (CCEA, 2003b, p. 22). Moreover, CCEA cite evidence from neuroeducationalist Robert Sylwester, who claims that a ‘junglelike’ brain is more likely to thrive in a ‘junglelike’ classroom, supported by a ‘junglelike’ curriculum (Sylwester, 1995, pp. 23-24).

The salient point is, however, that these claims all offend against the so-called ‘mereological fallacy.’ It is well understood what it is for a human being to: ‘pose questions,’ ‘use information,’ ‘see,’ ‘hear,’ ‘be ignorant of’ and ‘develop knowledge,’ but it is doubtful if the day will come when it can be demonstrated in the laboratory that a brain can do any of these things. Moreover, what precisely is meant by claims that the brain is ‘junglelike’ is far from clear, and not fitting of an form of scientific rigour.

To mistakenly attribute properties to the brain which are, in fact, properties of the human being is to fall prey to the mereological fallacy. As Bennett and Hacker claim:

> Psychological predicates are predicates that apply essentially to the whole living animal, not to its parts. It is not the eye (let alone the brain) that sees, but we see with our eyes (and we do not see with our brains, although without a brain functioning normally in respect of the visual system, we would not see). So, too, it is not the ear that hears, but the animal whose ear it is. The organs of an animal are part of the animal, and psychological predicates are ascribable to the whole animal, not its constituent parts. Mereology is the logic of part/whole relations.

(Bennett and Hacker, 2003, pp. 72-73)

By talking of the brain as ‘learning,’ ‘thinking,’ ‘believing’ or ‘understanding’ the neuroscientist is mistakenly reducing psychological predicates (ascribable only to the entire human being) to brain states (ascribable to the brain). Those who offer seminars and in-service training in ‘brain-based learning’ often refer to brains ‘thinking,’ ‘knowing,’ ‘believing,’ ‘deciding,’ ‘seeing an image of a cube,’ ‘reasoning,’ ‘learning’ and so on. Bennett and Hacker, however, contest:

> We know what it is for human beings to experience things, to see things, to know or believe things, to make decisions … But do we know what it is for a brain to see … for a brain to have
experiences, to know or believe something? Do we have any conception of what it would be like for a brain to make a decision? … These are all attributes of human beings. Is it a new discovery that brains also engage in such human activities?

(Bennett and Hacker, 2003, p. 70)

3.1 RESEMBLING A HUMAN BEING

According to Wittgenstein (Philosophical Investigations, §281): ‘Only of a human being and what resembles (behaves like) a living human being can one say: it has sensations; it sees, is blind; hears, is deaf; is conscious or unconscious.’ If, as many leading neuroscientists claim, the human brain can process information, make connections, search for patterns, ‘This would be astonishing, and we should want to hear more. We should want to know what the evidence for this remarkable discovery was’ (Bennett and Hacker, 2003, p. 71). In the absence of such astonishing evidence, we ought to discard such talk as science-fiction rather than science-fact.

3.2 INCOHERENT, NOT FALSE

It is important to appreciate the depth of the error committed here. When the neuroscientific claim that brains process information is called into question, this doesn’t render valid the assertion that brains, in fact, do not process information.

It is our contention that this application of psychological predicates to the brain makes no sense. It is not that as a matter of fact brains do not think, hypothesise and decide, see and hear, ask and answer questions; rather, it makes no sense to ascribe such predicates or their negations to the brain. The brain neither sees, nor is it blind – just as sticks and stones are not awake, but they are not asleep either.

(Bennett and Hacker, 2003, p. 72)

Advocates of brain-based learning see the brain as the either the subject or the locus of learning; the brain is the learning organ or it is where learning (and other such predicates e.g. thinking and understanding) occurs. Wittgenstein, while accepting that without a properly functioning brain one couldn’t learn, nevertheless teaches that learning is done by the whole person, and not the brain. When a teacher asks a pupil what she has learnt, the pupil expresses her thoughts in language. Were it not for
the pupil’s language skills, the teacher couldn’t ascribe learning to her. Since brains aren’t language-
using entities, how can it make sense to ascribe learning to a brain?

3.3 Neural Imaging: what it shows
But neuroscientists may protest that the brain’s ability to make connections while it (the brain) is 
thinking is visible from PET or fMRI images of the brain which are a staple of media portrayals of 
neuroscience. Bennett and Hacker reject this notion:

But this does not show that the brain is thinking, reflecting or ruminating; it shows that such-
and-such parts of a person’s cortex are active when the person is thinking, reflecting or 
ruminating. (What one sees on the scan is not the brain thinking – there is no such thing as a 
brain thinking – nor the person thinking – one can see that whenever one looks at someone sunk 
in thought, but not looking at a PET scan – but the computer-generated image of the excitement 
of cells in his brain that occurs when he is thinking.)

(Bennett and Hacker, 2003, pp. 83-84)

It suffices to say therefore that all that can be learnt from the most sophisticated neural imaging 
techniques such as PET and fMRI is that there is activity in certain areas of the brain which can be 
probabilistically correlated to certain behaviours whilst the living human being does them. And to 
emphasize once more, such correlations do not show that the brain learns, thinks or hypothesizes, as 
opposed to showing the activity in the brain whilst the human being whose brain it is, does these things. 
Any attempt to draw any further information from a neural scan results in confusion.

Glock (1996, p. 177) observes that Wittgenstein’s philosophical psychology, particularly his later 
 writings, does not permit the transgression from the ‘mentalist’ (mind/body dualism) view to the 
materialist (brain-body dualism) view. Despite the fact that the materialist view seems more plausible 
than the mentalist view – by virtue of the fact that it induces a physical entity (the brain) in place of 
some ethereal realm (the mind) – Wittgenstein, nevertheless dedicated some of his later writings to 
dispensing with anything more ‘up-to-date’. The hope that the neuroscientific method (neural-imaging) 
can reduce the uncertainty which has plagued the ‘hidden inner’ realm is pre-emptively halted before it 
can gather any pace. As Glock (1996) concludes:
… it seems plausible that mental phenomena are inner causes of outward behaviour, and must hence be identical with neurophysiological phenomena, that is, brain-processes or -states. However, even if one grants this causal conception of the mind, it does not follow that psychological statements describe neurophysiological phenomena. If Wittgenstein is right, first-person present tense psychological utterances are by-and-large not descriptions of anything, let alone the brain. Less controversially, what little I know about my brain is based on fallible evidence, but that I have certain sensations, intentions, beliefs, etc., is neither subject to error, ignorance or doubt, nor based on evidence or observation of any kind.

(p. 177)

There is clearly a category difference between the psychological and the neurophysiological, evident in the fact that – as Glock (1996) observes – the language used to talk about both realms is not interchangeable. Consider for example the following string of statements, used by Glock (1996, p. 178):

A1: I am in pain

A2: my C-fibres are firing

B: I can doubt whether my C-fibres are firing

Notice that the use of A2 in statement B leads to no apparent confusion. I can indeed doubt that my C-fibres are firing, since such an event is based on fallible evidence, which I may or may not be convinced by, or have knowledge of. However, Statement A1 cannot be readily substituted into statement B in place of A2, since it would then read:

B*: I can doubt that I am in pain,

which is clearly nonsense. What might it mean to doubt that one has such-and-such a pain? Even in cases of severe hypochondria, the person who claims to be in pain exhibits no doubt about their pain, regardless of its lack of substance. Their actions demonstrate a lack of doubt. The problem of ‘substitutability’ gives rise to a difference of categories between psychological states (such as pain, learning, thinking, etc.) and brain states. Whatever is shown on the brain scan or neural image, therefore, cannot be logically connected to a psychological state.
To be clear, this does not amount to a denial that a properly functioning brain is a ‘precondition for the possession of mental capacities’ (Glock, 1996, p. 178). Moreover, the lack of logical connection between psychological states and brain states does not preclude that there exists a correlation between some mental phenomena and neurophysiological states. However, Wittgenstein’s philosophy gives rise to the notion that there is, as a matter of fact, ‘a universal parallelism between the mental and the physical’ (ibid). Glock (1996) cites a series of propositions from Wittgenstein’s *Zettel* which seem to capture this feeling, namely §608-9 and §611:

> No supposition seems to me more natural than that there is no process in the brain correlated with associating or with thinking; so that it would be impossible to read off thought-processes from brain-processes. I mean this: if I talk or write there is, I assume, a system of impulses going out from my brain and correlated with my spoken or written thoughts. But why should such a *system* continue further in the direction of the centre? Why should this order not proceed, so to speak, out of chaos?

(*Zettel*, §608)

Wittgenstein, therefore concludes that our yearning for a causal picture between the psychological and the physiological should be abandoned:

> It is thus perfectly possible that certain psychological phenomena *cannot* be investigated physiologically, because physiologically nothing corresponds to them.

(*Zettel*, §609)

> The prejudice in favour of physiological parallelism is a fruit of primitive interpretations of our concepts. For if one allows a causality between psychological phenomena which is not mediated physiologically, one thinks one is professing a belief in a gaseous mental entity.

(*Zettel*, §611)

As a result of these realizations, the conclusion is that ‘even where neurophysiological phenomena are, as a matter of empirical fact, correlated with mental phenomena, they are neither necessary nor sufficient for the latter’ (Glock, 1996, p. 178). That is to say, even if brain-state A has, in the past, correlated to psychological state A*, this in no way suggests that being in brain-state A always means being in psychological state A*. One is in psychological state A* only when one is in that state. For example, the brain-state for being in pain does not mean that one is in pain. Rather, one is ‘in pain’
when one is in a state of pain, not in a state of ‘brain-state pain’. Conversely, it is logically possible to be in a psychological state B, even if the neural image does not correlate. So, for example, one could be thinking that things are thus-and-so, even if the neural scan suggests a contradictory brain-state. It is therefore logically impossible to establish necessary or sufficient brain-states for psychological states; and this logical impossibility results from the categorial distinction between psychological phenomena and neurophysiological phenomena. The conclusion is, therefore that ‘there is no conceptual connection between neurophysiological mechanisms and mental phenomena’ (Glock, 1996, p. 179). Moreover, ‘Neurophysiological concepts play no role in our explanation and application of mental terms: third-person uses of mental terms are based on behavioural criteria, first-person uses are not based on any criteria, let alone neurophysiological ones’ (ibid). This contrast between the first- and the third-persons will be examined later in the paper.

3.4 CLOSING THE METAPHORICAL LOOP
It is vital that the reader understand that falling prey to the mereological fallacy is more than a difficulty with nomenclature. For example, when CCEA claim that ‘thought is filtered through the emotional part of the brain first’ (CCEA, 2003b, p. 22) they are using the word ‘thought’ in the way it is usually used in everyday psychological vocabulary. They are making the case that the learning that takes place in traditional curriculum models - where pupils struggle to relate emotionally to dull domain-specific knowledge - is somehow mere ‘surface’ learning because the emotional brain occludes the pupil’s thought in its passage to the cognitive brain. If the curriculum was designed around projects which are emotionally engaging to pupils, however, learning would be ‘deep’ because thought would flow unobstructed to the cognitive part of the brain.

The defence that this is all just a matter of semantics, that reference to the brain thinking is little more than a façon de parler, is not open to neuroscience. To make their case, CCEA must be claiming that thoughts are in the brain or ascribable to the brain and that a thought follows a physical trajectory through a physical emotional section of the brain to a physical cognitive section of the brain.

Other authors such as Crick, Damasio, Marr, Blakemore, Edelman, Sylwester, and many others cited previously in this paper have similarly violated the notion that they are using these terms in a way which
the reader should interpret as metaphorical or as a deficiency in language. These terms are appealed to literally in how they are used and interpreted; so much is clear in the way in which research is predicated on their usage, and the context in which the terms are used².

Metaphorical extension of ordinary language is an avenue which is not open to the claims that have been highlighted in this paper. The brain, it seems, is where thoughts occur and it is the brain which thinks, learns, or understands. This is the neuroscientific undertone, and it has become a feature of education in the adoption of neuroscientific doctrine into the scientific description of educational phenomena. These claims are mereological to the core, and it is this conceptual blunder which refuses to yield, thus making neuroscience and education conceptually incompatible.

3.5 **MEREOLOGICAL IMPLICATIONS FOR BRAIN-BASED LEARNING AND NEUROEDUCATION: THE CONCLUSION**

In essence, any belief that understanding the brain more clearly would lead to better educational opportunities has been shown to be fraught with inherent conceptual difficulties. That is, if the notion that the brain is the learning, thinking understanding organ has been shown to be incoherent, the subsequent notion of predicing educational reform on such an idea is destined only to lead to greater problems. The problems of neuroscience would, essentially become the problems of education (or neuroeducation). The mereological fallacy of neuroscience is the mereological fallacy for brain-based learning and for neuroeducation. This author contests that such frivolity with education and its practices must be brought to a halt. Neuroscience is not the right conceptual model upon which to base radical educational reform; unfortunately for Northern Ireland, this realisation has come too late.

4 **CONCLUSION**

This paper has sought to examine the philosophical and conceptual compatibility of neuroscience and education, which is a pertinent examination given the recent surge in interest in the potential for the collaboration between the two disciplines.

² For a more detailed discussion on the non-metaphorical nature of these claims, see Bennett and Hacker (2003), pp. 75-78 and pp. 385-388
Having broadly defined neuroscience and brain-based learning, the author outlined the considerations of a recent collaborative neuroeducational project commissioned by The Royal Society, in which various bold assertions were made about what neuroscience can offer to education. Given the strength of these assertions, and also given the gravitas of the organization who put those forward, this author then set about demonstrating that the underpinning premises of the collaboration were questionable.

The essence of the critique of this paper has been what has become known – thanks to Bennett and Hacker (2003) – as ‘The mereological fallacy’. The grounds of the conceptual blunder are, in short, the unintelligible and incoherent ascription of psychological attributes to the brain, which can only meaningfully ascribed to the entire human being. This author has shown over the course of this paper that neuroscientific discourse is rife with falling prey to the mereological fallacy. More importantly, the collaboration between neuroscience and education is predicated on one simple, intuitive, yet erroneous view: that the brain is the learning, thinking, intelligent organ. It has been shown to be commonplace within the collaboration to posit that it is the brain which learns, thinks, poses questions, and reflects. These claims are all examples of the mereological fallacy.

The retort of metaphorical extension of ordinary language has also been shown to be closed off to the neuroscientist and the neuroeducationalist alike. The terms are used in their ordinary use and are extended to the brain in their *ordinary form*, not in an analogical, metaphorical or metonymical manner. The concepts of ‘learning,’ ‘thinking’ and ‘understanding’ have thus been definitively changed to mean processes which can be shown on a neural scan. And thus, the brain becomes the learning, thinking organ.

The neuroscientist might also contest that that is not at all what they mean when they say that ‘the brain learns’. However, if this is not what neuroscience attempts to show, then one wonders what the value of neuroscience is at all, and in particular to education. That is, of what value might it be to say that blood flows through such-and-such an area of the brain when a child learns, or that there is some activity in the frontal lobe when the child carries out some action?
The realization is that, because of the mereological fallacy, and what neuroscientists and neuroeducationalists must do in order to avoid the conceptual blunders they have so-far made, the value of the neuroscientific programme for educational purposes is fundamentally restricted. Indeed, whatever is shown through neuroscience and its techniques and methods, however sophisticated they become, it is not learning, thinking, nor any other psychological/educational attribute for that matter. It is not the brain that does these things; it is the entire human being. Any programme which is founded on a view that one can describe or explain the activities of the human being by looking at his brain, is conceptually mistaken. And if the retort is that this is not what neuroscience is seeking to do, then its value to education is minimal at best.

Either way, the neuroscience-education collaboration is not as intuitive as it first appears; the disciplines seem not to be as compatible as it might seem, and this author concludes that, realistically speaking, the collaboration is restricted to the point that the scientific elucidation of educational phenomena is unlikely to arrive via neuroscience.
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